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Corrective Measures Implementation Plan for Consolidated Unit 16-021(c)-99

Los Alamos
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EXECUTIVE SUMMARY

This corrective measure implementation plan presents the designs and plans for remediating high explosives and other contaminants present in a former outfall drainage channel and in the alluvial systems of Cañon de Valle and Martin Spring Canyon. These actions, which were identified by the corrective measures study (CMS) in 2003 and approved by the New Mexico Environment Department in 2006, consist of removing the outfall concrete trough and excavation of soils in three locations within the 260 Outfall channel, grouting of a contaminated surge bed in tuff under a former channel settling pond, maintaining the existing cap on the former settling pond, installing a carbon filter to remove contaminants in Burning Ground Spring, modifying the existing Martin Spring carbon filter, and installing a pilot permeable reactive barrier in Cañon de Valle for the remediation of barium and high explosives in groundwater. In addition, alluvial sediment samples will be collected from a location in Cañon de Valle to investigate possible silver contamination that may represent an ecological risk.

Target cleanup levels for these actions were established in the CMS. Target levels for 260 Outfall channel soils are risk-based and are driven by the potential hazards to on-site workers. For groundwater, the barium target level is the New Mexico Water Quality Control Commission standard for barium of 1000 µg/L; for research department explosive (RDX or hexahydro-1,3,5-trinitro-1,3,5-triazine), the target level is the groundwater concentration associated with a 10^{-5} carcinogenic risk level of 6.1 µg/L. For spring water, the target level is the RDX groundwater level.

The concrete trough for the former 260 Outfall will be demolished and removed; the underlying soils will be sampled and analyzed; and soils above screening levels will be removed. For the outfall channel soil remediation, soil will be excavated in three areas that exceed soil cleanup levels. Less than 50 yd^3 of soil may be removed from these locations. An upper surge bed under the former settling pond within the outfall channel that is contaminated with high explosives will be grouted to prevent groundwater infiltrating this horizon. Because of the natural variability of surge beds, the area for grouting is uncertain; however, boreholes installed in this area in March 2007 indicated that the surge bed does not extend beyond the limits of the former settling pond, an area of approximately 1250 ft^2.

Alluvial sediments from an area adjacent to the Sanitary Wastewater Systems Consolidation (SWSC) sewer pipeline right of way in Cañon de Valle will be sampled to investigate further an area of potential silver contamination of soil that may represent an ecological risk. The results of the investigation will be submitted to the New Mexico Environment Department and the need for remediation determined.

A subgrade carbon filter will be installed to remove RDX from spring water from Burning Ground Spring. The existing carbon filter system at Martin Spring will be modified by adding a second spring water collection box to collect water from a new seep. At SWSC Spring, which has been dry since 2002, a carbon filter will be installed if the spring flows again.

A pilot permeable reactive barrier will be installed in Cañon de Valle to remove RDX and barium from groundwater. The barrier will be installed near existing alluvial monitoring well 16-02658 and will consist of a set of diversion walls to divert groundwater into a reactive cell. The reactive cell will consist of two chambers for the reactive media. The final choice of these media awaits the results of laboratory column tests currently underway; however, preliminary results indicate that zero-valent iron and zeolite will be used. In the event that changeouts of the reactive media are required, the media can be accessed through the lid on the top of the cell. The permeable reactive barrier is a pilot project; operational data will be collected to determine the effectiveness of such barriers for the remediation of the alluvial system.

Specifications, drawings, and plans for construction quality-control and waste management were developed covering all excavation and construction activities. Implementation of these corrective measures is planned for calendar year 2008.

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1.0 INTRODUCTION

This corrective measures implementation plan (CMI) details the designs and plans for implementation of remediation actions for cleanup of high explosives (HE) and other contaminants in the former Technical Area 16 (TA-16) 260 Outfall channel and alluvial groundwater, spring water, and alluvial sediments of Cañon de Valle and Martin Spring Canyon at Los Alamos National Laboratory (LANL or the Laboratory).

The Laboratory is a multidisciplinary research facility owned by the U.S. Department of Energy (DOE) and managed by Los Alamos National Security, LLC. The Laboratory is located in north-central New Mexico, approximately 60 mi northeast of Albuquerque and 20 mi northwest of Santa Fe. The Laboratory site covers approximately 40 mi^2 of the Pajarito Plateau, which consists of a series of fingerlike mesas separated by deep canyons that contain ephemeral and intermittent streams running from west to east. Mesa tops range in elevation from approximately 6200 to 7800 ft. The eastern portion of the plateau stands 300 to 900 ft above the Rio Grande.

Under a national effort by the DOE to investigate and remediate sites formerly involved in weapons research and development, the Laboratory's Environmental Programs Directorate (EP) is responsible for investigating sites potentially contaminated by past Laboratory operations. The goal is to ensure that these sites do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico.

Investigation and remediation actions at the Laboratory are subject to the Compliance Order on Consent (hereafter, the Consent Order), signed on March 1, 2005. The Consent Order was issued pursuant to the New Mexico Hazardous Waste Act, New Mexico Statutes Annotated (NMSA) 1978, §74-4-10, and the New Mexico Solid Waste Act, NMSA 1978, §74-9-36(D). Information on radioactive materials and radionuclides, including the results of sampling and analysis of radioactive constituents, is voluntarily provided to the New Mexico Environment Department (NMED) in accordance with DOE policy.

1.1 General Site Information

Technical Area 16 is located in the southwestern corner of the Laboratory (Figure 1.1-1). It covers 2410 acres or 3.8 mi^2. The land was acquired by the Department of the Army for the Manhattan Project in 1943. TA-16 is bordered by Bandelier National Monument along State Highway 4 to the south and by the Santa Fe National Forest along State Highway 501 to the west. To the north and east, it is bordered by TA-08, -09, -11, -14, -15, -37, and -49. TA-16 is fenced and posted along State Highway 4. Water Canyon, a 200-ft-deep ravine with steep walls, separates State Highway 4 from active sites at TA-16 (Figure 1.1-2). Cañon de Valle forms the northern border of TA-16. Security fences surround the production facilities. A complete discussion of the TA-16 environmental setting is presented in the TA-16 Phase III Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) report (LANL 2003, 077965, section 6.0).

TA-16 was established to develop explosive formulations, cast and machine explosive charges, and assemble and test explosive components for the nuclear weapons program. Almost all the work has been conducted in support of developing, testing, and producing explosive charges for atomic weapons. Present-day use of this site is essentially unchanged, although the facilities have been upgraded and expanded as explosives and manufacturing technologies have advanced.

The administrative boundary for the study area is shown in Figure 1.1-2. The boundary runs along State Highway 501 to the west, follows a drainage divide (between Cañon de Valle and Water Canyon) across the TA-16 mesa to the south, and follows Cañon de Valle to its confluence with Water Canyon to the north and east. This area is referred to as the Cañon de Valle basin. The administrative boundary is intended to incorporate contaminant sources and fate and transport mechanisms within part of the Cañon de Valle drainage. The 260 Outfall is believed to be the major source of contaminants in the basin. Monitoring and data analysis performed at the basin scale will support decisions about remedial activities at other potential contaminant source locations as well. Other potential contaminant sources within this area are being addressed by other EP activities such as the Water Canyon/Cañon de Valle watershed investigations.

1.2 Corrective Measure Implementation Plan Overview

The remediation systems detailed in this plan were identified in the corrective measures study (CMS) report (LANL 2003, 085531) and were approved by NMED in 2006 (NMED 2006, 095631). The required remediation activities consist of (1) installing a pilot permeable reactive barrier (PRB) for treatment of HE and barium; (2) removing residual soil exceeding risk-based media cleanup standards (MCSs) in the 260 Outfall drainage channel and removing the concrete outfall trough; (3) maintaining an existing low-permeability cap on the former settling pond within the 260 Outfall drainage channel; (4) grouting a contaminated surge bed within tuff beneath a former settling pond along the drainage channel; (5) installing a carbon filter for the treatment of spring water at Burning Ground Spring in Cañon de Valle and modifying the existing carbon filter at Martin Spring in Martin Spring Canyon; and (6) sampling soil for silver in the Sanitation Wastewater Systems Consolidation (SWSC) cut of Cañon de Valle. Installing a carbon filter at SWSC Spring was proposed as part of the CMS, but this spring has been dry since 2001.

The following sections provide additional background information on these sites and present the plans and designs for implementation and operation of the approved remedial measures.

2.0 BACKGROUND

2.1 Site Description and Operational History

Building 260, located on the north side of TA-16 (Figure 2.1-1), has been used for processing and machining HE since 1951. Water is used to machine HE, which is slightly water-soluble, so wastewater from machining operations contains dissolved HE and may contain entrained HE cuttings. At building 260, wastewater treatment consists of routing the water to 13 settling sumps to recover any entrained HE cuttings. From 1951 to 1996, the water from these sumps was discharged to the 260 Outfall that drained into Cañon de Valle. In 1994, outfall discharge volumes were measured at several million gallons per year. The discharge volumes were probably higher during the 1950s when HE production output from building 260 was substantially greater than it was in the 1990s (LANL 1994, 076858). In the past, barium had been a constituent of certain HE formulations, and so barium was also present in the outfall wastewater from building 260.

During the late 1970s, the 260 Outfall was permitted by the U.S. Environmental Protection Agency (EPA) to operate as EPA Outfall No. 05A056 under the Laboratory’s National Pollutant Discharge Elimination System (NPDES) permit (EPA 1990, 012454). The last NPDES permitting effort for the 260 Outfall occurred in 1994. The NPDES-permitted 260 Outfall was deactivated in November 1996; EPA officially removed it from the Laboratory’s NPDES permit in January 1998. This waste stream is currently managed by pumping the sumps and treating the water at the TA-16 HE wastewater treatment plant.

As a result of the discharge, soils in the 260 Outfall drainage channel are contaminated, primarily with HE and barium. The sumps and drainlines of this facility are designated as Solid Waste Management Unit (SWMU) 16-003(k), and the 260 Outfall and drainage are designated as SWMU 16-021(c), according to

Module VIII of the Laboratory's Hazardous Waste Facility Permit (EPA 1990, 001585). Because of the Laboratory's consolidation of SWMUs, the two SWMUs are now collectively referred to as Consolidated Unit 16-021(c)-99.

The CMI addresses contaminants associated with Consolidated Unit 16-021(c)-99 present in shallow soils, springs, and shallow groundwater at several locations at TA-16. These contaminants include barium, research department explosive (RDX or hexahydro-1,3,5-trinitro-1,3,5-triazine), 2,4,6-trinitrotoluene (TNT), and high-melting explosive (HMX or 1,3,5,7-tetranitro-1,3,5,7-tetrazocine).

SWMU 16-021(c) consists of three portions: an upper drainage channel fed directly by the 260 Outfall, a former settling pond, and a lower drainage channel leading to Cañon de Valle. The former settling pond, which was removed during a 2000–2001 interim measure (IM) cleanup (LANL 2002, 073706), was approximately 50 ft long, 20 ft wide, and located within the upper drainage channel, approximately 45 ft below the 260 Outfall. The drainage channel runs approximately 600 ft northeast from the 260 Outfall to the bottom of Cañon de Valle. A 15-ft near-vertical cliff is located approximately 400 ft from the 260 Outfall and marks the break between the upper and lower drainage channels.

The IM cleanup removed more than 1300 yd^3 of contaminated soil from the settling pond and channel. Approximately 90% of the HE in the Consolidated Unit 16-021(c)-99 source area was removed (LANL 2002, 073706).

Other SWMUs located in the vicinity of the 260 Outfall are shown in Figure 2.1-2. Several of these SWMUs are described as follows.

- *Material Disposal Area (MDA) R (SWMU 16-019*). MDA R is located northwest of the 260 Outfall area (Figure 2.1-2). This MDA was constructed in the mid-1940s and was used as a burning ground and disposal area for waste explosives and other debris. Potential contaminants at this MDA include HE, HE byproducts, and metals (particularly barium). Use of the site was discontinued in the early 1950s. Soil removal and related site investigations were conducted at MDA R after the Cerro Grande fire (LANL 2001, 069971).
- *Burning Ground SWMUs [16-010(b), 16-010(c), 16-010(d), 16-010(e), 16-010(f), 16-010(j), and 16-028(a)] and Consolidated Units [16-010(h)-99 and 16-016(c)-99].* These sites are located on a level portion of the mesa in the northeast corner of TA-16. The burning ground was constructed in 1951 for HE waste treatment and disposal. Over the years, hundreds of thousands of pounds of HE and HE-contaminated waste material were destroyed by burning. After burning, the remaining noncombustible material was either placed in MDA P, north of the burning ground (through 1984), or taken to TA-54 for storage and treatment before it was disposed of off-site (1984 to present). Site investigations were conducted at several of these SWMUs during 1995 and later (LANL 2003, 076876). Information was also obtained from investigations conducted between 1997 and 2002 at Flash Pad 387 and the Consolidated Unit 16-016(c)-99. Flash Pad 387 underwent clean closure, and the sites representing Consolidated Unit 16-016(c)-99 underwent a voluntary corrective action (VCA) (LANL 2003, 085530) concurrently with the MDA P clean closure (LANL 2003, 076876). NMED approved these SWMUs for no further action (NMED 2006, 093249). Other closures include the HE Burn Tray 394 [SWMU 16-010(j)] (NMED 2002, 095630) and Filter Vessels 401 [SWMU 16-010(e)] and 406 [SWMU 16-010(f)] (NMED 2005, 092226).
- *MDA P (SWMU 16-018)*. This MDA contained wastes from the synthesis, processing, and testing of HE; residues from the burning of HE-contaminated equipment; and construction debris. Disposal of HE waste at this site started in the early 1950s and ceased in 1984. The site is located on the south slope of Cañon de Valle. Under RCRA, MDA P underwent clean closure in

which approximately 55,000 yd^3 of soil and debris were removed (LANL 2003, 076876). NMED approved the MDA P closure certification report in 2005 (NMED 2005, 093247).

- *The 90s Line Pond portion of Consolidated Unit 16-008(a)-99.* The 90s Line Pond is an inactive, unlined, settling pond located a few hundred feet west of building 260. The pond may have received HE, barium, uranium, and other inorganic and organic chemicals from machining operations discharges from TA-16, -89, -90, and -91. As recently as 2002, HE solids were observed at the pond area. Further investigation into this area is continuing in 2007 in accordance with the Consent Order.

2.2 Current and Future Land Use

Current and future land use at TA-16 is designated as HE research, development, and testing, according to the Laboratory's comprehensive site plan of 2000 and the 2001 update (LANL 2000, 076100; LANL 2001, 070210). Most areas within TA-16 are active sites for the former Engineering Science and Application Division of the Laboratory, and construction of new buildings and other facilities in the area is possible. As shown in Figure 2.1-1, numerous roads and utilities are present at the site in the vicinity of SWMU 16-021(c).

2.3 Historical Investigations

Five investigations into Consolidated Unit 16-021(c)-99 have been conducted, including a postremediation investigation of the outfall drainage channel conducted after the removal of drainage channel soils during IM activities. These investigations are summarized below chronologically.

A RCRA facility assessment (RFA) (LANL 1990, 007512) summarized soil and water sampling results dating from the 1970s for the outfall area.

The Phase I RFI site characterization (April 1995–November 1995) and Phase I RFI report (LANL 1996, 055077) concentrated on the drainage channel and its intersection with Cañon de Valle, including alluvial sediment, surface water, and groundwater. NMED approved the report in 1998 (NMED 1998, 093664).

The Phase II RFI site characterization (November 1996–November 1997) and the Phase II RFI report (LANL 1998, 059891) further delineated contamination in tuff surge beds beneath the drainage channel and in Cañon de Valle sediment and waters. The Phase II RFI included the sampling of surface and near-surface material within the drainage and the sampling of 13 boreholes (BHs) drilled to depths between 17 and 115 ft in and near the drainage. The Phase II RFI also included extensive field screening for RDX and TNT using immunoassay methods, as well as sampling for other chemicals. A risk characterization was also performed. NMED approved the report in September 1999 (NMED 1999, 093666).

An IM remedial excavation was conducted in the outfall drainage channel and settling basin in 2000 and 2001. More than 1300 yd^3 of contaminated material containing approximately 8500 kg of HE was removed from these areas. The investigation results are presented in the IM report (LANL 2002, 073706).

The Phase III RFI site characterization (October 1998–March 2002) and Phase III RFI report (LANL 2003, 077965) included analyses of water and sediment data collected since the Phase II RFI report (post-1998), a study of spring dynamics, a geomorphic alluvial sediment study, geophysical studies, and baseline risk assessments for the outfall source area and for selected reaches of Cañon de Valle and Martin Spring Canyon. In addition, a baseline ecological risk assessment was performed for Cañon de Valle. NMED approved the Phase III RFI report in June 2004 (NMED 2004, 093248).

A more detailed chronology of Laboratory activities at Consolidated Unit 16-021-(c)-99 is presented in Table 2.3-1.

Results of Historical Investigations

The results from previous investigations contributed to the development of the conceptual site model (CSM), which presents a unified description of the local hydrogeological and contaminant transport systems. Important features of the model, roughly corresponding to depth, are the outfall source area, the canyon alluvial system, the intermediate zone (also called the mesa vadose zone), and regional aquifer. These components of the CSM are shown in Figure 2.3-1. The results of previous investigations are summarized by area as follows.

2.3.1.1 Outfall Source Area

The RFA documented data collected for the 260 Outfall [SWMU 16-021(c)] since the early 1970s showed substantially elevated HE contamination in the sediment, outfall, and sump water. Levels up to 27 wt% (270,000 mg/kg) of HMX and RDX had been documented in the area of the former settling pond. The data showed HE contamination extending from the discharge point to Cañon de Valle (Baytos 1971, 005913; Baytos 1976, 005920). The historical data have also been summarized in the Phase I and II RFI reports for SWMUs 16-003(k) and 16-021(c) (LANL 1996, 055077; LANL 1998, 059891).

Phase I and Phase II results showed elevated concentrations of HE and barium within the outfall drainage from the surface down to the soil/tuff interface. Phase I and II surface sampling showed that surface contamination did not extend laterally beyond the reasonably well-defined drainage. Barium, HMX, RDX, and TNT were detected downgradient within the drainage and decreased rapidly beyond the settling pond, although substantial levels of HMX and barium were present at the base of the colluvial slope in Cañon de Valle.

Subsurface sampling indicated that HE concentrations also decreased rapidly below the soil/tuff interface. However, up to 1000 mg/kg of HE was found within the uppermost tuff unit (Unit 4 of the Tshirege Member of the Bandelier Tuff, Qbt 4), beneath the upper part of the drainage, and in the former settling pond area. Almost 1 wt% (10,000 mg/kg) HE was reported in a saturated sample from a BH at a depth of about 17 ft beneath the former settling pond (LANL 1998, 059891, p. 2-79). The sample was collected from a surge bed within Unit 4 of the Tshirege Member of the Bandelier Tuff. Below the level of this surge bed, HE was detected sporadically and at much lower concentrations (less than 5 mg/kg). However, thin surge bed deposits were reported in BH 16-06370, drilled into the center of the former settling pond during the IM, at depths of 40 and 46 ft below ground surface (bgs), indicating multiple potential transmissive zones at depth (LANL 2002, 073706, p. 35).

HE and barium were the principal contaminants found at the 260 Outfall, although several other metals, including cadmium, chromium, copper, lead, nickel, vanadium, and zinc, were consistently detected above background levels in the drainage. Other organic compounds (semivolatile organic compounds [SVOCs] and volatile organic compounds [VOCs]) were also detected in multiple samples. Details and results from the Phase I and II RFIs are presented in the two RFI reports (LANL 1996, 055077; LANL 1998, 059891).

The IM cleanup removed more than 1300 yd^3 of contaminated soil from the settling pond and channel. An IM report for SWMU 16-021(c) (LANL 2002, 073706, p. 72) detailing the postremoval sampling results indicated that approximately 90% of the HE at the source area had been removed by the IM.

The Phase III baseline risk assessment (LANL 2003, 077965, section 6.0) for the outfall source area identified chemicals of potential concern (COPCs) and assessed potential exposures to an on-site environmental worker, a trail user, and a construction worker. The cumulative excess cancer risk to the environmental worker from potential exposures to COPCs in soil and tuff is slightly above the NMED target level of 10^{-5}; the cumulative excess cancer risk for the other receptors is below the NMED target level. A noncancer hazard index (HI) greater than 1.0 is associated with exposure to the outfall source area COPCs for the construction worker scenario but not for the other receptors (HI below 1.0). These elevated risks were primarily from the presence of HE and barium.

2.3.1.2 Alluvial System

Phase II sampling in the Cañon de Valle alluvial system included collecting surface and subsurface sediment samples, three pairs of overbank sediment samples, filtered and unfiltered surface water samples, and one quarterly round of filtered and unfiltered alluvial groundwater samples. These samples were collected during three different investigations that took place in 1994, 1996, and 1997–1998.

The Phase II RFI report (LANL 1998, 059891) included the following results:

- Barium was the most abundant inorganic chemical contaminant in sediment. For the surface samples, barium ranged from 6.3 to 40,300 mg/kg. Other inorganic chemicals consistently above background levels included cadmium, chromium, copper, lead, nickel, vanadium, and zinc. Several types of HE were detected: A-DNTs (amino-dinitrotoluenes), HMX, nitrobenzene, 3-nitrotoluene, RDX, TNB (1,3,5-trinitrobenzene), and TNT. The two HE compounds highest in abundance and concentration were HMX (maximum of 170 mg/kg) and RDX (maximum of 42 mg/kg).
- Surface water samples and alluvial groundwater samples from five alluvial wells and Peter Seep were collected in Cañon de Valle. Filtered/unfiltered sample pairs were collected during 1994 and 1997–1998; primarily unfiltered samples were collected in 1996. The inorganic chemicals identified as COPCs in water were antimony, barium, chromium, lead, manganese, mercury, nickel, vanadium, and zinc. Barium is the most abundant, with concentrations ranging from 99 to 16,000 µg/L. As with the sediment, HE appears to be the other major COPC in Cañon de Valle surface water and alluvial groundwater. The HE COPCs identified were A-DNTs, HMX, nitrobenzene, 2-nitrotoluene, RDX, TNB, and TNT. RDX is the HE with the highest concentration, with a maximum of 818 µg/L in surface water. COPC concentrations generally decrease downgradient from Peter Seep to the confluence with Water Canyon (LANL 1998, 059891).
- The springs investigation included quarterly sampling of SWSC, Burning Ground, and Martin Springs. The results showed detectable RDX and other HE in all three springs. Several major cations and anions, including calcium, magnesium, sodium, and boron, were detected. Boron is particularly elevated (1800 µg/L) in Martin Spring. Aluminum, iron, barium, phosphate, and nitrate concentrations were also elevated. Although VOCs were detected in all three springs, the detections were sporadic and occurred primarily during the quarterly sampling round of June 1997.
- Time-series analysis of the springs data indicates extreme variability in the concentration of constituents (up to a factor of 20 in RDX concentration at Martin Spring). Similarities in element variability and flow-rate changes over time indicated that SWSC Spring and Burning Ground Spring are hydrogeologically related but that Martin Spring probably represents a different hydrogeological system.

- A potassium bromide tracer was deployed at SWMU 16-021(c) in April 1997. A breakthrough of bromide ions was observed in SWSC Spring in August 1997. The breakthrough may also have occurred at Burning Ground Spring in August 1997, but the effects were more subtle because the bromide was partially masked by variability in all of the anions (LANL 1998, 059891, p. 4-91). This finding indicates that the springs are hydrologically connected to the SWMU 16-021(c) source area.

The Phase III RFI (LANL 2003, 077965) resulted in the following conclusions about the alluvial system:

- Sediments in Cañon de Valle and Martin Spring Canyon represent a secondary source for HE and barium that is potentially mobilized by surface water and alluvial groundwater. Moreover, the perennial reach of Cañon de Valle alluvial groundwater provides a high potential for subsequent infiltration of mobile contaminants.
- For the Cañon de Valle alluvial area, a trail-user exposure scenario was assessed. The cumulative excess cancer risk to the trail user from potential exposure to all COPCs in sediment and surface water was below the 10^{-5} target risk specified by NMED. The noncancer hazard was below an HI of 1.0.
- The ecological risk assessment followed EPA guidance (EPA 1997, 059370). For the terrestrial system in Cañon de Valle, elevated metals concentrations were found in small mammals but not at levels that are likely to cause adverse effects to the Mexican spotted owl. The numbers of species, population densities, and reproductive classes for those species indicated that the Cañon de Valle small-mammal community is not being adversely affected by contaminants. In Cañon de Valle, a viable benthic macroinvertebrate community is present, which is a meaningful indicator that site contaminants have caused minimal negative ecological effects.
- For Martin Spring Canyon, a trail user scenario was assessed. The cumulative excess cancer risk to the trail user from potential exposures to all COPCs in sediment and surface water is below the 10^{-5} target risk specified by NMED. The noncancer hazard was below an HI of 1.0.

2.3.1.3 Mesa Vadose Zone

The Phase III RFI (LANL 2003, 077965, section 4) supports the following conclusions about the mesa vadose zone:

- Borehole sampling in the mesa vadose zone indicated no contamination in the unsaturated depth intervals in any BHs, except in the immediate vicinity of the former settling pond. These results indicate that mesa vadose zone contamination is concentrated beneath source area SWMUs, such as the former and current ponds and drainages (90s Line Pond, V-Site Pond, 30s Line Pond) on the mesa top. However, the ephemeral groundwater from mesa vadose zone wells not located in the vicinity of the former settling pond also showed contamination, indicating lateral movement (possibly through surge beds) of water and contaminants within the mesa subsurface. Based on the oxygen and deuterium stable isotope results, mesa vadose zone groundwater from wells near Martin Spring Canyon and the 90s Line Pond, as well as surface water from the 90s Line Pond, show evaporative signatures, but the spring water does not. These results support the CSM of a mesa vadose zone groundwater flow regime dominated by fractures and surge beds and, in general, the importance of hydrologic heterogeneity at TA-16.
- The intermediate-depth perched aquifer investigation included drilling five wells (91 to 207 ft bgs) at locations likely to intersect the saturated zones at TA-16. The local trend of subunit/subunit contacts is to the north and east. When installed, two of these wells intersected ephemeral

perched water, which disappeared in less than 1 month. Analysis of this perched water indicated the presence of HE.

- Contaminant transport in the mesa vadose zone is dominated by a fracture or surge bed flow regime, of which contaminated springs are a known manifestation. Since the IM source removal, a substantial source for this contamination is no longer present, although reductions in spring contaminant concentrations are not yet evident.

2.3.1.4 Intermediate and Regional Groundwater

The investigation of intermediate and regional groundwater (LANL 2006, 093798) reached the following conclusions.

- The analytical results for intermediate groundwater samples showed concentrations (less than 80 µg/L) of HE within the area defined by wells R-25, CdV-16-1(i), and CdV-16-2(i)r. In CdV-16-1(i) and R-25, RDX exceeded the EPA Region 6 tap water screening level of 0.61 µg/L. The NMED risk-based level (based on a 10^{-5} risk level) for RDX is 6.1 µg/L.
- For regional groundwater samples, analytical results from R-25 showed RDX and TNT above EPA Region 6 tap water screening levels. Results from other wells located east of (downgradient of) R-25 showed that RDX was detected once in R-19 in 2000 but at a concentration less than the tap water screening level. RDX has recently been detected in well R-18 at very low levels (<1 µg/L).
- The COPCs for regional and intermediate groundwater are RDX and TNT; these compounds will be the focus of an upcoming corrective measures evaluation, due to NMED in August 2007.

3.0 260 OUTFALL DRAINAGE CHANNEL

3.1 Remedial Objectives

The remedial objectives for the 260 Outfall drainage channel are threefold: (1) to demolish and remove the concrete trough leading from the building 260 trough at the roadway to the 260 Outfall, (2) to remove isolated pockets of soil exceeding risk-based MCSs that had not been removed during the IM, and (3) to maintain the existing low-permeability cap on the former settling pond. Figure 3.1-1 provides a topographical map of the drainage channel area, including the concrete trough. The specifications and drawings for these tasks are presented in Appendix D.

The concrete outfall trough is approximately 1 ft wide and 3 ft tall, and is covered with steel plating, which, in turn, is covered by approximately 6 in. of loose soil. Approximately 150 ft of the trough will be removed from the outfall to the road, and the underlying soils will be sampled and analyzed. The section of the trough to be removed is shown in Figure 3.1-1.

The outfall drainage channel consists of the former settling pond and the drainage channel running from the former settling pond into Cañon de Valle. Soils were excavated along the entire reach of the drainage channel; the greatest mass of HE-contaminated soil was concentrated in the former settling pond, which was excavated during the IM (LANL 2002, 073706). The soils in the former settling pond were removed down to tuff, and approximately 6 in. of tuff was removed. Several isolated pockets of soil exceeding the risk-based MCSs were identified during the IM. They are located within the former settling pond and within the drainage channel. These isolated pockets of residual soil contamination will be removed.

Concentrations of contaminants in these soils exceeded both carcinogenic and noncarcinogenic risk standards (LANL 2003, 085531, section 6). The primary contaminants for carcinogenic risk were RDX and TNT. TNT, barium, and other metals contributed to noncarcinogenic risk. The remedial objective is to reduce the carcinogenic and noncarcinogenic risks to levels below their respective action-level thresholds of 10^{-5} and an HI of 1. For RDX and TNT, the soil screening levels (SSLs) at the 10^{-5} risk level are 174 and 342 mg/kg (NMED 2006, 092513), respectively. To determine compliance, a risk calculation will be performed using confirmatory sampling and analysis results to ensure that action levels for carcinogenic and noncarcinogenic risks are met throughout the drainage channel.

3.2 Design Basis

This section presents important information and site data that support the development of excavation plans for the 260 Outfall channel. Excavation of soils within the drainage channel is based on the results of a risk assessment conducted as part of the Phase III RFI (LANL 2003, 077965, section 6), which showed unacceptable levels of risk associated with several risk scenarios. The risk assessment used soil data collected and analyzed as part of the IM. Figure 3.2-1 shows the drainage-channel soil concentrations of RDX and TNT as determined during postexcavation sampling as part of the IM (LANL 2002, 073706). Barium concentrations generally track with RDX and TNT, and therefore only RDX and TNT concentrations are shown. Complete results are presented in the IM report. Though both laboratory and field sampling concentrations are presented in Figure 3.2-1, only laboratory results were used in the risk assessment conducted during the Phase III RFI (LANL 2003, 077965, section 6), in accordance with standard risk-assessment practice.

Soil removal will focus on three areas that were delineated by IM postexcavation sampling and analyses (LANL 2002, 073706): the former settling pond (sampling locations 16-06378 and 16-06379), an area within the drainage approximately 250 ft east of the settling pond (sample 16-06390), and the area beneath the cliff (sample 16-06404). These sampling locations and other IM postexcavation sampling results are shown in Figure 3.2-1. The area of contamination around these locations is assumed to lie within a 5-ft radius of each point.

3.3 Removal Plan

3.3.1 Concrete Trough

This section presents the plan for removal of the concrete trough. Specifications and drawings for the removal are presented in Appendix D. A construction quality control plan covering removal of the trough is presented in Appendix E. The removal will be conducted in accordance with the Laboratory's health, safety, and security policies.

Approximately 150 ft of the concrete trough from the outfall to the northern edge of the access road will be removed. Approximately 6 in. of loose soil overlies the steel plates covering the drainage channel. This soil will be removed to expose the steel plates covering the concrete channel, the plates will be removed, and an excavator will be used to break up the drainage channel. A photograph of the trough is shown in Figure 3.3-1.

During the IM, a trench was excavated along the trough to investigate the extent of soil contamination. The trench extended 20 ft along the side of the trough to a depth of approximately 1.5 ft below the trough bottom. As the excavation progressed, screening samples were collected at five locations along the excavation surface at a depth of 2.5 to 3.0 ft below grade. All screening samples tested negative for the presence of HE based on the HE field test (LANL 2002, 073706). Based on these results, high levels of HE soil contamination are not anticipated beneath the trough.

Sampling and analysis of the soil underlying the concrete drainage channel will be conducted through a process of visual inspection, field screening, and confirmatory laboratory analyses. Field screening of the soils directly beneath the concrete will be conducted for HE and barium at intervals of 1 m, or as indicated by visual inspection and identification of potential leak areas. Additional confirmatory sampling and laboratory analyses will be conducted at locations where field analytical results show RDX and TNT levels above SSLs: 174 and 342 mg/kg respectively (NMED 2006, 092513). If field screening does not indicate the presence of elevated levels, three confirmatory soil samples will be collected along the trough at locations shown schematically in Figure 3.1-1. Laboratory sampling locations will be biased to the highest RDX screening locations; if no screening samples show elevated RDX, then the confirmatory samples will be selected randomly. Confirmatory laboratory analyses will consist of HE, metals, VOCs, SVOCs, and uranium. Soils above the SSLs will be removed in 6-in. lifts. Resampling will be conducted after soil removal, and, if necessary, additional soil will be removed. If necessary, samples of the underlying tuff will be collected. Sampling and analyses will be conducted in accordance with the Laboratory's standard operating procedures (SOPs), which are described in Appendix G.

Concrete debris and soil will be segregated and stored on plastic sheeting pending receipt of sampling results for the concrete and analytical results for the soil. Final disposition of these waste streams will be contingent on contaminant status. A more detailed demolition plan will be prepared by the removal contractor before removal activities begin. A waste-management plan for excavated soils and concrete is presented in Appendix F.

Site restoration will consist of backfilling the excavation with clean fill and reseeding with a Laboratory-approved seed mix.

3.3.2 Former Settling Pond Soil Removal and Sampling

This section describes the plan for removing soils from the former settling pond area. Specifications and drawings for the soil removal are presented in Appendix D. A construction quality-control plan covering the removal of soils in the settling pond is presented in Appendix E. The removal will be conducted in accordance with the Laboratory's health and safety and security policies.

Soil removal at the former settling pond will focus on locations 16-06378, and 16-06379, shown in Figure 3.3-2. These sites will be located in the field by use of their existing survey coordinates. A 5-ft radius around these sample points will be marked. The low-permeability cap will be removed to expose the underlying soil. The cap consists of a crushed tuff/bentonite mixture and is approximately 20 in. thick. Approximately 5 yd^3 of cap materials will be removed and stockpiled for reuse from each location if the cap covers these areas.

Settling pond soils within a 5-ft radius of the sampling points will be removed by excavation to a depth of 1 ft. Excavated soils will be stockpiled on plastic. Three samples will be collected from the bottom of each excavation and analyzed using field screening methods for HE. If the results fall below the SSLs for TNT and RDX, one laboratory sample will be collected from the bottom of each excavation and submitted for laboratory analyses of HE, VOCs, SVOCS, uranium, and metals. The laboratory sample will be biased to the highest RDX screening result; if all the RDX screening results are negative the laboratory sample will be selected randomly. All sampling and analyses will be conducted in accordance with the Laboratory's SOPs, which are described in Appendix G.

Laboratory analytical results will be incorporated into a risk-assessment calculation to determine the total carcinogenic and noncarcinogenic risks. For carcinogens (HE), the concentrations at a 10^{-5} risk level are the SSLs. For noncarcinogens, the analytical results for TNT and metals will be incorporated into a risk-assessment calculation to determine whether the site HI is below 1.0. This risk-assessment methodology is described in the Phase III RFI (LANL 2003, 077965, section 6). If the results indicate that the soil does not meet the risk-based standards, additional excavation of these locations will be conducted until the standards are met.

After the soil standards are attained, the excavations will be backfilled up to the original grade. If the cap in these locations was removed, it will be replaced using the stockpiled cap material. The existing low-permeability cap consists of multiple, compacted 4-in. lifts of crushed tuff amended with 2.5 wt% dry bentonite (approximately twenty 50-lb bags of 3/8 bentonite per lift). Four lifts were installed. The fourth layer was amended with 1.5% bentonite and was hydrated after placement. A finish cap of compacted crushed tuff was placed over the hydrated layer, bringing the average total thickness of the barrier to 20 in. The replacement cap will follow these specifications.

The total volume of soil from these excavations will probably be less than 15 yd^3. The excavated soil will be sampled at a frequency necessary to meet the waste disposal facility waste-acceptance criteria, generally one sample per 20 yd^3. One possible waste disposal facility is the Clean Harbors Deer Trail landfill in Colorado. Generally, the full suite of analyses (HE, metals, VOCs, SVOCs, and uranium) will be required. A waste-management plan for excavated soils is presented in Appendix F.

3.3.3 Other Outfall Channel Areas

Other sample locations to be excavated are 16-06390 and 16-06404. This section describes the excavation of these areas. Complete drawings and specifications are presented in Appendix D. A construction quality-control plan covering removal of the channel soils is presented in Appendix E. The removal will be conducted in accordance with the Laboratory's health, safety, and security policies.

Sample location 16-06390 will be pinpointed by using its survey coordinates. A 5-ft radius will be marked around this location, and the soil will be removed to a depth of 1 ft below grade in this area. Excavated soils will be stockpiled on plastic. Approximately 3 yd^3 of soil may be removed from this location.

Sample location 16-06404 is located at the base of the cliff within the drainage channel. A photograph of this area is shown in Figure 3.3-3. Because of the steep terrain and the presence of rocks and boulders, hand excavation will be required to remove soil to a depth of 1 ft below grade within 5 ft of the original sampling location. Approximately 3 yd^3 of soil may be removed from this location.

Three samples will be collected from each of these excavations and analyzed using field screening methods for HE. If the results fall below the SSLs for TNT and RDX, one laboratory sample will be collected from the bottom of each excavation and submitted for laboratory analyses of HE, VOCs, SVOCS, uranium, and metals. The laboratory sample will be biased to the highest RDX screening result; if all the RDX screening results are negative, the laboratory sample will be selected randomly. All sampling and analyses will be conducted in accordance with the Laboratory's SOPs, as described in Appendix G.

Laboratory analytical results will be incorporated into a risk-assessment calculation to determine the total carcinogenic and noncarcinogenic risks. For carcinogens (HE), the concentrations at a 10^{-5} risk level are the SSLs. For noncarcinogens, the analytical results for TNT and metals will be incorporated into a risk-assessment calculation to determine whether the site HI is below 1.0. This risk-assessment methodology is described in the Phase III RFI (LANL 2003, 077965, section 6). If the results indicate that the soil does not meet the risk-based standards, additional excavation of these locations will be conducted in 1-ft lifts until the standards are met.

Site restoration at both of these locations will consist of backfilling to grade with clean fill, reseeding with a Laboratory-approved seed mixture, and replacement of erosion control matting.

3.4 Waste Handling

It is possible that hazardous wastes will be found during the soil-removal operations; thus, the Laboratory will request that NMED designate the 260 Outfall channel area as an area of contamination to allow the efficient handling and disposal of the excavated soil. An area of contamination was previously granted for this area by the NMED for the IM (NMED 2000, 070649).

Removal of the concrete drainage channel will generate approximately 20 yd^3 of concrete debris that will be stored on and covered with plastic and stored on site until a final disposal is determined. Depending on the contaminant concentrations, options for disposal include a local construction debris landfill or an out-of-state landfill (e.g., the Clean Harbors Deer Trail facility). The disposal sites will require specific analyses for their waste-acceptance criteria. In general, debris will be sampled for HE, metals, VOCs, SVOCs, and uranium.

Less than 50 yd^3 of soil will be generated by removing residual soil from the former settling pond area and the other soil-removal locations. This soil will be stored on plastic and covered with plastic until receipt of waste-profile laboratory analytical data. The final disposal site for these wastes will be dependent on these results and the available disposal sites. Personal protective equipment (PPE) waste will also be generated. A waste-management plan for these wastes (with anticipated volumes) is presented in Appendix F.

3.5 Former Settling Pond Cap Inspection and Maintenance

The low-permeability cap in the former settling pond will be replaced in the excavated areas after attaining the appropriate soil standards in those locations. The purpose of this cap is to prevent surface water from infiltrating. The cap, which will have a nominal conductivity of 10^{-7} cm/s or less, will, in conjunction with the grouting of the upper surge bed (section 5), prevent surface and groundwater from coming into contact with potentially contaminated tuff.

As part of the CMI, the cap will be inspected every March and August, and the cap will be repaired if necessary in a timely manner.

3.6 Health and Safety

Both the outfall drainage channel removal and soil-removal projects will be conducted in compliance with applicable Occupational Safety and Health Administration and Laboratory safety processes, including TA-16 requirements. Remediation work in this area must be coordinated with building 260 operations, which may restrict working hours, restrict the type of equipment used, and limit access. Currently, safety processes are embodied in the integrated work process (IWP) used at the Laboratory; however, safety procedures at Laboratory are frequently updated, and it will be the responsibility of the remediation contractor to ensure compliance with applicable Laboratory safety standards. A detailed health and safety plan will be prepared by the remediation contractor.

3.7 Outfall Drainage Channel Contingency Plan

Additional soil removal may be required within the outfall drainage channel if results from the first round of postexcavation sampling and analyses indicate noncompliance with the risk-based MCSs. As described above, soil will be removed as necessary to attain the risk-based MCSs.

4.0 SWSC CUT SOIL INVESTIGATION

4.1 Investigation Objectives

A limited soil investigation will be conducted in the vicinity of the SWSC sewer pipeline near SWSC Spring (shown in Figure 2.1-1). The remedial plan for this area consists of a phased approach. The first phase will be a focused investigation. It will be followed by a second phase, if necessary, consisting of limited excavation. The reason for the investigation in this area is a failed ecotox sample associated with the RFI Phase III (sample 16-06709, LANL 2003, 077965). The suspected contaminant in the soils is silver. Five sediment samples will be analyzed for metals. This analysis will be followed by one sediment ecotox (chironomus) test in the location with the highest detected silver concentrations. If elevated concentrations of silver above background (1 mg/kg) are found and the chironomus test fails, the Laboratory will consult with NMED regarding the need for soil excavation and a schedule for implementation.

4.2 Soil Investigation

Five sediment samples will be collected in the locations shown in Figure 4.2-1 and analyzed for metals by an off-site laboratory. The five samples provide for reasonable coverage of this area. After the results are received, a sample for ecotox (chironomus) testing will be collected from the location with the highest silver soil concentration. If elevated concentrations of silver above the background value for silver (1 mg/kg) are found and the chironomus test fails, NMED will be consulted to determine the need for soil excavation. Sampling and analyses will be conducted in accordance with the Laboratory's SOPs. The relevant SOPs are summarized in Appendix G.

5.0 FORMER SETTLING POND SURGE BED

5.1 Remedial Objectives

Soils from the former settling pond located at the upper end of the outfall drainage channel were removed during the 2000 IM (LANL 2002, 073706). To determine the vertical extent of HE, several BHs next to the former settling pond were installed into tuff as part of the Phase II RFI (LANL 1998, 059891). Several but not all of these BHs indicated the presence of surge beds. Surge beds are typically highly discontinuous features on the Pajarito Plateau, and, if they are present, they can vary in thickness and permeability over short distances (WoldeGabriel et al. 2001, 092523).

Samples from the upper surge bed at approximately 17 ft bgs from BH 16-2700 contained RDX (4500 mg/kg), HMX (1700 mg/kg), and TNT (3500 mg/kg). In several other BHs in this area, the presence of the upper surge bed can possibly be inferred by the lack of recovery from coring. The extent of the surge bed and related contamination is therefore uncertain. In BH 16-02705, located 50 ft east of BH-16-02700, a tuff sample collected in tuff above the surge bed horizon contained RDX (477 mg/kg) and TNT (143 mg/kg); however, because of a lack of core recovery, no sample was collected from the surge bed. These results and others (see Appendix C) indicate that the upper surge bed is discontinuous and variably contaminated with the highest contamination observed at BH 16-2700. Figure 5.3-1 shows the settling pond area and these borings. All borings except 16-27665 and 16-27666 have been abandoned.

The remedial objective is to prevent groundwater from making contact with the contaminated upper surge bed within the settling pond area by isolating the surge bed using pressure grouting.

5.2 Design Basis

This section presents information and site data that support the design of the grouting system, including the area to be grouted and the permeability of the surge bed.

To help determine the lateral extent of the upper surge bed and associated HE contamination, NMED requested that the Laboratory install three additional BHs near the former settling pond. These BHs were completed in March 2007, and a report was prepared (Appendix C). The location of these borings is shown on Figure 5.3-1. The BHs were geologically, geophysically, and videographically logged with special emphasis on identifying surge beds. RDX field screening was conducted on 10 screening samples for each 30-ft BH. Based on field-screening and geological results, two samples were collected from each BH and submitted for off-site fixed lab analysis. No evidence of surge beds was observed in core samples, downhole video logs, or downhole gamma logs. HE-screening results and fixed analytical results both reported RDX concentrations of less than 3 mg/kg. The surge bed deposits and associated HE contamination do not extend continuously more than 80 ft to the northwest, southeast, or east from BH 16-02700.

Based on these results, the area for grouting appears to be limited to the area of the former settling pond, which covers approximately 1250 ft^2. Because of the probable variability in surge bed thickness and permeability (WoldeGabriel et al. 2001, 092523), it is not known whether this entire area will be transmissive to grout; this question must be answered in the field once the grouting operation begins.

Permeability tests on the upper surge bed have not been conducted; however, results from two such tests conducted on surge beds in two nearby borings (Newman et al. 2007, 095632) showed hydraulic conductivities of 3.8×10^{-3} and 5.0×10^{-4} cm/s.

Because of the general capabilities of grouting and the anticipated surge bed permeability, a performance goal of 5.0×10^{-5} cm/s, representing 1 to 2 orders of magnitude reduction in permeability, is set as the performance standard for grouting.

Groundwater will probably not be encountered during grouting operations. Groundwater was encountered during installation of borings during the Phase II RFI (LANL 1998, 059891) but was probably related to operation of the former settling pond.

The surface cover of the former settling pond currently consists of an approximately 20-in.-thick clay cap. At the location of former BH 16-02700, the upper surge bed is expected to lie approximately 17 ft bgs.

Other important design basis information involves restrictions on working hours and formulation of the grout. Because of its location adjacent to building 260, all field work at the former settling pond location is restricted to weekends and selected Fridays. Grout formulations should not include chemicals that can cause groundwater contamination.

5.3 Design and Installation of the Upper Surge Bed Grout System

This section describes the design of the grouting system. The drawings and specifications are provided in Appendix D. A construction quality-control plan is provided in Appendix E. To incorporate potentially proprietary grout formulations or grouting techniques, this grouting design may be modified by the grouting contractor as part of the proposal to perform the work. Consequently, a grouting plan will be requested of potential grouting contractors.

The existing cap will remain in place during grouting, and any damage to the cap will be repaired as part of site restoration. Grouting of the upper surge bed is expected to take approximately 2 weeks to complete. Coordination with building 260 operations will be required. Available work days will be restricted to weekends and selected Fridays.

Grouting of the surge bed will focus on the area immediately adjacent to BH 16-02700, the location with the highest surge bed HE contamination, and will advance from this location with the objective of covering the area of the former settling pond. Because of the extreme variability of the surge bed, the final area for grouting cannot be determined a priori and will be determined through implementation in the field.

To grout the surge bed, a series of injection and observation wells will be installed in the tuff to the 17-ft-bgs surge bed horizon. These wells will be installed with air-rotary drilling techniques. A “five-spot” pattern of injection wells and observations wells, shown in Figure 5.3-1, will be installed within the confines of the former settling pond. Injection wells will be installed at the center of each pattern, and the observation wells will be used to confirm grout penetration. The optimal dimensions of the five-spot pattern will be determined in the field during grouting. The observation wells also will serve as vent wells to remove air displaced by the injected grout. Initial grouting will focus on the area adjacent to BH 16-02700. If success is achieved in this area, adjacent areas will be grouted using the five-spot pattern until the area of the former settling pond is covered.

Based on the general capabilities of grouting, a goal of 5.0×10^{-5} cm/s, representing 1 to 2 orders of magnitude reduction in hydraulic conductivity, is possible with a single pass of Type I cement grout. Further reduction in permeability in the range of 1.0×10^{-5} cm/s may require a second pass with microfine cement. Reduction to 1.0×10^{-6} cm/s will probably require a final pass of polyacrylamide grouting.

Admixtures to make a stable cement grout are available to enhance the injectability of grouts. A candidate grout formulation will be tested to ensure proper quality and stability of the grout formulation by evaluating the bleed and pressure filtration. Other grout parameters, such as viscosity and specific gravity, affect the injection spacing and pressure but do not impact long-term performance. A field quality-assurance program will be required to ensure that the same grout approved during the design phase is exactly what gets injected. The grout will be evaluated with simple production-level tests such as Marsh funnel and mud balance. Small, unapparent changes in the batching process may result in large changes in grout quality.

Real-time monitoring of injection pressure and flow rate will be accomplished with pressure transducers, flowmeters, and a data-acquisition system with computer interface. This approach will allow injection in multiple points simultaneously but, more importantly, will provide real-time feedback about the grouting process itself. In general, grout is injected into an injection well up to the point of refusal, at which point grout flow stops. Attempts to inject beyond this point may lead to hydrofracturing. Real-time monitoring provides the information needed to control the process, using the longest injection spacing possible without stepping over the hydrofracturing threshold.

Attainment of the performance criteria will be verified by installing two borings spaced over the grouted area and into the grouted horizon. An air-permeability test will be conducted in each BH, from which the hydraulic conductivity can be calculated. To monitor the long-term effectiveness of grouting, a new monitoring well will be installed east of the former settling pond for the purpose of sampling groundwater, if present (see Figure 5.3-1). This well will be installed into the upper surge bed.

Wastes generated by the grouting operation will include drill cuttings and PPE. The plan to manage these wastes is presented in Appendix F. Site restoration will involve plugging of the BHs and repair of the settling pond cap.

5.4 Health and Safety

The grouting project will be conducted in compliance with applicable Laboratory safety processes, including TA-16 requirements. Work in this area must be coordinated with building 260 operations, which can substantially restrict working hours, the type of equipment used, and access. Currently, safety processes are embodied in the IWP used at the Laboratory; however, safety procedures at the Laboratory are frequently updated, and it will be the responsibility of the remediation contractor to ensure compliance with applicable Laboratory safety standards. A detailed health and safety plan will be prepared by the remediation contractor.

5.5 Operations and Maintenance

The in situ grouting system will not require operations and maintenance; however, to monitor the effectiveness of the grouting, the new monitoring well installed adjacent to the grouted area will be monitored quarterly for the presence of groundwater. Groundwater, if present, will be sampled and analyzed for HE. One of the gauging events will coincide with the summer monsoon season. Sampling and analyses will be conducted in accordance with the Laboratory's SOPs. Relevant SOPs are described and listed in Appendix G.

5.6 Grouting Contingency Plan

If grouting cannot be successfully implemented in the area of former BH 16-02700, other options, such as excavation of the upper surge bed near BH 16-02700, will be reconsidered. Such an excavation may involve removing the former settling pond cap, drilling a series of BHs, fracturing the highly welded tuff using nonblasting means, and removing blocks of tuff to expose the surge bed. NMED will be consulted regarding these other options if grouting fails to meet the performance criteria.

6.0 SPRINGS CARBON FILTERS

6.1 Remedial Objectives

The CMS report (LANL 2003, 085531) identified carbon filters as the preferred option for cleanup of SWSC and Burning Ground Spring in Cañon de Valle, and Martin Spring in Martin Spring Canyon, the locations of which are shown on Figure 1.1-2. NMED approved this remedy in October 2006 (NMED 2006, 095631). These filters have generally been used to collect and treat stormwater runoff from areas such as parking lots. They consist of a subgrade system of piping and carbon filters designed to collect, treat, and discharge treated water. The design for a carbon filter for Burning Ground Spring is presented in this section. The installation will entail installing a modified spring collection box and connecting the collection box to the carbon filter using subgrade piping. Figures 6.1-1, 6.1-2, and 6.1-3 show photographs of SWSC, Burning Ground Spring, and Martin Springs, respectively.

A pilot filter of this type has already been installed in Martin Spring Canyon and has been shown to be effective; implementation of the remedy in Martin Spring Canyon will consist of installing a second spring collection box at a new seep adjacent to the original seep, installing new filter cartridges within the existing filter, and continuing operating this filter system. SWSC Spring has been dry since 2002, and installing a filter there is not proposed at this time but is reserved as a contingency.

The remedial objective for the carbon filters placed on these springs is to treat RDX present in the spring waters to levels below the 10^{-5} risk-based standard for RDX of 6.1 µg/L.

6.2 Design Basis

The design basis for the spring filters consists of the spring water-flow rate, the expected RDX influent concentration, and the target effluent concentration. Important design constraints consist of the accessibility of the sites, a requirement for a minimum hydraulic head difference across the filter, and the desire to preserve any existing wetlands associated with the spring, both during and after construction.

Figures 6.2-1, 6.2-2, and 6.2-3 present graphs of spring flow at Burning Ground, SWSC, and Martin Springs, respectively. SWSC has been dry since approximately December 2001. Based on these graphs, Table 6.2-1 presents the design basis flow rates for these springs.

Figures 6.2-4, 6.2-5, and 6.2-6 present graphs of RDX concentrations in spring waters for the period from 1996 to 2006 for Burning Ground, SWSC, and Martin Springs, respectively. Based on these graphs, Table 6.2-2 presents the design basis RDX concentrations for spring water. The MCS for RDX in spring water is 6.1 µg/L, which is the target treatment concentration for the spring filters.

6.3 Design and Installation of the Burning Ground Spring Carbon Filter

This section provides an overview of the design and installation of the Burning Ground Spring carbon filter. Detailed drawings and specifications are provided in Appendix D. A construction quality control plan is provided in Appendix E.

The design consists of a spring collection box to collect the spring water, subgrade piping to convey the water to the carbon filter, and piping to convey the treated water to the discharge point. To preserve the small wetland area associated with this spring, the treated spring water will be discharged to the surface within the existing wetland area.

The proposed carbon filter consists of a subgrade vault containing two activated carbon canisters, each with approximately 45 lb of activated carbon. A similar unit was installed and is operating at Martin Spring. Flow through the two canisters is in parallel and is activated by a float valve within each canister. For proper function, a minimum hydraulic head of 1.5 ft is required across the unit. The carbon filter is a commercially available unit.

The spring collection box consists of a weir and a reservoir and will be fabricated out of aluminum by a machine shop. Final shop drawings will be issued before the box is constructed.

A U.S. Army Corps of Engineers (USACE) wetlands permit and a stormwater pollution prevention plan (SWPPP) will be required. Consolidated permits for both the carbon filter and the PRB will be prepared by the Laboratory. These requirements are discussed in section 7.4.2.

Before installation, temporary piping will be used to divert the spring around the construction site, which will then be allowed to dry out for a period of 1 week. Excavation equipment will be brought into Cañon de Valle and to the site through the SWSC sewer line cut or through the access road at MDA P. A low ground pressure tracked excavator will be used to install the carbon filter and piping to minimize disruption of vegetation and soils. Topsoil from the excavations will be stockpiled for later reuse.

The carbon filter, spring collection box, and related piping will be installed. Gravel will be used to backfill the carbon filter to prevent settling in the damp soils. In addition, a small concrete pad will be installed around the carbon filter. The discharge pipe from the carbon filter will be brought to the surface and secured with a small riprap structure.

Site restoration will consist of backfilling the carbon filter with gravel, replacing the topsoil with stockpiled soil from the excavation, installing the flow data logger at the spring collection box, and seeding disturbed areas using a Laboratory-provided seed mix.

Wastes generated by the installation of the carbon filter will include soil and PPE. The plan to manage these wastes is presented in Appendix F.

6.4 Installation of a Seep Collection Box at Martin Spring

The carbon filter for Martin Spring was installed in 2002 and is currently operating; however, a second seep has emerged since the carbon filter was installed, and a second spring collection box will be added to collect and treat water from this seep. Piping from the new spring collection box will be installed to drain water into the existing weir and carbon filter. In addition, new filter cartridges will be installed in the existing filter. The design for this spring collection box is identical to the Burning Ground Spring collection box; however, additional hardware may be required to divert the seep into the collection box properly. For this reason, a revised shop drawing that reflects the configuration of the seep at the time of installation will be submitted by the installation contractor.

6.5 Operations and Maintenance

Operations and maintenance for the carbon filters will consist of periodic sampling of the effluent from the carbon filters and replacement of the carbon elements of the filters, if necessary. Sampling and analyses will be conducted in accordance with the Laboratory's SOPs. Relevant SOPs are listed in Appendix G. Specific elements will include the following:

- For startup of the Burning Ground Spring carbon system, weekly sampling of the influent and effluent to the carbon filter will be conducted for the first month, with laboratory analysis for HE (standard suite); thereafter, monthly sampling will be conducted during the first quarter, and subsequently, quarterly sampling will be performed.
- The carbon filters will be replaced if the effluent concentration exceeds 6.1 µg/L, which is the performance standard.
- The spring flow rate will be measured quarterly using the existing ultrasonic flow detector.
- Based on the flow-rate measurements and the influent and effluent analytical results, the mass of HE removed will be calculated.
- For the Martin Spring carbon system, monthly influent and effluent sampling will be conducted during the first quarter, followed by quarterly sampling thereafter. Samples will be analyzed for HE (standard suite).

- For both systems, the results of operations and maintenance activities will be summarized in annual reports.

Used carbon-filter elements will be removed and characterized for disposition in accordance with Laboratory waste-management procedures.

6.6 Spring Carbon Filter Contingency Plan

Because the carbon filters at Martin Springs (LANL 2003, 085531) have been operating successfully since 2001, major problems with the spring carbon filter are not anticipated. Possible maintenance issues involving fouling with silt and premature contaminant breakthrough can be addressed by more frequent carbon replacement. If problems persist, a different particle size of carbon may be required. No carbon filter will be installed at SWSC Spring, which has been dry since 2002, until the spring flows again. NMED will be notified if this spring resumes flow, and a plan and schedule for installation will be developed (NMED 2006, 095631).

7.0 CAÑON DE VALLE PILOT PERMEABLE REACTIVE BARRIER

7.1 Remedial Objectives

The CMS identified installation of PRBs as the preferred remedial alternative for the Cañon de Valle alluvial system (LANL 2003, 085531). Three PRBs were proposed for Cañon de Valle and one for Martin Spring Canyon. The primary remedial objective for these PRBs is to reduce RDX and barium concentrations in alluvial groundwater to below their respective groundwater standards, which, in turn, will reduce the concentrations of contaminants in groundwater infiltrating to intermediate and regional groundwater zones. To achieve these goals, locations for the PRBs were selected in reaches of Cañon de Valle identified by geophysical field investigations as areas with high recharge potential to these underlying zones. In addition, a PRB proposed for the eastern edge of the perennial stream in Cañon de Valle was designated to be equipped with an infiltration gallery to allow surface water storm surges to infiltrate the PRB for treatment.

In the approval letter for the CMS (NMED 2006, 095631), NMED requested that the Laboratory install one PRB in Cañon de Valle as a pilot project to investigate the effectiveness of the concept before other PRBs are installed. The pilot PRB is located next to alluvial monitoring well 16-02658, which is located in a potential recharge area for deeper groundwater. This location is shown in Figure 2.1-1. Because this remedy is a pilot project and concentrations of RDX in alluvial groundwater have decreased below the standard during recent years, a key goal is to demonstrate a significant decrease (>90%) in RDX concentration.

7.2 Design Basis

The PRB design basis supports the PRB design and consists of operational requirements, existing data on site conditions, and any important assumptions. Important site-specific data for the design include depth to tuff, thickness of saturated alluvium, average hydraulic conductivity of the alluvium, and the expected groundwater flow rate. A photograph of the site, which is adjacent to existing well 16-02658, is shown in Figure 7.2-1.

The depth to bedrock at the PRB site, as determined from the boring log for well 16-02658, is approximately 5 ft bgs. The thickness of saturated alluvium, depth to groundwater, hydraulic gradient, and expected groundwater flow rate through the PRB were determined from calculations using alluvial groundwater data from 1998 to 2002 (see Appendix B-3 of this report). The average hydraulic conductivity of the saturated alluvium, determined from permeability testing conducted in alluvial wells (LANL 2006, 095626), is approximately 1 ft/day (see Appendix B-2 of this report). Using these values, the average and peak flows were calculated to be approximately 24 and 30 gal. per day, respectively. Because the slug-testing method generally underestimates the permeabilities, the average and peak groundwater flow rate through the PRB may be closer to 50 and 100 gal. per day, respectively. Given these uncertainties, the hydraulic capacity of the PRB should be conservatively designed. Table 7.2-1 summarizes the design-basis values for these parameters.

Target PRB groundwater treatment goals are 6.1 and 1000 µg/L for RDX and barium, respectively (LANL 2003, 085531). Historical groundwater contaminant data from a nearby alluvial well (16-02658) were used to determine the average, minimum, and maximum expected contaminant concentrations. Figures 7.2-2 and 7.2-3 present graphs of RDX and barium concentrations in well 16-02658, respectively, from 1998 to 2006. Based on these graphs, Table 7.2-2 summarizes the design basis contaminant concentrations for the pilot PRB.

The width of the alluvial channel at the PRB was determined using a seismic refraction survey conducted in 2001 (LANL 2003, 077965, Appendix D) at nearby alluvial well 16-02658, which lies approximately 20 ft north of the location for the pilot PRB. Based on the results, the alluvial channel is approximately 45 ft wide. As discussed in sections 7.4 and 7.5, three test pits along the PRB installation site will be installed to confirm several important site conditions.

The PRB should be designed to withstand erosional forces from stormwater runoff. Erosion was identified as a primary factor in the partial collapse of the PRB installed in Mortandad Canyon (Daniel B. Stephens & Associates Inc. 2006, 093888). A perennial stream is present within the canyon. Under normal conditions, the stream is approximately 1 ft wide, but stormwater surges can swell its width to approximately 20 ft, providing additional erosional forces. Other important lessons from the Mortandad PRB include the need for a proper seal between the groundwater diversion walls and the underlying tuff to prevent underflow bypass of the diversion walls and the general importance of construction quality assurance.

Finally, as a pilot PRB, the design of the PRB should allow ready sampling and testing of the media and groundwater within the reaction cell, inspection of the media and, if necessary, removal and replacement of the reactive media. These needs preclude a traditional PRB design in which the reactive media are buried under soil and excavation is required for access.

7.3 Results of Laboratory Tests on Candidate PRB Reactive Media

Candidate PRB reactive media for the treatment of RDX consist of activated carbon for sorption of RDX and zero-valent iron (ZVI) for the reductive destruction of RDX. Candidate PRB reactive media for barium include calcium sulfate, zeolites, and fish-bone apatite. Several of these media were identified in the CMS (LANL 2003, 085531); however, additional laboratory and field studies completed since the CMS are now available, including results from the Mortandad PRB.

For RDX treatment, results from a full-scale PRB system for HE for a site in Nebraska (Johnson et al. 2004, 095627) indicate that ZVI efficiently destroys TNT through a process of reductive denitrification. Numerous laboratory scale studies have shown that ZVI effectively treats RDX in water (Singh et al. 1999, 095715; Comfort 2005, 095718; Wanaratna et al. 2006, 095714). Rather than destroy HE, activated carbon adsorbs it, which means that disposal of the spent carbon with sorbed HE will eventually be required. As described in the CMS (LANL 2003, 085531), when potential HE-treatment technologies are identified and evaluated, HE destruction is preferable to transfer to another medium, such as adsorption onto carbon. For these reasons, ZVI is selected as the pilot PRB reactive medium for RDX.

To determine the best medium for barium, batch sorption, column tests, and numerical calculations were performed. Because the column tests are still in progress, partial results from these tests and calculations are summarized in Appendix B-1 of this report. The isotherm batch tests were used on candidate barium media to quantify their barium treatment capacity. Site groundwater from alluvial wells was used for these tests. Tested media consisted of media that function by sorption of barium (zeolite, apatite, and tuff) and a medium (calcium sulfate) that functions by precipitating barium as relatively insoluble barium sulfate.

The results of the sorption tests are summarized by the linear adsorption constant for each medium, which reflects its sorption capacity. Figure 7.3-1 presents a graph of the linear isotherm constants for the candidate media for several test durations. All tested media including crushed local tuff showed some capacity to immobilize barium, with gypsum and zeolite having the highest K_ds.

Column tests of the candidate media were designed to assess possible media problems, including competitive adsorption of noncontaminants and loss of permeability as a result of chemical or biological fouling. To better simulate the actual PRB configuration, which will consist of a two-stage PRB reaction cell, two combinations of media were used: ZVI and calcium sulfate and zeolite and ZVI. The results of these column tests, and others currently underway, are described in Appendix B-1.

Calculations were also performed to assess the geochemical behavior of the reactive media and to evaluate possible deleterious reactions. With calcium sulfate, the calculations indicated that precipitation of calcium carbonate (calcite) is possible given that calcium will be added by the gypsum and that calcium and carbonate concentrations in Cañon de Valle alluvial groundwater are relatively high. Precipitation of calcite has the potential to clog the PRB media, and preliminary results from media column tests (Appendix B-1) confirm this potential problem. Although gypsum is being used successfully to treat barium in a PRB in Delaware (Wilkens et al. 2001, 079572; EPA 2005, 095628), the groundwater calcium concentrations there may be lower than in Cañon de Valle alluvial groundwater because of the higher rate of precipitation in the East or because of local soil characteristics (data for calcium from the Delaware PRB were not available). This potential for calcite precipitation and clogging of the PRB makes gypsum less favorable for use in the PRB in Cañon de Valle.

The Mortandad PRB used fish-bone apatite as one component of a multicomponent reactive medium (Daniel B. Stephens & Associates Inc. 2006, 093888). The apatite material was apparently prone to biodegradation, which caused settling and collapsing of the reactive cell. For this reason, apatite will not be used in the pilot PRB.

While a final determination of the PRB reactive media awaits the completion of the long-term column test, which will be completed by October 2007, the evaluation of reactive media to date indicates that ZVI and zeolite are superior to other media (see Appendix B-1.) Using these media, the PRB reactive cell will consist of two chambers: the first with zeolite mixed with sand in a 50% ratio by weight, and the second with ZVI mixed with sand in a 30% ratio by weight. Selection of the final PRB reactive media is not critical for this design; the PRB reactive cell has been designed to be flexible enough to use different media and to allow for change of those media, if necessary.

7.4 Design, Permitting, and Installation of the Pilot PRB

7.4.1 PRB Design

The design for the PRB uses a "funnel and gate" concept. Groundwater is funneled by diversion walls through a gate into a two-stage reactive cell, where the contaminants are treated by the reactive media. After treatment in the PRB, the groundwater returns to the alluvium. A conceptual drawing of a PRB is shown in Figure 7.4-1. Detailed design drawings and specifications for the PRB are provided in Appendix D.

The groundwater diversion walls consist of a bentonite soil mixture that will be emplaced in a 2-ft-wide, excavated, linear trench. The walls will be keyed into the underlying tuff. Before the area is backfilled, any visible fractures in the tuff will be grouted to prevent groundwater bypass of the trench.

The two-stage reactive cell will be constructed of fiberglass reinforced plastic and will consist of two media chambers separated by a screen. Although the PRB is installed belowground, the PRB cells will be accessible through an exposed lid, which will facilitate access to the media and allow for possible media replacement. Four 1-in.-diameter sampling tubes will be installed within the media and will penetrate the lid, allowing groundwater gauging and sampling and other data gathering within the cells. A vent tube will be installed within the lid to vent air that is displaced by rising or falling groundwater levels and also to allow the venting of any generated gas. The reactive cell will be prefabricated and installed at the site. The reactive cell is approximately 8 ft long by 6 ft wide by 6 ft tall. The reactive cell has been offset from the perennial stream to minimize erosion effects around the reactive cell. In addition, the cell will be bolt-anchored to a prepared base on the underlying tuff, and a concrete collar will be added around the reactive cell to secure it in place.

The PRB was designed to meet the objectives of the design basis. In a pilot PRB, a primary feature of the design is the accessibility of the reactive media. If the pilot PRB is a success, subsequent designs for the other PRBs may use a simpler design.

Monitoring wells around the PRB will consist of existing monitoring well 16-02658 and three additional alluvial monitoring wells. One of these wells will be installed upgradient of the PRB, and two will be installed downgradient. These wells will be constructed of stainless-steel well materials, and will be screened across the alluvium. Periodic monitoring of these wells, along with use of the four reactive cell sampling tubes, will be part of the operations and maintenance program (section 7.7).

Lessons learned from the PRB installed in Mortandad Canyon (Daniel B. Stephens & Associates Inc. 2006, 093888) have been applied to the design of the Cañon de Valle PRB. These lessons include using bentonite to seal any fractures that may underlie the wing walls and reactive cell; designing reactive media permeabilities to avoid excessive mounding within the reactive cell; and using controls to prevent erosion, surface water infiltration, and settling of the PRB. Finally, a construction quality-assurance plan has been developed to ensure the pilot PRB will be properly installed. The construction quality-assurance plan is provided in Appendix E.

Groundwater modeling was conducted to assess the hydraulic behavior of the PRB and its effect on local groundwater flow. Wherever possible, the model used site-specific data, including alluvial permeability, saturated thickness, the width of the saturated alluvium, and the local groundwater gradient. The results indicate that the groundwater diversion walls will cause minimal groundwater mounding on the upgradient side of the diversion wall, primarily because of the relatively low hydraulic gradient present in the canyon. Other details of the groundwater modeling and calculations in support of the design are presented in Appendix B-3.

7.4.2 PRB Construction Permit Requirements

Several permits and approvals are required before the PRB is constructed and the carbon filter is installed at Burning Ground Spring. Permits and approvals include a USACE Section 404 permit, an EPA SWPPP, and a "No-Longer Contained-In" determination from NMED. In addition, because of the presence of the Mexican spotted owl in the canyon, National Environmental Policy Act (NEPA) threatened and endangered species provisions may apply, probably including a prohibition of construction during the owl breeding season from March through May. Required permits and approvals are discussed in greater detail below.

The National Environmental Policy Act. All NEPA requirements will be completed before construction begins. As part of the Laboratory's project requirements identification process, these and other requirements will be identified. Important NEPA issues relevant to the site are covered in the following section.

Wetlands Permitting Process. The wetlands permitting process involves completing a Section 404 permit and related permits. This process, summarized in Figure 7.6-1, involves the Albuquerque District Regulatory Office of the USACE and the NMED. Because Cañon de Valle has a perennial stream running through the proposed work area and a wetland is present, a 401 certification and a 404 permit will be required. This permitting process involves a joint application to obtain the 401/404 permit. NMED and the USACE will both receive a copy of the submittal. From that point on, the state of New Mexico will handle and certify the 401, and the USACE will handle the 404 permit. The permitting process begins with a determination of the presence of jurisdictional waters subject to the requirements of Section 404 of the Clean Water Act (CWA). For federally funded projects such as this, determination of the presence of jurisdictional waters typically occurs during the NEPA review phase of the project, either through an environmental assessment (EA) or an environmental impact statement (EIS). Wetlands are determined to be present or absent in accordance with the findings of a review of vegetation, soil, and hydrologic indicators. As part of the sitewide EIS, the area containing the pilot PRB was identified as a wetland.

After the presence of jurisdictional waters is established, the applicability of Section 404 is evaluated with regard to types of proposed construction activities. In general, the USACE has determined that activities that involve placement of fill material, ditching, levee construction, road construction, or land-clearing in an area that could affect jurisdictional waters require permitting under Section 404 of the CWA. In New Mexico, an application is submitted for the Section 404 permit by use of the joint application for a permit through the USACE and the Surface Water Quality Bureau (SWQB).

Based on the criteria presented, the Albuquerque District of the USACE determines if a Section 404 permit is required for the project. After the applicability of Section 404 is established and the application is made for the permit, USACE makes a determination as to whether the project can be permitted under either an individual permit or a nationwide permit (NWP). Similar projects completed at the Laboratory have used the NWP process. The review process takes 45 days for NWPs and from 60 to 120 days for individual permits. If an individual permit is sought, a public review and response period is required, and the USACE conducts or updates the NEPA EA or EIS for the project.

Under Section 401 of the CWA, the state of New Mexico has the option to certify any Section 402 or 404 CWA permits or licenses. If the certification option is exercised, the state can deny, approve, or approve conditionally the subject permit. In New Mexico, the NMED–SWQB is charged with this responsibility. Typically, SWQB approval requires that the project be in accordance with applicable state laws and regulations, such as the New Mexico Surface Water Quality Standards.

In general, the NMED elects to certify Section 404 NWPs if affected streams are perennial or intermittent. Certification is typically waived for small ephemeral streams. All Section 404 individual permits undergo state certification. The state has up to 60 days to conduct or waive Section 401 certification. If for any reason a Section 404 permit cannot be certified under Section 401, the applicant has to make appropriate modifications (e.g., mitigation measures, engineering controls, best management practices [BMPs]), and resubmit the permit application through the process.

Construction Stormwater Pollution Prevention Plan. The Laboratory has a general SWPPP, which will apply to this work. The amendment process consists of completing a form to describe the intended construction scope of work and proposed BMPs.

Area of Contamination and "Contained-In" Designations. To allow the efficient handling of excavated soil, the Laboratory will request that NMED designate the PRB construction site as an area of contamination. An area of contamination designation was previously used for the IM at the 260 Outfall (NMED 2000, 070649). In addition, the Laboratory will request a "contained-in" determination from NMED for soil and particularly groundwater (EPA 1998, 064705). Groundwater at the site may contain trace concentrations of F-listed solvents NMED has previously granted "contained-in" determinations for soils associated with the IM and for alluvial purge waters in Cañon de Valle (e.g., NMED 2000, 064730).

7.4.3 PRB Construction

To ensure proper installation of the PRB, detailed specifications and a construction quality-control plan have been prepared (see Appendixes D and E). In addition, the PRB will be installed by qualified personnel; potential installation contractors will be evaluated with respect to their experience installing PRBs. Proper installation is critical for PRB function. Before construction begins, the contractor will complete several plans, including an excavation plan and a health and safety plan. In addition, several field activities will be conducted before the excavation plan is final, including test pits, collecting soil samples, and laboratory geotechnical testing of the soils.

Before installation, a site topographic survey will be performed, and three test pits will be installed along the length of the PRB. The test pits will confirm the depth to tuff along the PRB location, determine the extent of weathering or fracturing of the tuff, determine the need for construction dewatering, and yield soil samples, which will be used to test the proposed 10% bentonite soil mixture used for the groundwater diversion walls. Information and data from the test pits will be used to finalize the design of the PRB, including important PRB dimensions and the development of shop drawings for the fabrication of the reactive cell.

Several permits and approvals are required before construction begins (section 7.4.2), including a USACE Section 404 permit, a SWPPP, and a "Contained-In Determination" from the NMED. In addition, because of the presence of the Mexican spotted owl, a threatened and endangered species, construction will probably not be allowed in the spring.

Because of the relatively low alluvial hydraulic conductivity and groundwater flow rate (Table 7.2-1), construction dewatering should not be required during the installation of the PRB; the need for dewatering will be assessed from the test pits. The PRB should be installed during the dry months (e.g., September to November) to minimize groundwater infiltration into the excavations. Diversion of the perennial stream around the construction area will be required during construction of the PRB.

Once all preliminary activities are complete, including the preparation of final drawings that reflect information obtained from test pits, the PRB will be installed according to the following sequence:

1. Temporary diversion of the stream around the construction site and installation of BMPs
2. Excavation of the trenches for the groundwater diversion wall and the PRB reactive cell, with both locations keyed into tuff
3. Grouting of the visible fractures in tuff along the wall and at the reactive cell location
4. Construction of a level reactive cell base using concrete
5. Installation of the reactive cell by sealing it to its concrete base using lag bolts and grout
6. Installation of the groundwater diversion walls by mixing soil with bentonite in the proper proportions, backfilling, and compacting according to the specifications
7. Sealing of the diversion wall against the sides of the reactive cell
8. Backfilling of the reactive cell and placement of the reactive media within the cell
9. Installation of a concrete collar around the reactive cell
10. Installation of three new alluvial groundwater wells for the purpose of monitoring PRB performance
11. Restoration of the site, to include reseeding and installation of erosion-control measures along the streambed and along the groundwater diversion wall

Wastes generated by the installation of the PRB will include soil, drill cuttings, development and decontamination water, and PPE. To the extent possible, soil from trenching operations will be reused on-site after it is mixed with bentonite. The plan to manage these wastes is presented in Appendix F.

7.5 Qualifications of Construction Personnel

As part of the contractor-selection process, potential PRB installation contractors will be evaluated on their qualifications. Only experienced PRB-installation contractors will be considered. In addition, as described in the following section, an experienced construction quality-control officer, independent from the contractor, will be present during the PRB construction to ensure that the specifications and design drawings are followed.

7.6 Construction Quality-Control Plan

A construction quality-control plan (Appendix E) has been developed to ensure the PRB is properly installed. This plan, in conjunction with the design drawings and specifications, emphasizes important details in the installation of the PRB and details which are critical to proper PRB function. These details include the following steps.

- Ensuring that the groundwater diversion walls are keyed into tuff, that any obvious fractures in bedrock are sealed with grout, and that the walls are sealed at the canyon walls. These measures are necessary to avoid groundwater bypass and will be monitored in the field during installation.

- Ensuring that the proposed soil and 10% bentonite mixture form a low-permeability wall. Completion of this step will be established by permeability testing of a test mixture derived from soil excavated from the test pits before and during construction (as part of quality control during field mixing and placement of the wall).
- Ensuring that excavated faces of the alluvium at the entrance and exit of the PRB are not "smeared" by the excavator bucket. Smearing can cause low permeability, which will impede groundwater flow through the PRB. These details will be monitored and documented in the field.
- Ensuring that the PRB reactive cell is keyed into tuff, that any visible fractures are grouted and that the reactive cell is grouted and then bolted in place. These measures will preclude groundwater bypass of the PRB.
- Ensuring that proper as-built drawings are developed.

To ensure proper installation, a full-time, independent construction quality-control officer will be present during construction. In addition, the construction specifications identify several key submittals that must be approved by the Laboratory before construction begins, including final shop drawings for fabrication of the PRB. Several "hold and witness" points have been identified at which the construction contractor must suspend construction until the construction quality-control officer authorizes further construction.

During construction, NMED will be apprised of construction progress and consulted if construction issues arise.

7.7 Operations and Maintenance and Reporting

Operations and maintenance of the pilot PRB will focus on the collection of PRB performance data so that the effectiveness of the pilot PRB may be evaluated. Criteria for effectiveness include ability to treat HE and barium to groundwater standards, the flow rate of groundwater treated, the durability of the PRB installation, and the life of the PRB media. The performance data will consist of both hydrological and geochemical data involving both field and laboratory analyses. Important data will include

- Groundwater levels within the reactive cell and in the surrounding alluvial groundwater wells;
- Groundwater flow rate through the PRB as determined from groundwater levels;
- Prereactive and postreactive cell groundwater concentrations of RDX, other selected HE; constituents (including TNT, HMX, and TNT and RDX-breakdown products), and barium
- Geochemical sampling (analyzed in Earth and Environmental Sciences [EES-6] laboratories) and testing consisting of field and laboratory methods for alkalinity, major cations and anions, nitrogen species, stable isotopes of carbon and nitrogen, and oxidation reduction potential within the reactive cell; and
- Visual observation of the structural integrity of the PRB.

Hydrological data will consist of periodic groundwater gauging data collected from the four alluvial wells and four PRB reactive cell wells. These data will permit an evaluation of local hydraulic head across the PRB, help to identify fouling, and allow the calculation of the groundwater flow rate through the PRB.

Groundwater samples will be periodically obtained from two upgradient wells (16-02658 and a proposed new alluvial well), from four sampling points within the PRB reactive cell, and from two new downgradient monitoring wells. Groundwater samples will be analyzed for a series of field and laboratory analytes in addition to RDX and barium to identify the processes that are occurring and to identify any problems that may arise during operation of the PRB. As discussed in section 7.3, one potential problem is the clogging of the PRB, which can result from precipitation of minerals such as calcite or biofouling within the reactive media.

The hydrological monitoring and geochemical sampling required to assess the performance of the PRB are summarized in Table 7.7-1. Cations should be analyzed in both filtered (0.45 micron) and unfiltered sample splits. The ratio of iron concentrations in filtered and unfiltered splits is an independent indicator of redox conditions. The ratio of manganese in filtered and unfiltered splits serves a similar purpose. The ratio of barium in filtered and unfiltered splits can be used to assess the role of suspended particulates in barium transport.

Sulfide and ferrous iron can be measured in the field using readily available field test kits. This approach avoids problems with the very short holding times for these analytes. Care will be taken to perform the sulfide and ferrous iron field tests quickly while minimizing contact with air, which will rapidly oxidize these analytes. Measurements of oxidation reduction potential and dissolved oxygen will also be performed while minimizing contact with air, possibly through use of an in situ probe, which can be placed within a reaction cell sampling port. Table 7.7-1 summarizes the key elements of the operations, maintenance, and sampling plan. Sampling and analyses will be conducted in accordance with the Laboratory's SOPs; relevant SOPs are summarized in Appendix G.

Data will be collected monthly for the first three months and then quarterly for the first year. After 1 yr of operation, a report summarizing the performance of the PRB will be prepared for the NMED. Any spent media removed from the PRB will be characterized for disposal in accordance with Laboratory waste-management procedures.

7.8 Contingency Plan for the Pilot PRB

The pilot PRB will provide operational data from which the effectiveness of the PRB for remediation of alluvial groundwater can be determined. A 1-yr operational period is proposed. If evidence arises that the PRB reactive media are not effective, the media will be replaced with an alternative. Consultation with NMED will precede any PRB corrective actions.

After 1 yr, if the data indicate that PRBs are not an effective technology for remediating alluvial groundwater, other alternatives will be examined in consultation with NMED. These alternatives, which are summarized in the CMS (LANL 2003, 085531), include groundwater recovery and treatment in a central treatment plant.

8.0 SUMMARY, PLAN FOR EVALUATING CORRECTIVE MEASURES, AND SCHEDULE

8.1 Summary

This CMI plan presents the designs and plans for implementing remediation actions within the former 260 Outfall channel and in the alluvial systems of Cañon de Valle and Martin Spring Canyon. These actions consist of removing the outfall concrete trough and excavation of soils in selected areas within the 260 Outfall channel, grouting a contaminated surge bed under the former settling pond, maintaining the existing low-permeability cap on the settling pond, installing a carbon filter on Burning Ground Spring, modifying the existing carbon filter at Martin Spring, and installing a pilot PRB in Cañon de Valle. In addition, soil samples will be collected from a location in Cañon de Valle for the purpose of investigating possible silver contamination.

Target cleanup levels for these actions were established as part of the CMS (LANL 2003, 085531). They consist of risk-based soil remediation levels for cleanup of outfall soils, the New Mexico Water Quality Control Commission groundwater standard for barium (1000 µg/L), and the RDX groundwater concentration (6.1 µg/L) derived from the 10^{-5} carcinogenic risk level.

For the remediation of the 260 Outfall channel soils, residual soils exceeding the cleanup levels in the former settling pond and in two additional areas will be excavated, stockpiled, sampled, and disposed of properly. Field and laboratory analytical methods will be used to guide the excavation and confirm attainment of cleanup levels. Less than 50 yd^3 of soil may be removed from these areas. After meeting of the remediation objectives, a low-permeability cap will be installed over excavated areas. Operations and maintenance will consist of inspection and maintenance of the cap. In addition to excavation of the former settling pond, the existing concrete outfall trough will be removed, and the underlying soils will be sampled for possible contamination. Soils exceeding the SSLs will be removed.

An upper surge bed contaminated with HE under the former settling pond will be grouted to preclude groundwater infiltration into this horizon. As defined by area BHs, the maximum area for grouting is approximately 1250 ft^2. Because of the natural variability of surge beds, the final area for grouting cannot be determined a priori and will be determined in the field during grouting implementation. Operations and maintenance will consist of periodically checking a downgradient well for the presence of groundwater, and, if it is present, sampling it.

Soils from an area next to the SWSC pipeline right of way in Cañon de Valle will be sampled to investigate further an area of potential soil contamination by silver. Five soil samples will be collected and analyzed for metals. A second sample will be collected from the location with the highest silver concentration and submitted for biological toxicity analysis (chironomus testing). The results of the investigation will be submitted to NMED, and the need for subsequent action will be determined.

A subgrade carbon filter will be installed to remove RDX from spring waters from Burning Ground Spring. The new filter will be similar to the filter previously installed at Martin Spring. The existing carbon filter system at Martin Spring will be modified by adding a second spring-water collection box to collect water from a new seep. At SWSC Spring, which has been dry since 2002, a carbon filter will be installed if the spring flows again. Operations and maintenance activities will consist of periodic sampling of the spring water to ensure compliance with treatment levels, and replacement of the carbon filters when required.

A pilot PRB will be installed in Cañon de Valle to remove RDX and barium from groundwater. The pilot PRB has been designed to investigate the effectiveness of PRBs and to accommodate a testing program and possible media replacement. The PRB will be installed near existing alluvial monitoring well 16-02658 and will consist of a set of walls to divert groundwater into a reactive cell. The reactive cell will consist of two chambers for the reactive media. One chamber will contain ZVI. Media in the second chamber will remove barium; however, finalizing the choice of these media awaits the results of laboratory column tests, which are currently in progress. Candidate media include zeolite and calcium sulfate, with preliminary results indicating that zeolite is superior. If changeouts of the reactive media are required, the media can be accessed through lids on the top of the cell. The reactive cell contains four sampling ports for sampling of the groundwater within the cell. Existing well 16-02658 and a new alluvial well will be used as the upgradient, pretreatment sampling points. Two new alluvial wells to be installed downgradient of the PRB will serve as the post-treatment sampling points. Operations and maintenance activities will consist of the collection of data important for determining the effectiveness of the PRB.

All construction and excavation activities will be performed in accordance with a set of specifications and drawings, a construction quality-control plan, and Laboratory SOPs. Waste handling and disposal will be conducted in accordance with a waste-management plan presented in Appendix F.

8.2 Plan for Evaluating Corrective Measure Effectiveness

For each corrective measure, site and operational data will be gathered from which the performance of the corrective measure will be assessed. Key criteria for this assessment consist of the remedial objectives and performance criteria that have been developed for each corrective measure. The data-gathering activities are summarized in the operations and maintenance strategies that have been developed for each corrective measure. Following the implementation of the corrective measures, the Laboratory will submit to NMED a yearly report summarizing corrective measures implementation, operations and maintenance problems and corrections, important data tables and graphs, and other operational data. An assessment of measure effectiveness will also be provided in the annual report.

8.3 Schedule

During the implementation and operations phases, NMED will be informed of progress through regular monthly reports. The proposed implementation schedule includes the following milestones:

- May 2007: submittal of the CMI to the NMED
- August 2007: final approval of the CMI by the NMED
- June to August 2008: installation of test pits at the PRB location, completion of shop drawings and completion of final project plans
- September to November 2008: installation of the remedies

9.0 REFERENCES AND MAP DATA SOURCES

9.1 References

The following list includes all documents cited in the main body of this report. Parenthetical information following each reference provides the author(s), publication date, and Environmental Remediation Support Services (ERSS) (ER ID) number. This information is also included in text citations. ER ID numbers are assigned by the EP-ERSS Division Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the EP-ERSS Division master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; DOE–Los Alamos Site Office; EPA, Region 6; and the EP-ERSS Division. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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9.2 Map Data Sources

Boundary of Department of Energy Property In and Around the Los Alamos National Laboratory; LANL, Site and Project Planning Group; 01 February 2003 (Acquired 07 September 2004).

Fault Traces; Los Alamos National Laboratory, ENV Remediation Services Project, ER2005-0007; 1:24,000 Scale Data; 04 January 2005.

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LANL Technical Areas; Los Alamos National Laboratory.

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Locations of Springs; Los Alamos National Laboratory, Environmental Stewardship Division, in cooperation with New Mexico Environment Department, DOE Oversight Bureau, ER2005-0495; 1:2,500 Scale Data; 18 July 2005.

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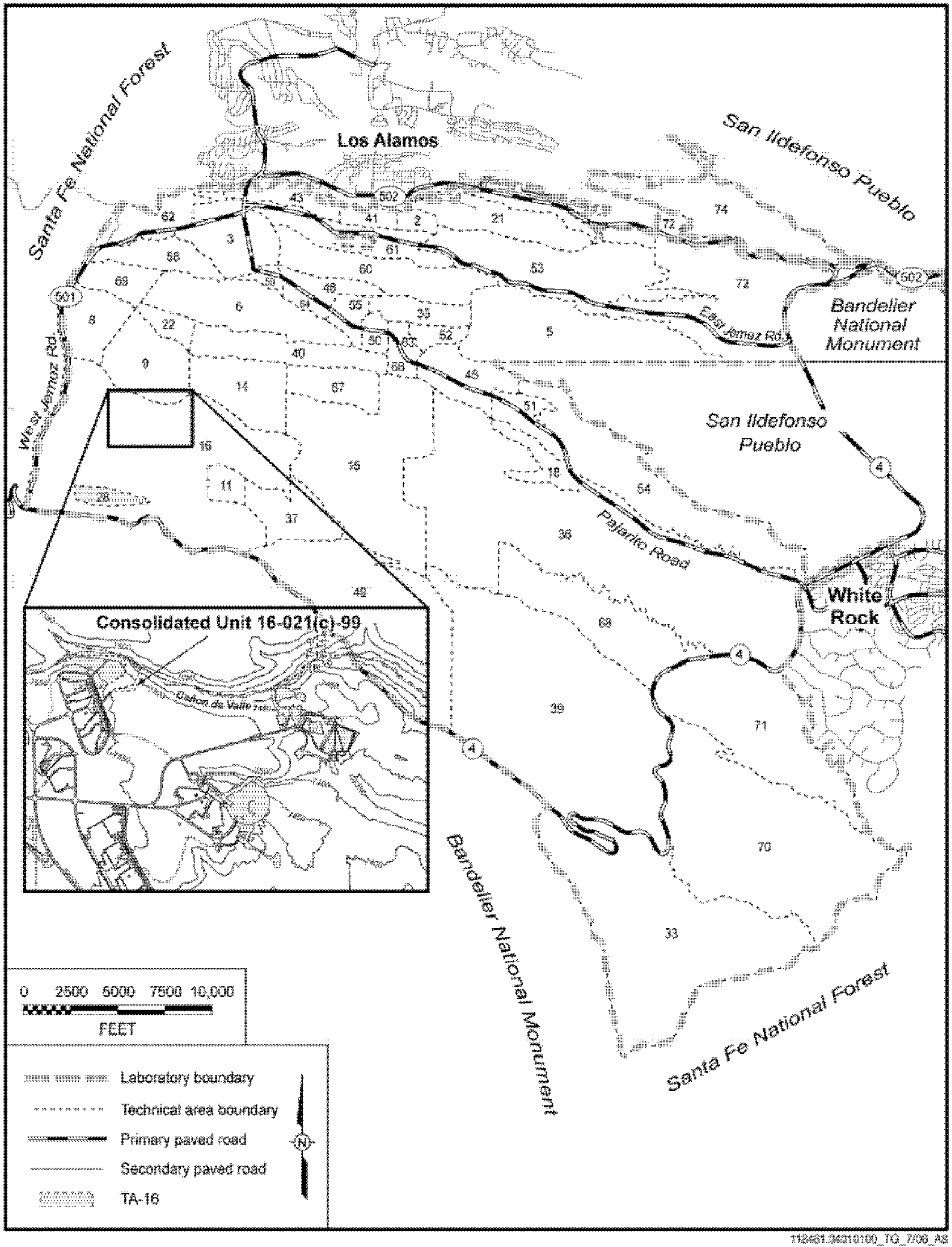

Figure 1.1-1 Location of TA-16 with respect to Laboratory technical areas and surrounding landholdings. Consolidated Unit 16-021(c)-99 is also shown.

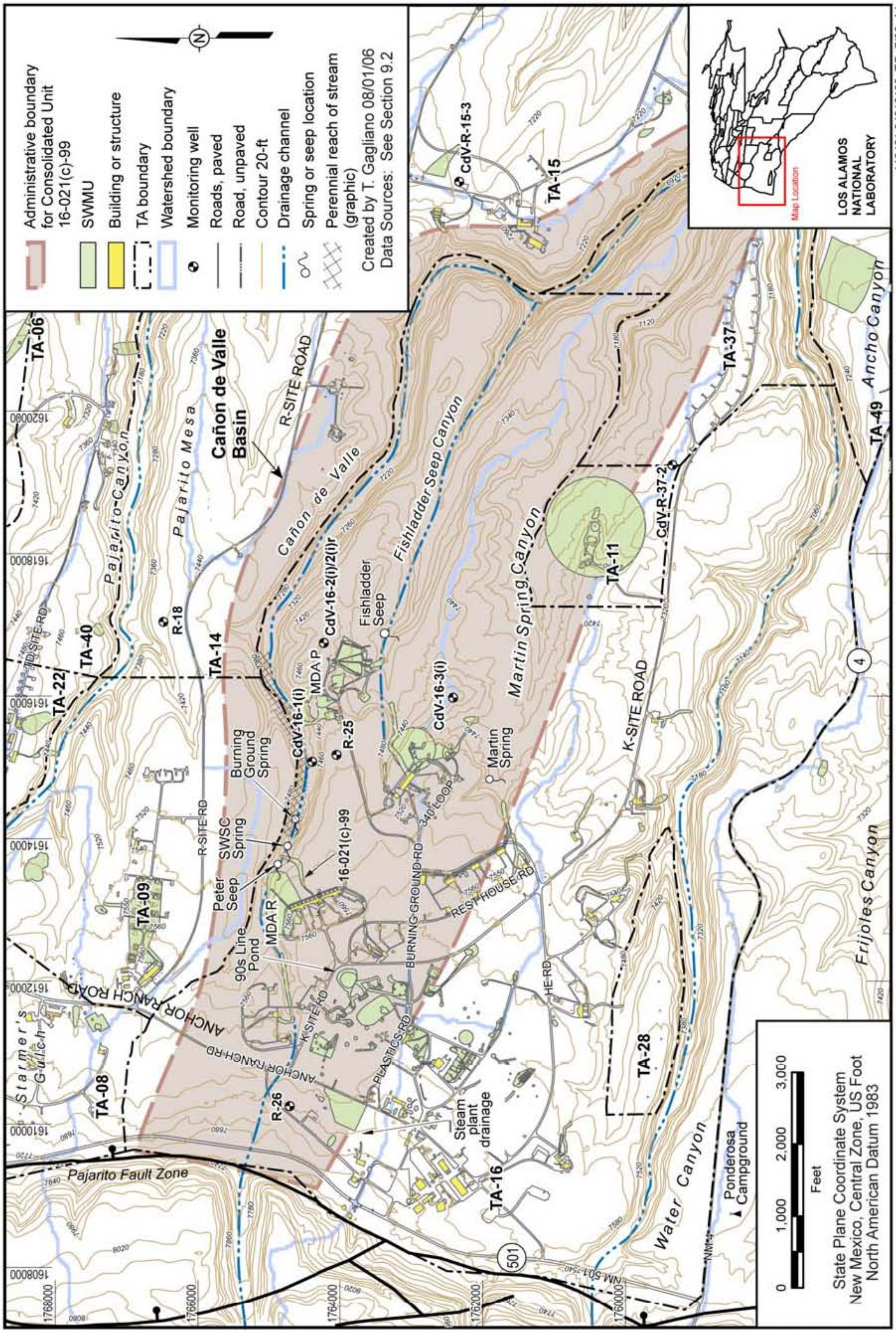

Figure 1.1-2 Administrative boundary for Consolidated Unit 16-021(c)-99 activities

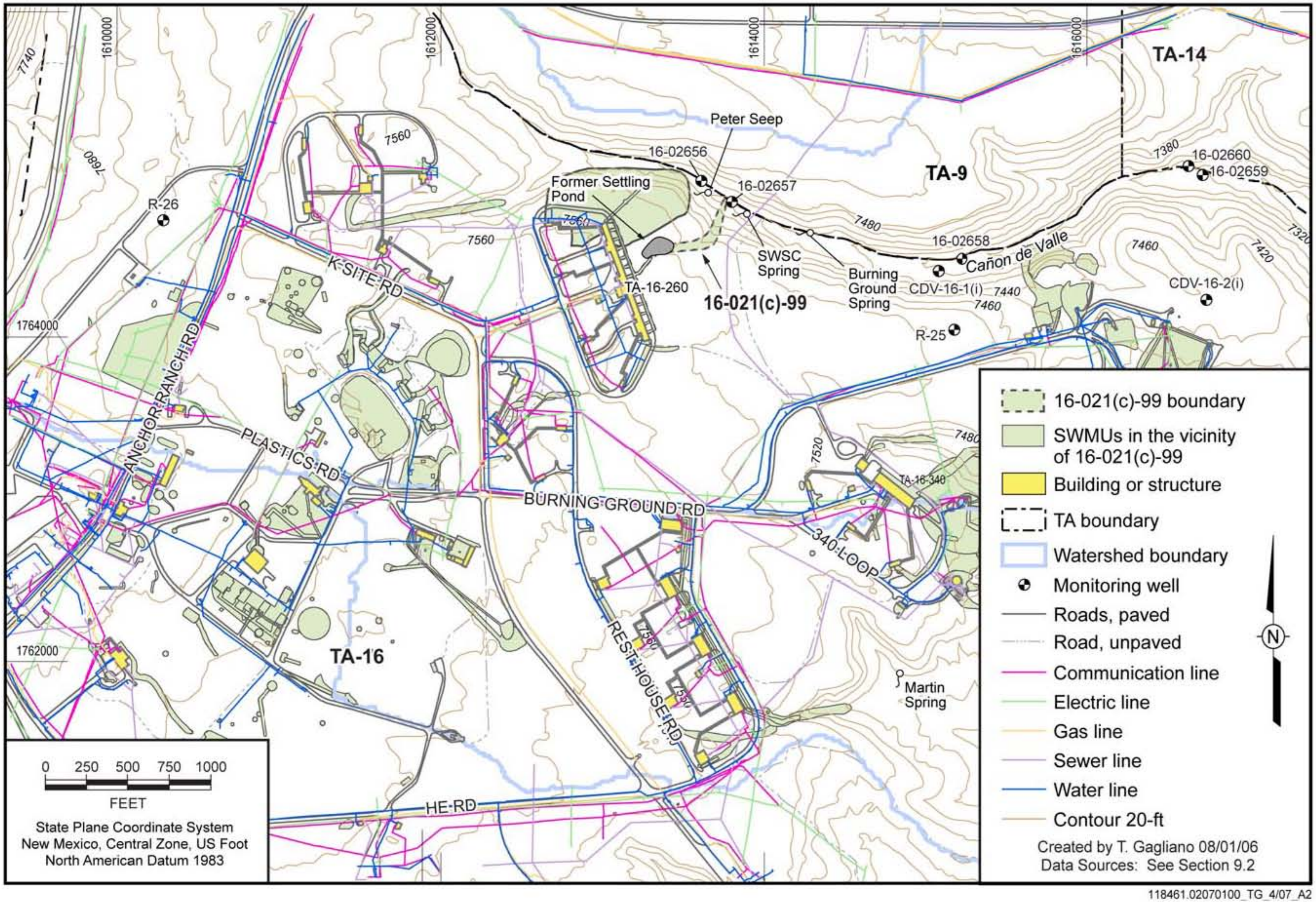

Figure 2.1-1 Location of Consolidated Unit 16-021(c)-99 and associated features

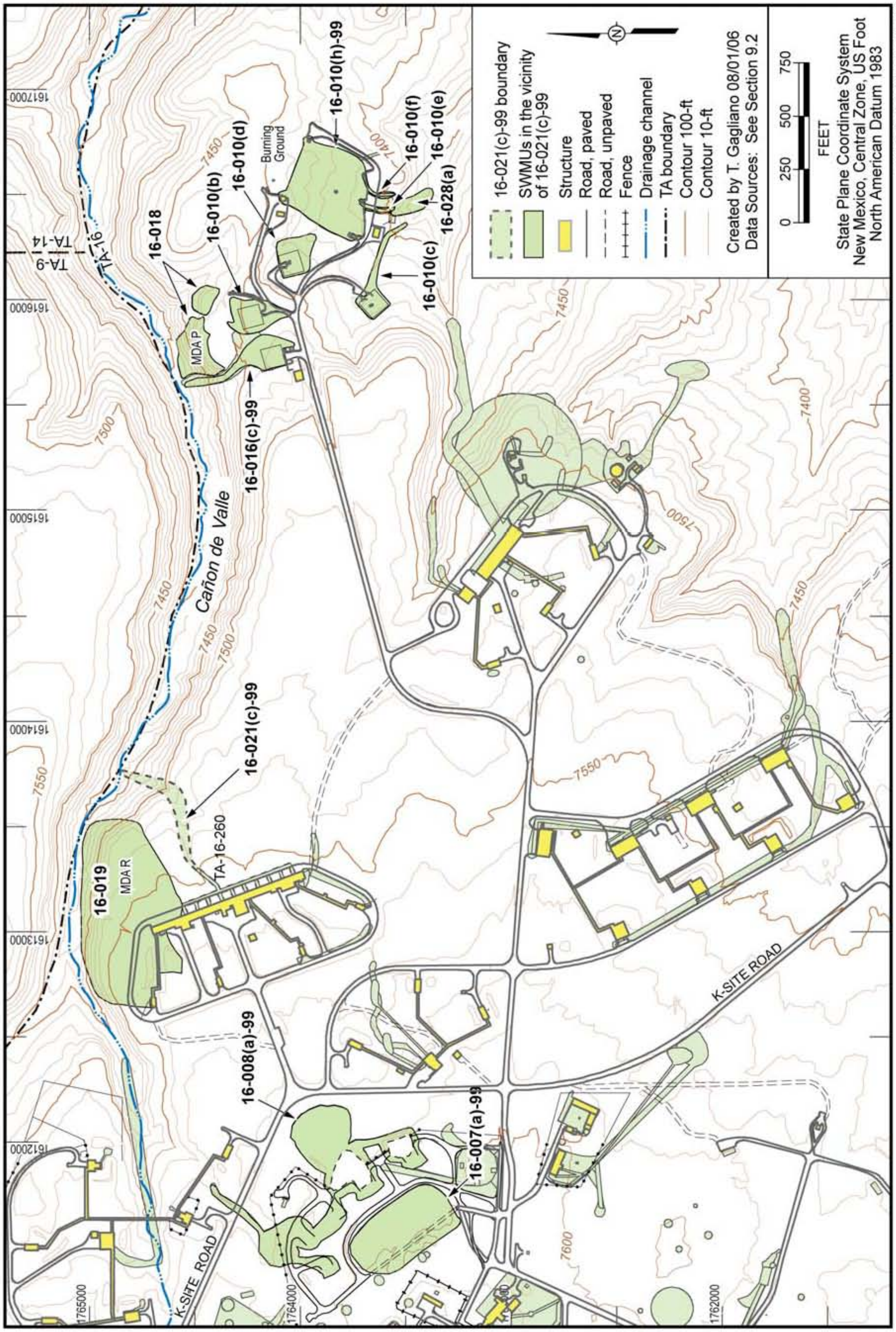

Figure 2.1-2 Major SWMUs in the vicinity of Consolidated Unit 16-021(c)-99

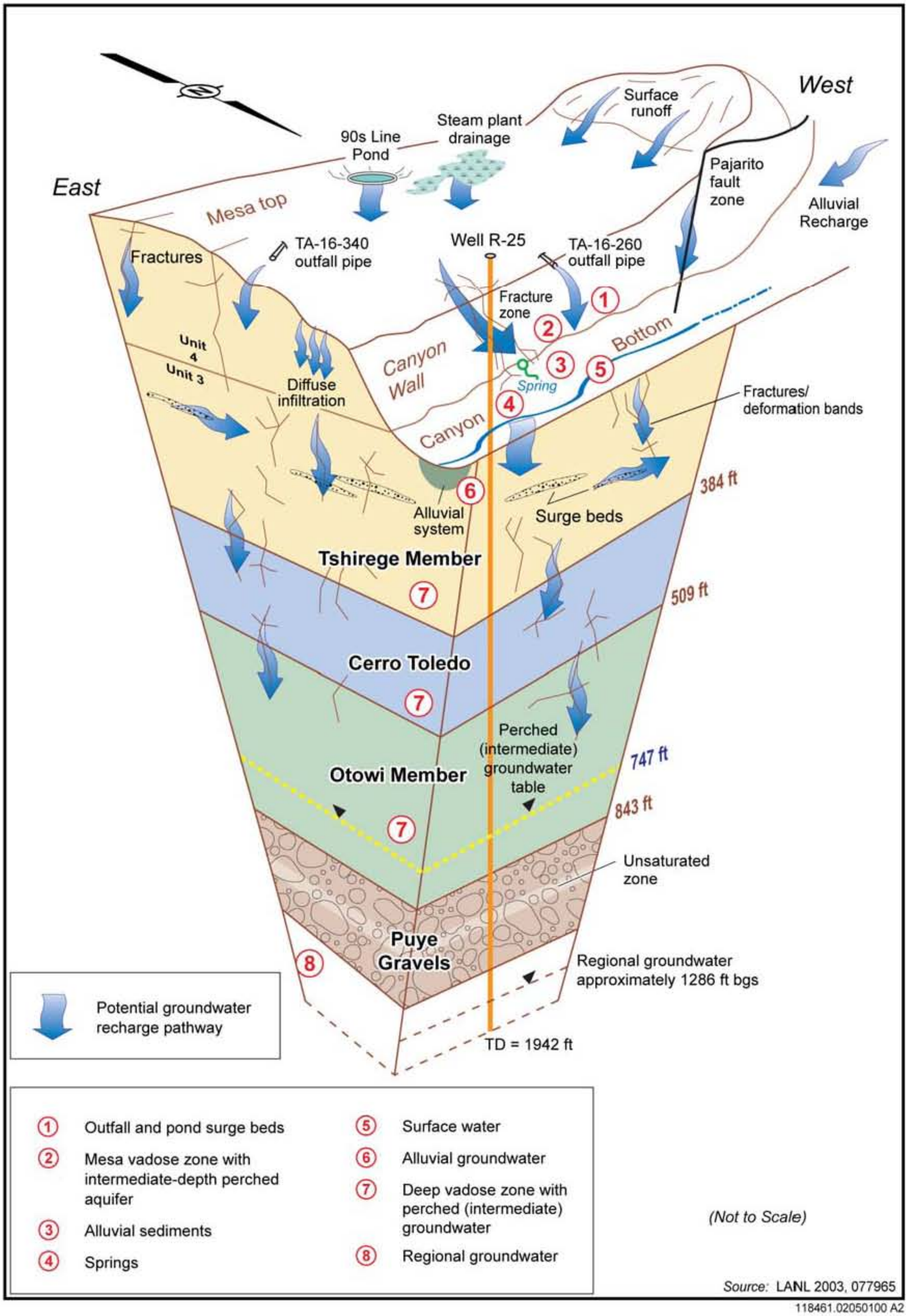

Figure 2.3-1 Conceptual model of hydrogeology and contaminant transport for TA-16 and Consolidated Unit 16-021(c)-99

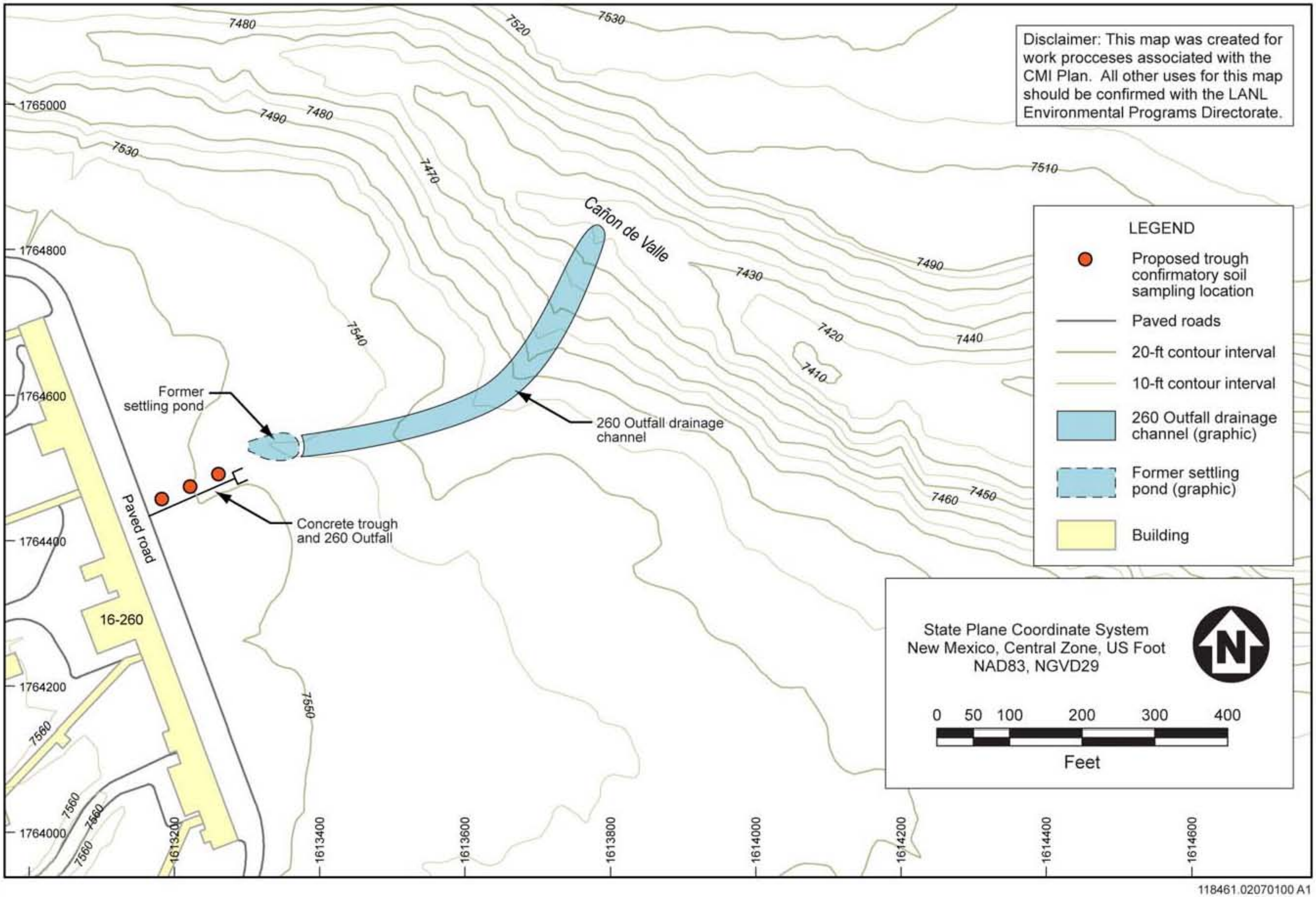

Figure 3.1-1 260 Outfall drainage channel and associated structures

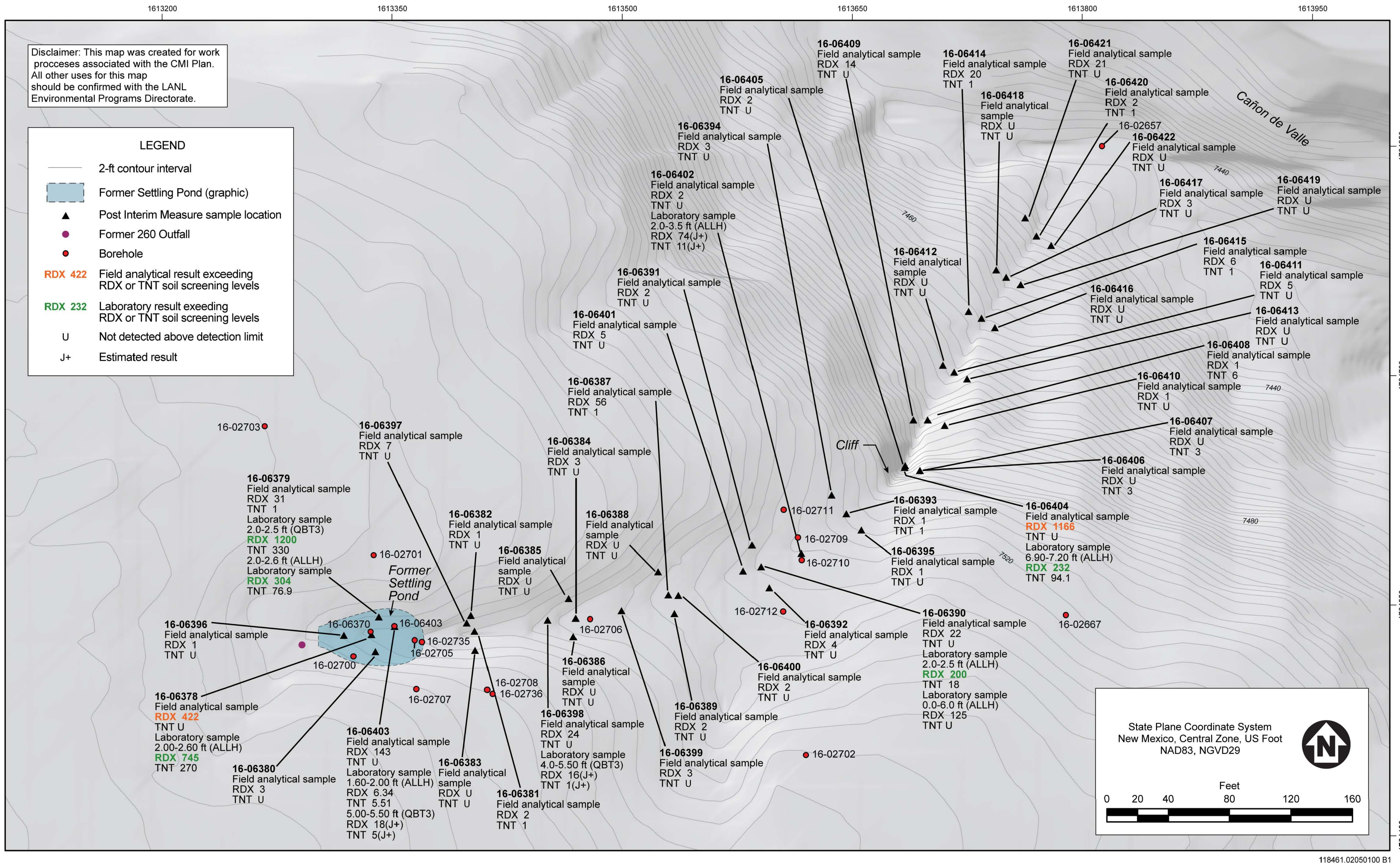

Figure 3.2-1 Post-IM RDX and TNT soil sampling results, 2000–2001

Figure 3.3-1 Photograph of concrete drainage trough

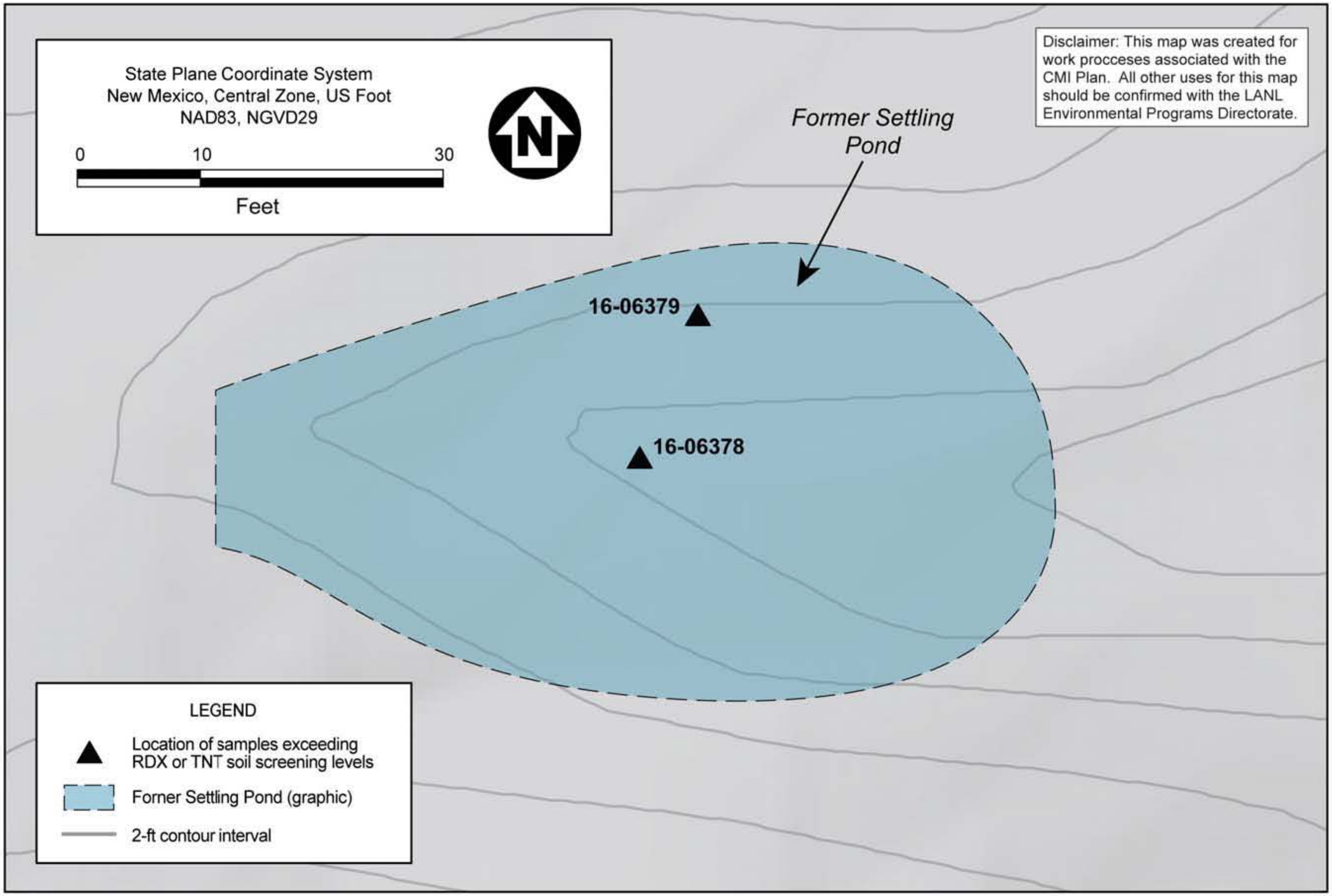

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Figure 3.3-2 Former settling pond with locations for soil removal

Figure 3.3-3 Photograph of sample location 16-06404

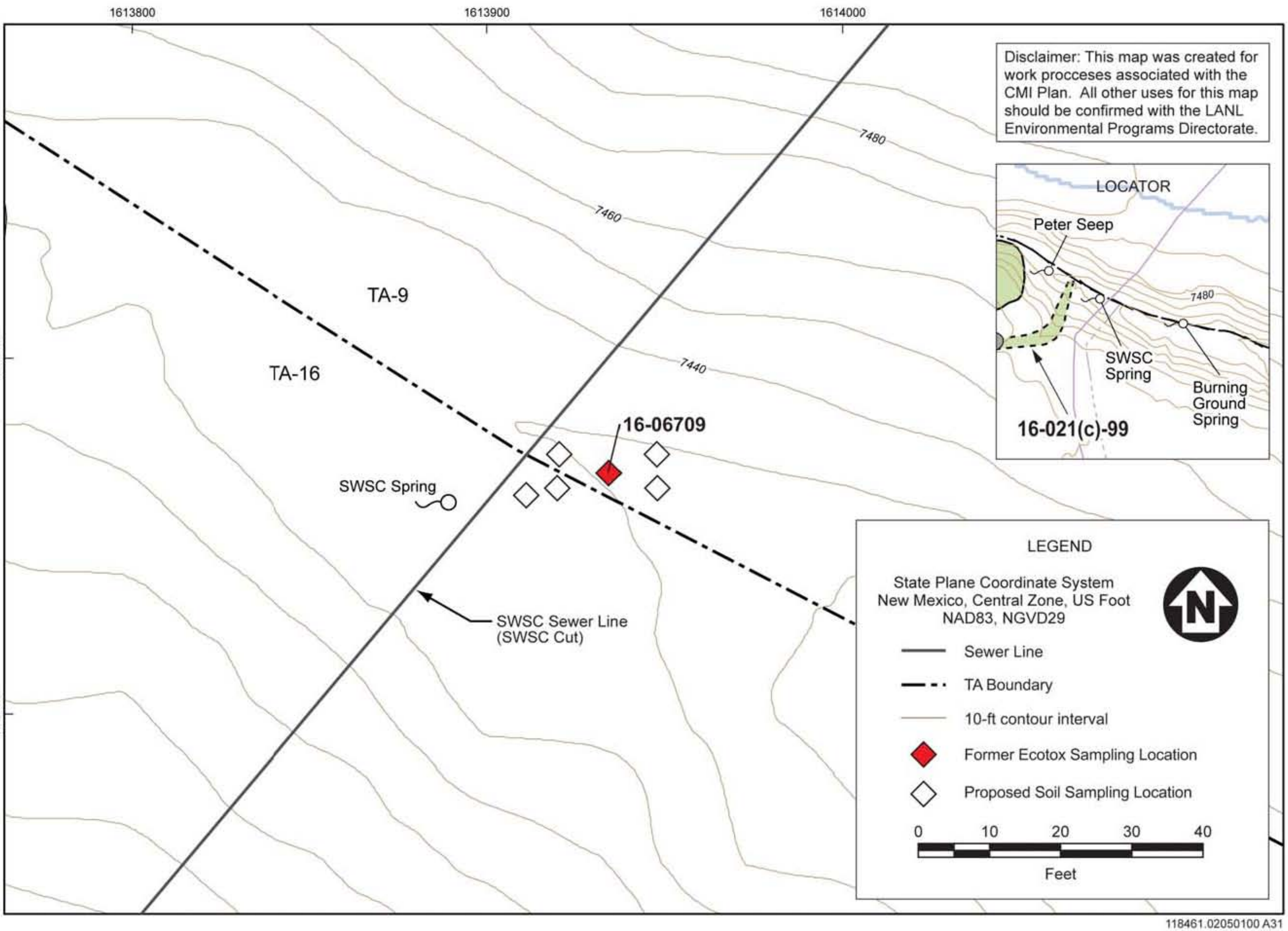

Figure 4.2-1 SWSC cut and proposed sampling locations

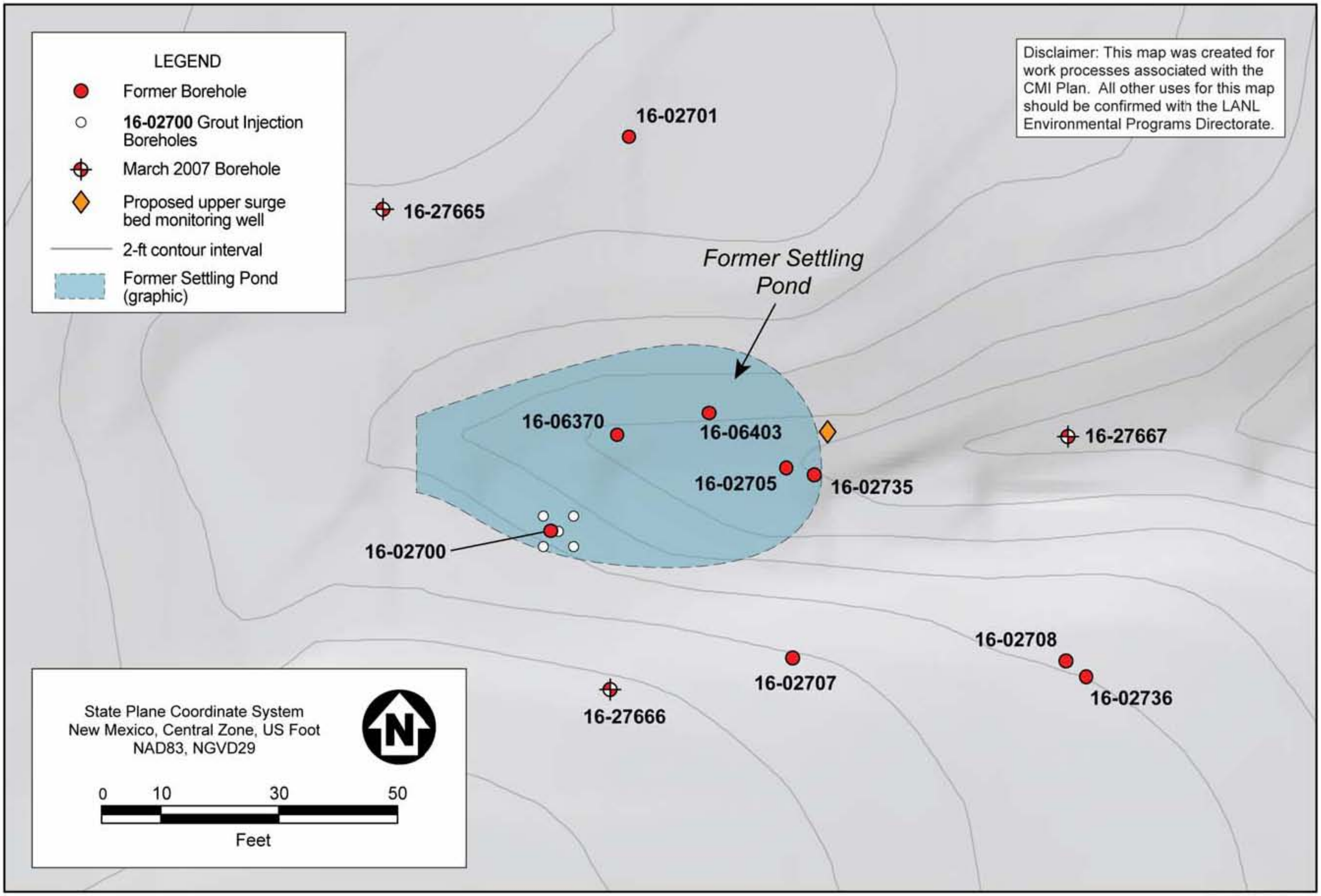

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Figure 5.3-1 Former settling pond grouting injection boreholes near BH 16-02700

Figure 6.1-1 Photograph of SWSC Spring and weir

Figure 6.1-2 Photograph of Burning Ground Spring and weir

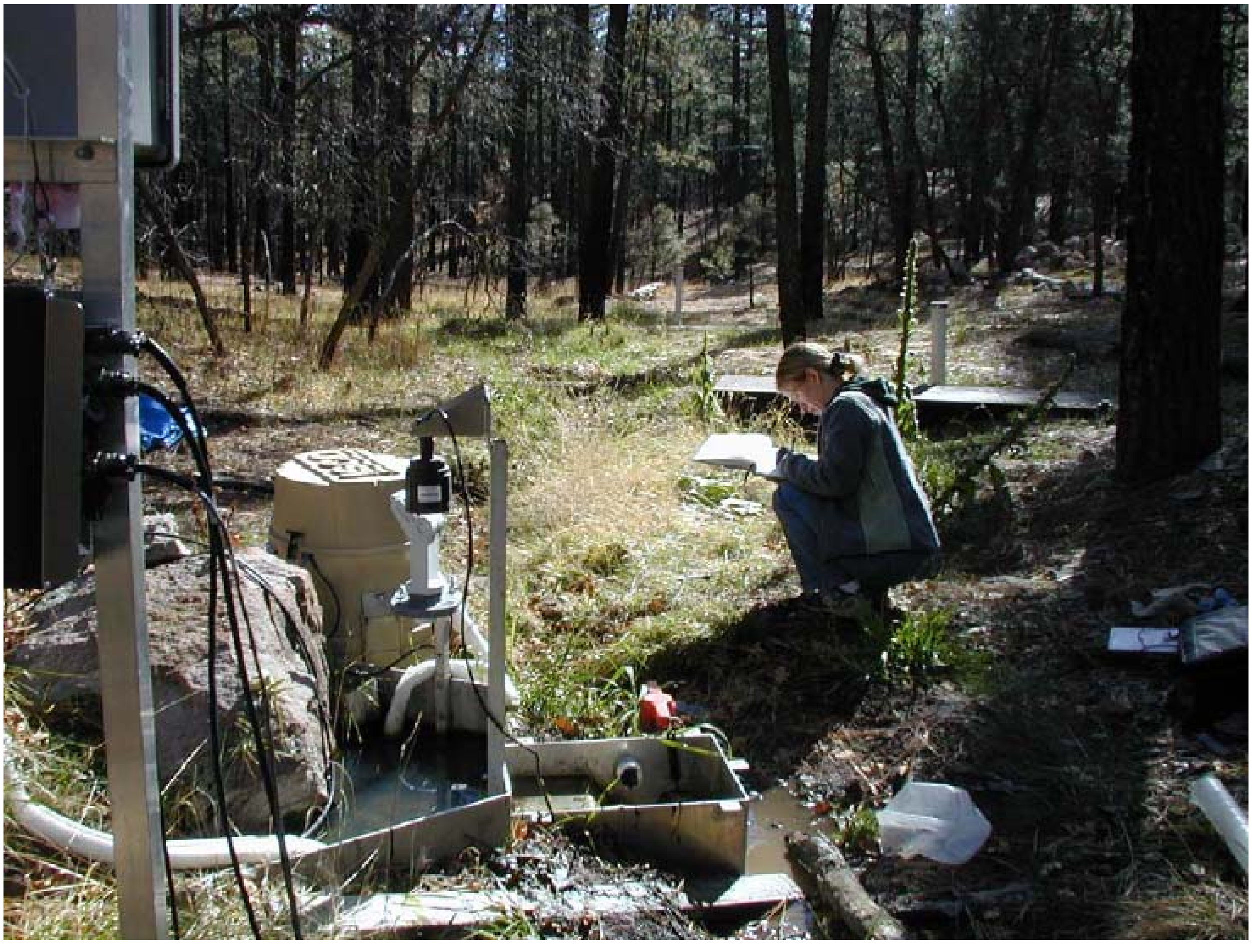

Figure 6.1-3 Photograph of Martin Spring and existing spring collection box

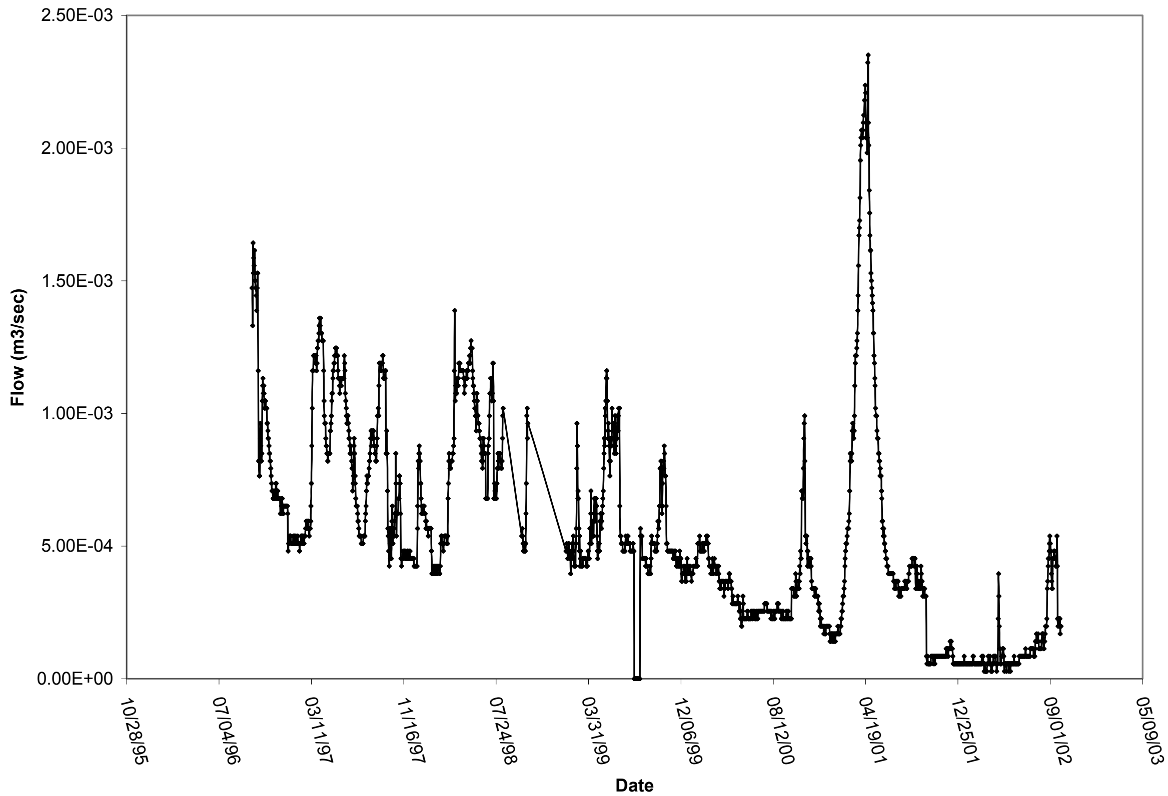

Figure 6.2-1 Burning Ground Spring water flow rate, 1996–2002

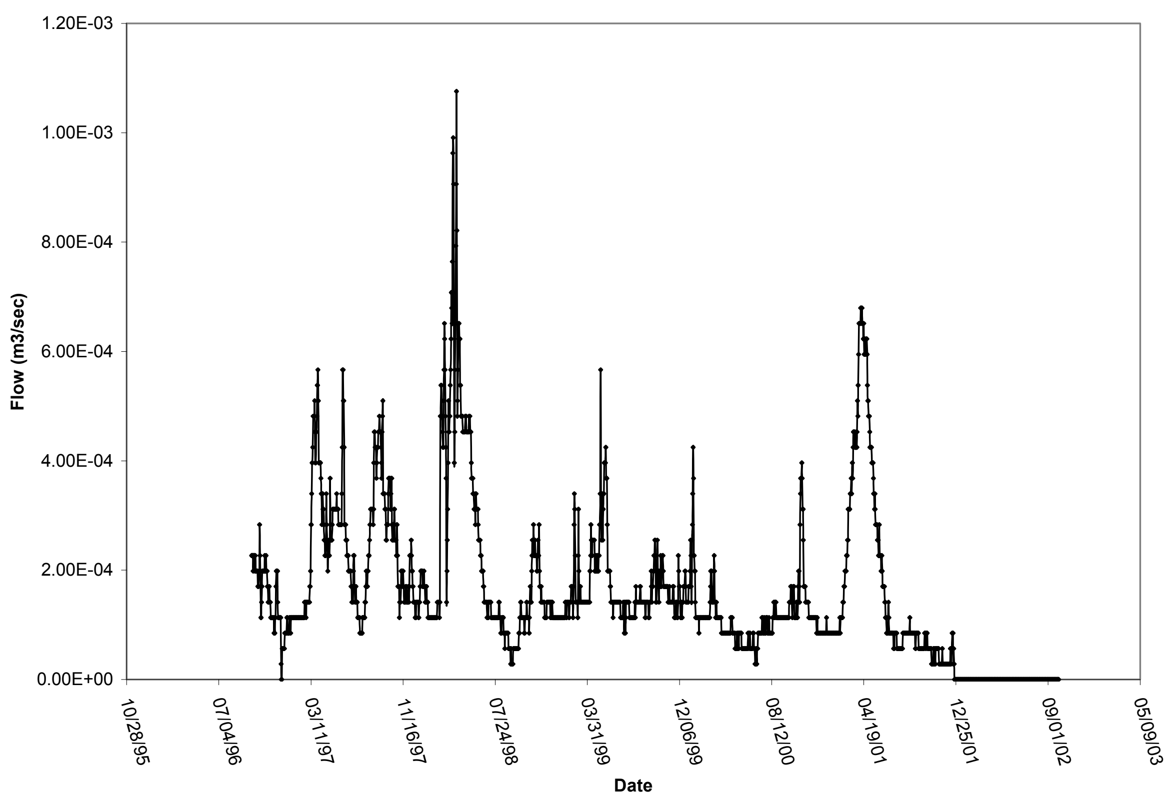

Figure 6.2-2 SWSC Spring water flow rate, 1996–2002

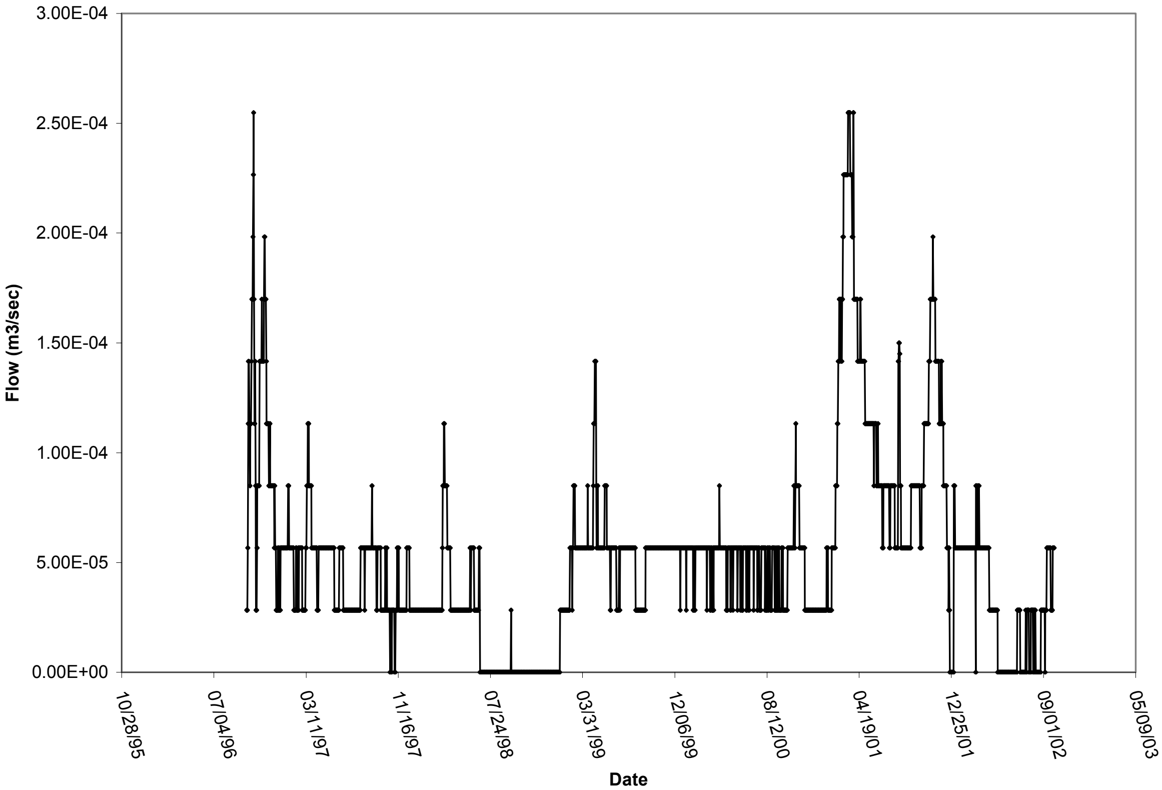

Figure 6.2-3 Martin Spring water flow rate, 1996–2002

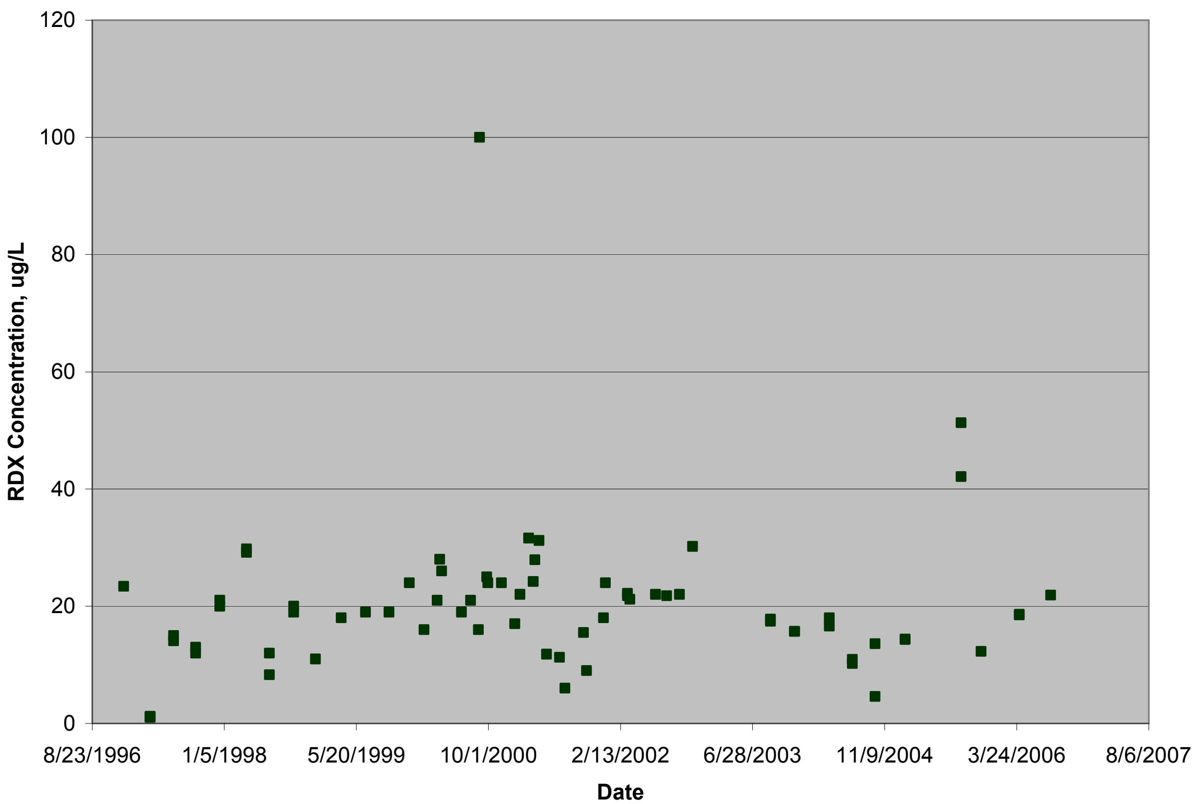

Figure 6.2-4 RDX concentrations in Burning Ground Spring, 1996–2006

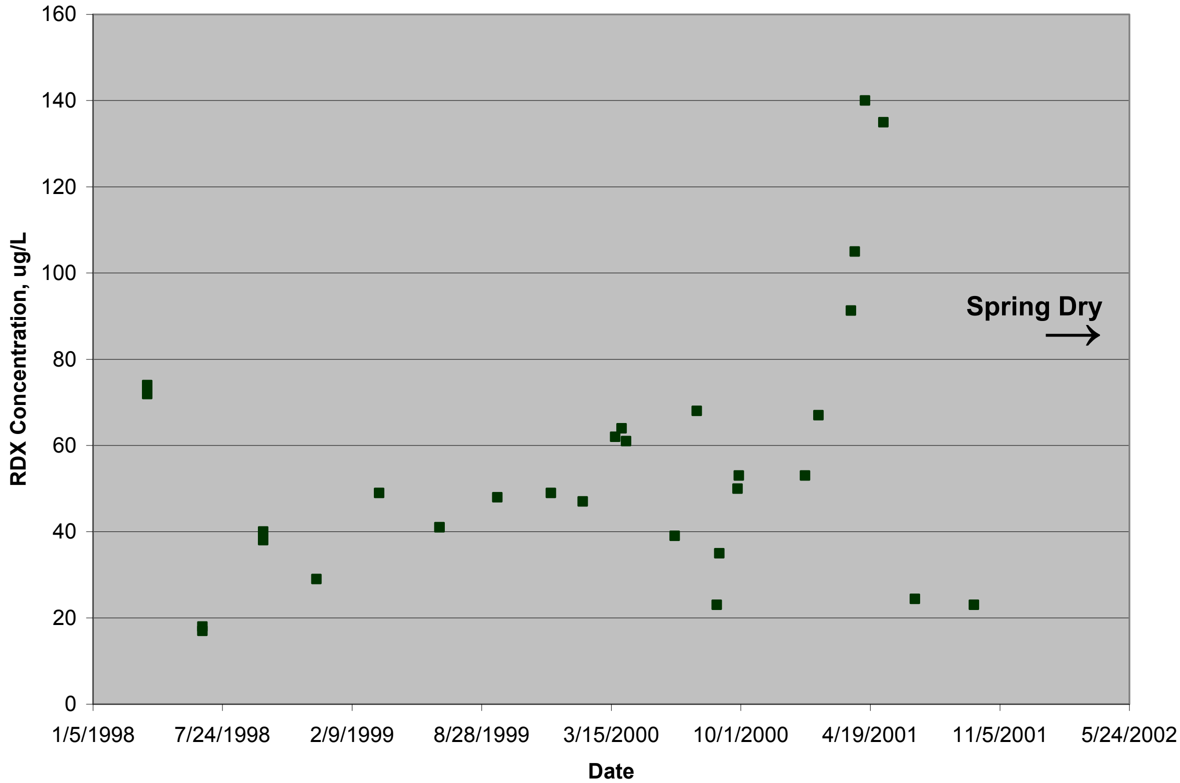

Figure 6.2-5 RDX concentrations in SWSC Spring, 1998–2001

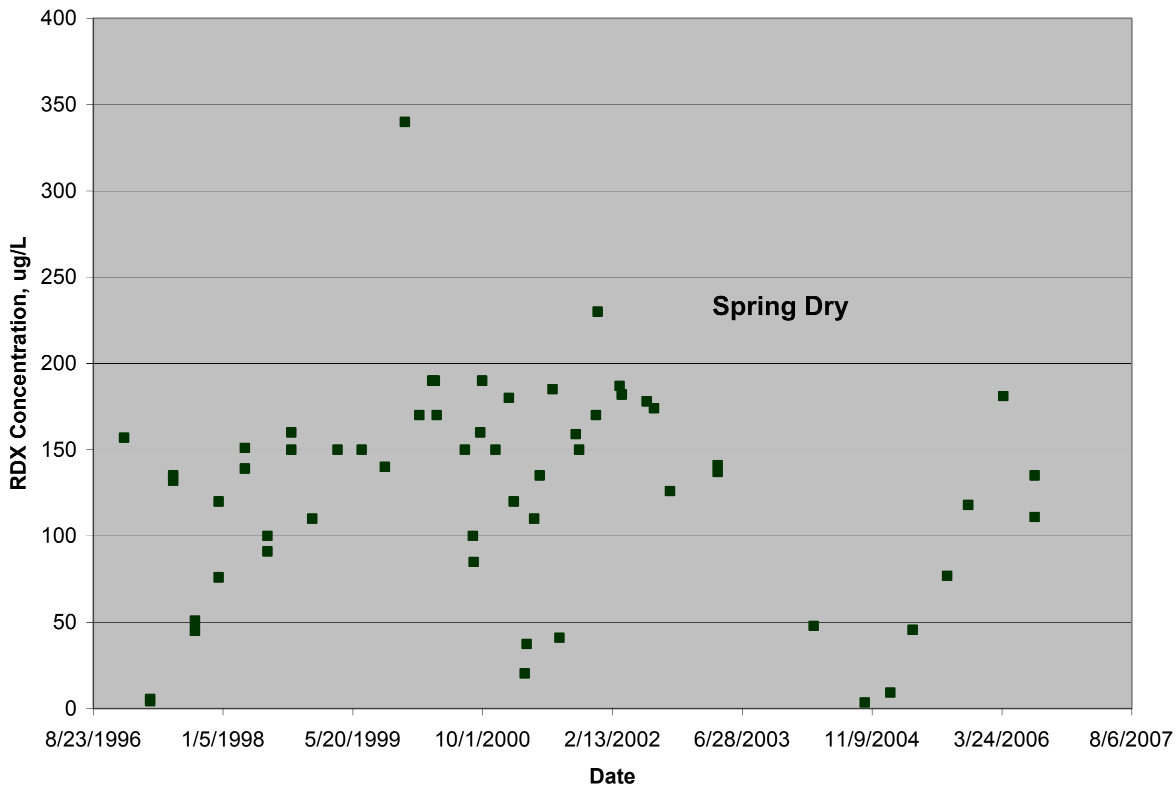

Figure 6.2-6 RDX concentrations in Martin Spring, 1996–2006

Figure 7.2-1 Photograph of the pilot PRB location and monitoring well 16-02658

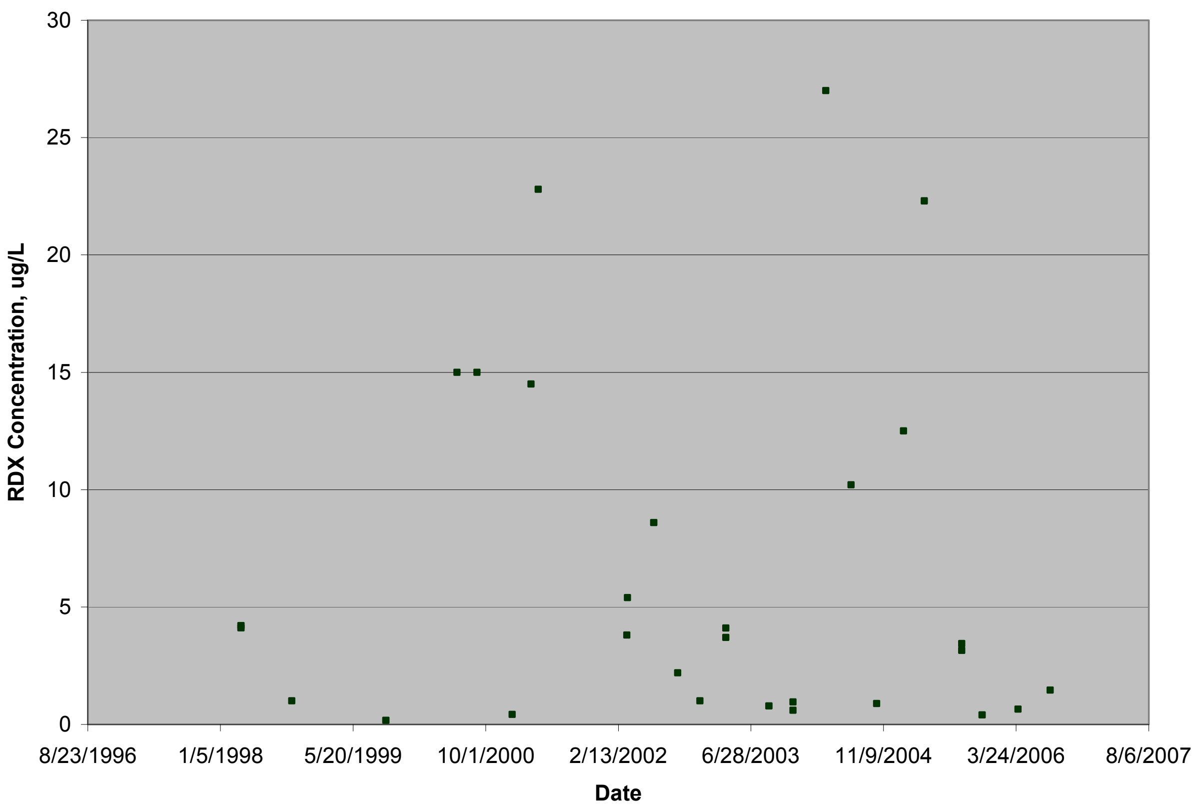

Figure 7.2-2 RDX groundwater concentrations in well 16-02658, 1998–2006

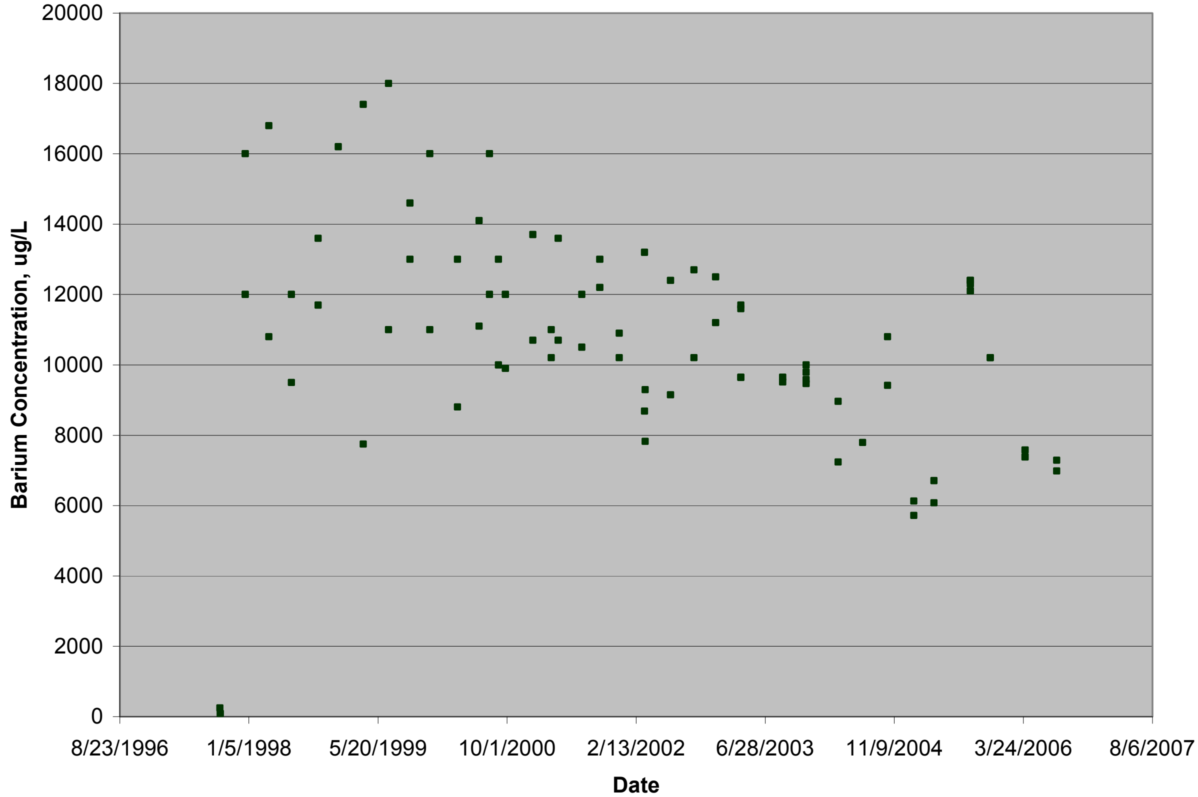

Figure 7.2-3 Barium concentrations in well 16-02658, 1998–2006

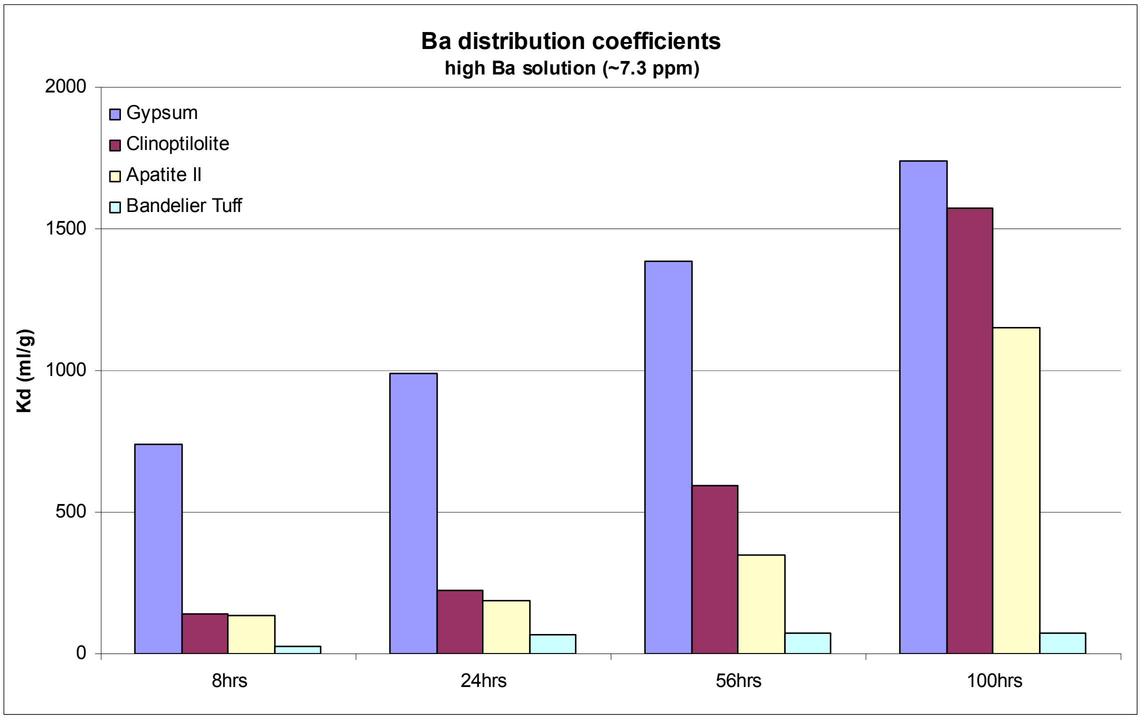

Figure 7.3-1 Distribution coefficients for different time intervals for Ba using high-Ba water

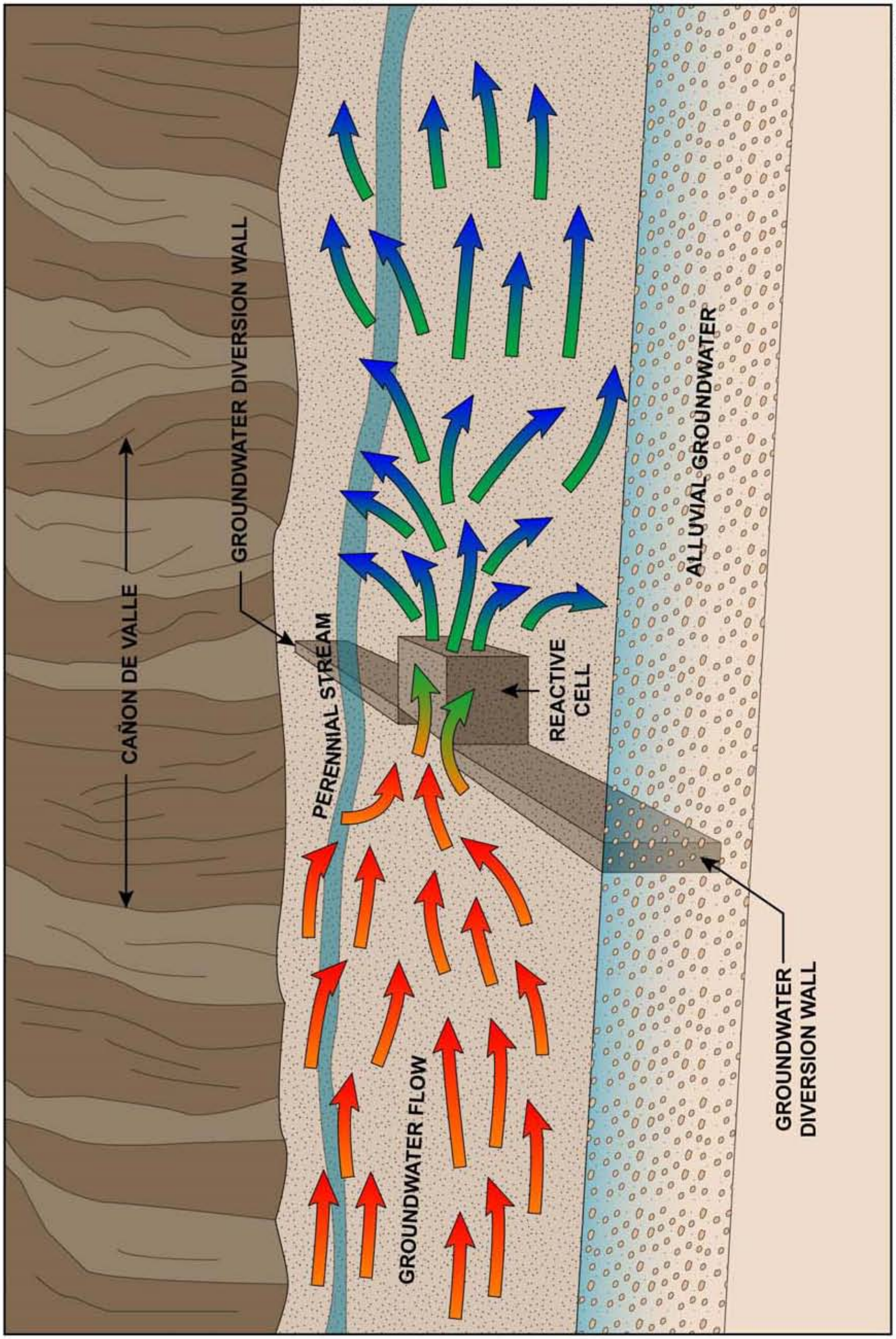

Figure 7.4-1 Conceptual drawing of the pilot PRB

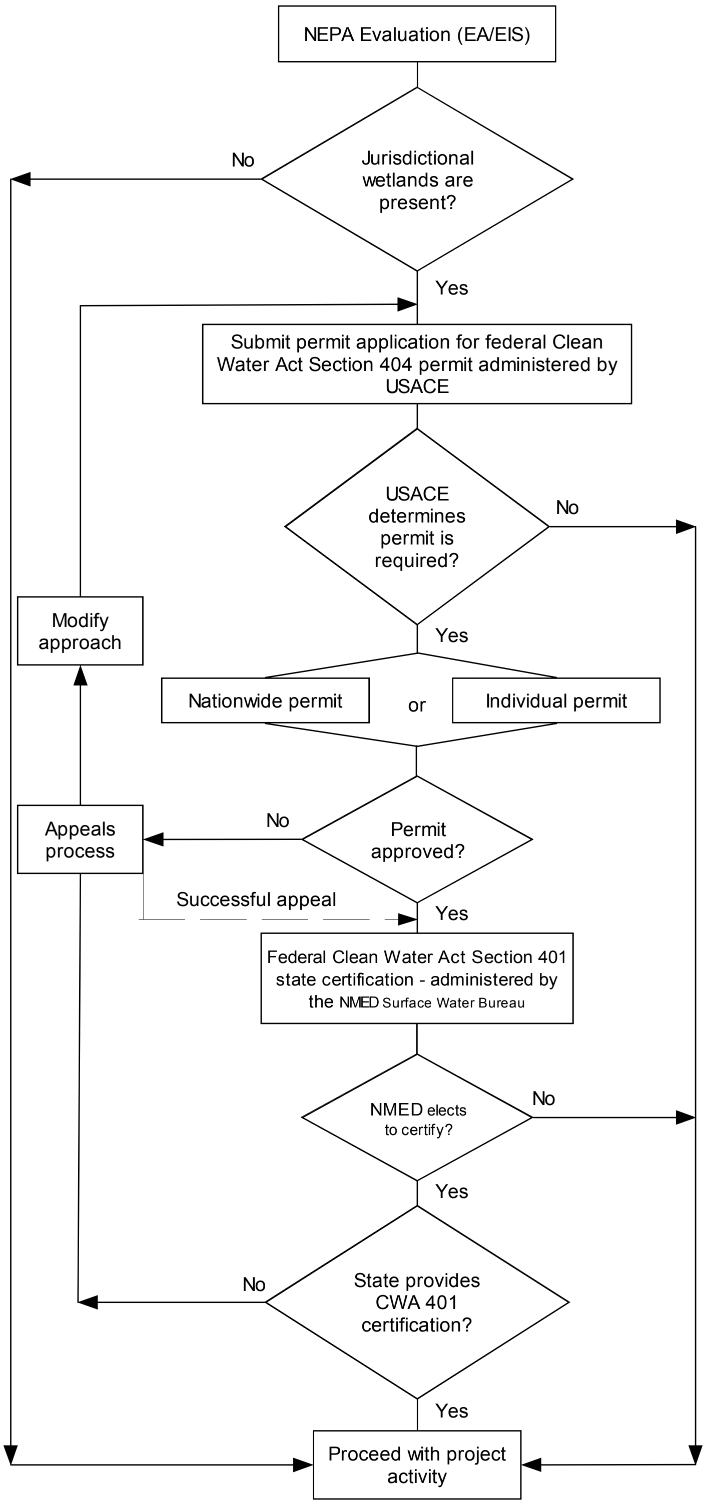

Figure 7.6-1 Flowchart of wetlands-permitting process

Table 2.3-1
Chronology of Laboratory Environmental Activities at Consolidated Unit 16-021(c)-99

Date	Activity (Reference)	Summary of Activity
1990	RFA (LANL 1990, 007512)	RFA initial site assessment is completed. Previous studies are summarized, and document extensive contamination in TA-16-260 sump water.
July 1993	Phase I RFI work plan—site characterization plan (LANL 1993, 020948)	“RFI Work Plan for Operable Unit 1082” is issued. Plan addresses Phase I sampling at SWMU 16-021(c).
May 1994	First addendum to Phase I RFI work plan (LANL 1994, 052910)	“RFI Work Plan for Operable Unit 1082, Addendum 1” is issued. Plan approved by NMED in January 1995.
April 1995–November 1995	Phase I RFI Site Characterization	Phase I RFI is implemented, including Phase I investigation of 16-021(c)-99.
1995–1996	Interim action – BMPs (LANL 1996, 053838)	Sandbag dam and diversion pipe are installed upgradient of the former HE pond; sandbag dam is located east of the parking lot behind TA-16-260; geotextile fabric matting is placed in former HE pond area; eight hay bale check dams are placed within the SWMU drainage between the rock dam and the 15-ft-high cliff.
September 1996	Phase I RFI Report (LANL 1996, 055077)	Phase I RFI report is issued. Data show widespread HE contamination at 16-021(c)-99, extending from the 260 Outfall discharge point down to the sediment and waters of Cañon de Valle. Report is approved by NMED in March 1998.
September 1996	Phase II RFI work plan (part of LANL 1996, 055077)	Phase II RFI work plan is included in Phase I RFI report. Report approved by NMED in March 1998.
November 1, 1996–December 23, 1996; May 1997–November 9, 1997	Phase II RFI site characterization	Phase II RFI implemented at 16-021(c)-99.
September 1998	Phase II RFI report (LANL 1998, 059891)	Phase II RFI report is issued. Data confirm widespread HE contamination extending from the 260 Outfall discharge point down to the sediment and waters of Cañon de Valle and show deeper subsurface contamination. Up to 1% total HE is detected in surge bed at a depth of 17 ft. Report documents risk to human health and the environment. Report approved by NMED in September 1999.
September 30, 1998	CMS plan (LANL 1998, 062413)	CMS plan is issued. Alternatives are evaluated. Report includes Phase III RFI sampling plan and describes ongoing hydrogeologic investigations for the site. Report approved by NMED in September 1999.
October 1998–March 2002	Phase III RFI site characterization	Continued monitoring and sampling are used to characterize the temporal and spatial variability of site contamination; components of the site hydrogeologic system are undergoing continued evaluation.
October 1998–November 2003	CMS—ongoing evaluation of alternatives	CMS is initiated. Series of soil and water corrective measures technologies are evaluated. Investigation of components of the site hydrogeologic system continues.

Table 2.3-1 (continued)

Date	Activity (Reference)	Summary of Activity
September 30, 1999	Addendum to CMS plan (LANL 1999, 064873)	Addendum to CMS plan is issued. Addendum expands investigations to include deeper perched and regional groundwater potentially impacted by releases from 16-021(c)-99.
November 1999	IM plan—abatement of potential risks at the source area (LANL 2000, 064355)	IM plan is issued. Plan specifies removal of the highly contaminated soil and tuff identified in the 260 Outfall drainage channel. Plan approved by NMED in April 2002.
November 12, 1999–November 18, 2000	Abatement of ongoing risks is initiated	TA-16-260 IM begins. Activities are interrupted by Cerro Grande fire. Initial stage of project completed in November 2000.
January 7, 2000	"Contained-in" determination (NMED 2000, 064730)	NMED memo of "contained-in" determination sent to the Laboratory (J. Brown) and DOE-ER (T. Taylor).
April 4, 2000	Designation of area of contamination (NMED 2000, 070649)	NMED designates 16-021(c)-99 an area of contamination. Purpose of designation is to allow material from entire drainage area to be excavated, processed, and segregated without invoking RCRA land disposal restrictions. Excavated material considered potentially hazardous waste is staged in covered piles within area-of-contamination boundary.
June 5, 2000	In situ blending authorization (NMED 2000, 067094)	NMED authorizes in situ blending in memo sent to the Laboratory and DOE. To ensure worker health and safety during the IM and after, settling-pond soil is robotically blended in situ with clean or low-HE-concentration material to reduce maximum concentration of settling pond sediment to below-reactive limit.
August 4, 2001–October 13, 2001	Abatement of ongoing risks is completed	Remobilization and removal of isolated areas containing more than 100 mg/kg of RDX is completed. Waste disposal stage of project is completed.
July 2002	260 Outfall IM report (LANL 2002, 073706)	IM results are presented in IM report. Report approved by NMED in January 2003.
March 2003	Revision 1 to CMS plan addendum—evaluation of alternatives (LANL 2003, 075986)	Addendum to CMS plan updated. Investigation into deeper perched and regional groundwater and deeper vadose zone potentially impacted by releases from Consolidated Unit 16-021(c)-99 is expanded further. Plan approved by NMED in March 2003.
September 2003	Phase III RFI report (LANL 2003, 077965)	Report focuses on investigations into the surface water, alluvial groundwater, canyon sediment, and springs in Cañon de Valle and Martin Spring Canyon. Report includes analysis of data generated since Phase II RFI report (post-1998) and baseline risk assessments using a comprehensive database of both pre- and post-1998 data and emphasizes greater understanding of site hydrogeology and contaminant behavior. Report presents human health baseline risk assessments for source area and selected reaches of Cañon de Valle and Martin Spring Canyon. In addition, a baseline ecological risk assessment is performed for that reach of Cañon de Valle.

Table 2.3-1 (continued)

Date	Activity (Reference)	Summary of Activity
November 2003	CMS report for alluvial system corrective measures evaluated/selected (LANL 2003, 085531)	CMS report for Consolidated Unit 16-021(c)-99 alluvial system. Report is a companion document to Phase III RFI report and relies heavily on the understanding of site hydrogeology and contaminant behavior outlined in that document. Report evaluates potential remedial technologies for media and proposes appropriate technologies.
May 2006	NMED request for public comment, alluvial system statement of basis	NMED issues request for public comment for selection of PRBs as the preferred alternative the alluvial system.
August 2006	Investigation report for intermediate and regional groundwater (LANL 2006, 093798)	Investigation report for the nature and extent of 16-021(c)-99 impacts to intermediate and regional groundwater.
October 2006	NMED approval of CMS (NMED 2006, 095631)	Final remedy approval for Cañon de Valle and Martin Spring Canyon alluvial groundwater and spring water, and 260 Outfall soils.
April 2007	Evaluation of the Suitability of Wells Near TA-16 for Monitoring Contaminant Releases from Consolidated Unit 16-021(c)-99 (LANL 2007, 095787)	Documents conditions of wells and well screens and evaluates locations of wells for monitoring releases and migration to groundwater for 16-021(c)-99.
May 2007	Corrective Measures Implementation Plan for Consolidated Unit 16-021(c)-99	Documents plans, including drawings and specifications for cleanup of 260 Outfall and copilot PRB in Cañon de Valle.

Table 6.2-1
Design Basis Flow Rates for Springs

	Burning Ground Spring	SWSC Spring	Martin Spring
Average, m^3/sec (gpm)*	2.5×10^{-4} (4.0)	2.0×10^{-4} (3.1)	0.5×10^{-5} (0.1)
Minimum, m^3/sec (gpm)	1.0×10^{-4} (1.6)	0.0 (dry spring)	0.0 (dry spring)
Maximum, m^3/sec (gpm)	2.4×10^{-3} (38.0)	1.1×10^{-3} (17.4)	2.5×10^{-4} (4.0)

*m^3/sec = Cubic meter(s) per second; gpm = gal. per min.

Table 6.2-2
Design Basis RDX Concentrations for Springs

	Burning Ground Spring	SWSC Spring	Martin Spring
Average, µg/L	23	50	126
Minimum, µg/L	1	20	4
Maximum, µg/L	100	140	340

Table 7.2-1
Design Basis Aquifer Parameters for the Pilot PRB

	Thickness of Saturated Alluvium (ft)	Depth to Water from Ground Surface (ft)	Hydraulic Gradient	Expected Groundwater Flow Rate (gallons per day)
Average	2.27	3.13	0.044	50
Minimum	0.50	2.45	0.043	10
Maximum	2.95	4.90	0.045	100

Table 7.2-2
Design Basis RDX and Barium Concentrations for the Pilot PRB

	RDX	Barium
Average, µg/L	6.6	9,400
Minimum, µg/L	0.2	90
Maximum, µg/L	27.0	18,000

Table 7.7-1
Summary of Monitoring and Sampling Plan for the Pilot PRB

Parameter	Frequency
Hydrology	
Water levels in four alluvial and four PRB wells	Monthly for the first three months; quarterly thereafter
Laboratory Chemistry	
HE (selected compounds)	Monthly for the first three months; quarterly thereafter. Samples collected from four alluvial wells and four PRB wells.
Barium	
Cations (calcium, magnesium, iron, manganese)	
Anions (sulfate, chloride, nitrate, alkalinity)	
General chemistry (total dissolved solids, total organic carbon, stable isotopes)	
Stable isotopes	
Field Chemistry	
Oxidation reduction potential.	Monthly for the first three months; quarterly thereafter. Samples collected from four alluvial wells and four PRB wells.
Dissolved oxygen	
pH	
Temperature	
Electrical conductivity	
Turbidity	
Sulfide	
Ferrous iron	

Appendix A

Acronyms, Glossary, and
Metric Conversion and Data Qualifier Tables

A-1.0 ACRONYMS AND ABBREVIATIONS

A-DNT	amino-dinitrotoluene
AK	acceptable knowledge
amsl	above mean sea level
AOC	area of concern
ASTM	American Society for Testing and Materials
BCT	breakthrough curve
bgs	below ground surface
BH	borehole
BMP	best management practice
CCSM	contractor construction site manager
CMI	corrective measures implementation plan
CMS	corrective measures study
COPC	chemical of potential concern
cps	counts per second
CQCP	Construction Quality Control Plan
CSM	conceptual site model
CWA	Clean Water Act
DI	deionized water
DOE	Department of Energy (U.S.)
DOT	Department of Transportation (U.S.)
dpm	disintegrations per minute
EA	environmental assessment
EIS	environmental impact statement
EP	Environmental Programs (Directorate)
EPA	Environmental Protection Agency (U.S.)
ER	Environmental Restoration
ERSS	Environment and Remediation Support Services (Laboratory program)
FD	field duplicate
FR	field rinsate
FTB	field trip blank
gpm	gallons per minute
GPS	global positioning system

HE	high explosive(s)
HI	hazard index
HMX	high-melting explosive (1,3,5,7-tetranitro-1,3,5,7-tetrazocine)
HPLC	high-performance liquid chromatography
HSA	hollow-stem auger
HTO	tritiated water
ICP-OES	inductively coupled plasma optical emission spectrometry
I.D.	inside diameter
IDW	investigation-derived waste
IM	interim measure
IWD	integrated work document
IWP	integrated work process
LANL	Los Alamos National Laboratory (the Laboratory)
LANS	Los Alamos National Security, LLC
LIR	Laboratory implementation requirement
LSC	liquid scintillation counter
MCS	media cleanup standard
MDA	material disposal area
NEPA	National Environmental Policy Act
NMED	New Mexico Environment Department
NMSA	New Mexico Statutes Annotated
NPDES	National Pollutant Discharge Elimination System
NRC	nonconformance report
NWP	nationwide permit
PIC	person in charge
PID	photoionization detector
PM	project manager
PPE	personal protective equipment
ppm	parts per million
PRB	permeable reactive barrier
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
QMC	quality control manager
QMP	quality management plan

QP	quality procedure
RCF	relative centrifugal force
RCRA	Resource Conservation and Recovery Act
RDX	research department explosive (hexahydro-1,3,5-trinitro-1,3,5-triazine)
RFA	RCRA facility assessment
RFI	RCRA facility investigation
RPF	Records Processing Facility
SEM	scanning electron microscope
SMO	Sample Management Office
SOP	standard operating procedure
SSHASP	site-specific health and safety plan
SSHO	site safety and health officer
SSL	soil screening level
SSO	site safety officer
SVOC	semivolatile organic compound
SWMU	solid waste management unit
SWPPP	stormwater pollution prevention plan
SWQB	Surface Water Quality Bureau
SWSC	Sanitation Wastewater Systems Consolidation Plant
TA	technical area
TCLP	toxicity characteristic leaching procedure
TNB	1,3,5-trinitrobenzene
TNT	dynamite (2,4,6-trinitrotoluene)
TSD	treatment, storage, and disposal
USACE	Army Corps of Engineers (U.S.)
VCA	voluntary corrective action
VOC	volatile organic compound
WAC	waste acceptance criteria
WCSF	waste characterization strategy form
WQCC	Water Quality Control Commission (New Mexico)
ZVI	zero-valent iron

A-2.0 GLOSSARY

abandonment—The plugging of a well or borehole in a manner that precludes the migration of surface runoff or groundwater along the length of the well or borehole.

absorption—The uptake of water, other fluids, or dissolved chemicals by a cell or organism (e.g., tree roots absorb dissolved nutrients in soil).

administrative authority—For Los Alamos National Laboratory, one or more regulatory agencies, such as the New Mexico Environment Department, the U.S. Environmental Protection Agency, or the U.S. Department of Energy, as appropriate.

administrative order on consent—A legal agreement signed by the U.S. Environmental Protection Agency and an individual, business, or other entity through which a violator agrees to pay for the correction of violations, take the required corrective or cleanup actions, or refrain from an activity. It describes the actions to be taken, may be subject to a comment period, applies to civil actions, and can be enforced in court.

adsorption—The surface retention of solid, liquid, or gas molecules, atoms, or ions by a solid.

alkalinity—In water analysis, the presence of carbonates, bicarbonates, and/or hydroxides, and occasionally borates, chlorates, silicates, or phosphates.

alluvial—Pertaining to geologic deposits or features formed by running water.

alluvial fan—A fan-shaped piedmont accumulation of alluvium.

alluvium—Soil deposited by a river or other running water.

analysis—A critical evaluation, usually made by breaking a subject (either material or intellectual) down into its constituent parts, then describing the parts and their relationship to the whole. Analyses may include physical analysis, chemical analysis, toxicological analysis, and knowledge-of-process determinations.

analyte—The element, nuclide, or ion a chemical analysis seeks to identify and/or quantify; the chemical constituent of interest.

analytical method—A procedure or technique for systematically performing an activity.

aquifer—An underground geological formation (or group of formations) containing water that is the source of groundwater for wells and springs.

area of contamination—As defined by the U.S. Environmental Protection Agency, certain areas of generally dispersed contamination that could be equated to a Resource Conservation and Recovery Act (RCRA) landfill. The movement of hazardous wastes within those areas would not be considered land disposal and would not trigger RCRA land-disposal restrictions. An area of contamination may be designated by the Environmental Remediation and Surveillance Program as part of a corrective action for waste management purposes, subject to approval by the administrative authority.

assessment—(1) The act of reviewing, inspecting, testing, checking, conducting surveillance, auditing, or otherwise determining and documenting whether items, processes, or services meet specified requirements. (2) An evaluation process used to measure the performance or effectiveness of a system and its elements. In this glossary, assessment is an all-inclusive term used to denote any one of the following: audit, performance evaluation, management system review, peer review, inspection, or surveillance.

background concentration—Naturally occurring concentrations of an inorganic chemical or radionuclide in soil, sediment, or tuff.

background data—Data that represent naturally occurring concentrations of inorganic and radionuclide constituents in a geologic medium. Los Alamos National Laboratory's (the Laboratory's) background data are derived from samples collected at locations that are either within, or adjacent to, the Laboratory. These locations (1) are representative of geological media found within Laboratory boundaries, and (2) have not been affected by Laboratory operations.

background level—(1) The concentration of a substance in an environmental medium (air, water, or soil) that occurs naturally or is not the result of human activities. (2) In exposure assessment, the concentration of a substance in a defined control area over a fixed period of time before, during, or after a data-gathering operation.

background value—A statistically derived concentration (i.e., the upper tolerance limit [UTL]) of a chemical used to represent the background data set. If a UTL cannot be derived, either the detection limit or maximum reported value in the background data set is used.

basalt—A fine-grained, dark volcanic rock composed chiefly of plagioclase, augite, olivine, and magnetite.

baseline risk assessment—A site-specific analysis of the potential adverse effects of hazardous constituents that have been released from a site in the absence of any controls or mitigating actions. A baseline risk assessment consists of the following four steps: data collection and analysis, exposure assessment, toxicity assessment, and risk characterization.

bentonite—An absorbent aluminum silicate clay formed from volcanic ash and used in various adhesives, cements, and ceramic fillers. Because bentonite can absorb large quantities of water and expand to several times its normal volume, it is a common drilling mud additive.

borehole—(1) A hole drilled or bored into the ground, usually for exploratory or economic purposes. (2) A hole into which casing, screen, and other materials may be installed to construct a well.

borehole logging—The process of making remote measurements of physical, chemical, or other parameters at multiple depths in a borehole.

breccia—A coarse-grained rock that consists of angular fragments cemented together or embedded in a fine-grained matrix.

caldera—A large crater formed by a volcanic explosion or by the collapse of a volcanic cone.

calibration—A process used to identify the relationship between the true analyte concentration or other variable and the response of a measurement instrument, chemical analysis method, or other measurement system.

canyon—A stream-cut chasm or gorge, the sides of which are composed of cliffs or a series of cliffs rising from the chasm's bed. Canyons are characteristic of arid or semiarid regions where downcutting by streams greatly exceeds weathering.

casing—A solid piece of pipe, typically steel, stainless steel, or polyvinyl chloride plastic, used to keep a well open in either unconsolidated material or unstable rock and as a means to contain zone-isolation materials, such as cement grout.

certification—A signed statement required by permits, or certain enforcement documents (e.g., a compliance order), that is submitted with reports and other information requested by the administrative authority. Certification ensures that a document and all of its attachments were prepared under the direction or supervision of an authorized person in accordance with a system designed to ensure that qualified personnel properly gather and evaluate the information submitted. Known violations of certification carry significant penalties.

chemical—Any naturally occurring or human-made substance characterized by a definite molecular composition.

chemical analysis—A process used to measure one or more attributes of a sample in a clearly defined, controlled, and systematic manner. Chemical analysis often requires treating a sample chemically or physically before measurement.

chemical of potential concern (COPC)—A detected chemical compound or element that has the potential to adversely affect human receptors as a result of its concentration, distribution, and toxicity.

cleanup—A series of actions taken to deal with the release, or threat of a release, of a hazardous substance that could affect humans and/or the environment. The term cleanup is sometimes used interchangeably with the terms remedial action, removal action, or corrective action.

community—In ecology, an assemblage of populations of different species within a specified location in space and time. Sometimes, a particular subgrouping may be specified, such as the fish community in a lake or the soil arthropod community in a forest.

Compliance Order on Consent (Consent Order)—For the Environmental Remediation and Surveillance Program, an enforcement document signed by the New Mexico Environment Department, the U.S. Department of Energy, and the Regents of the University of California on March 1, 2005, which prescribes the requirements for corrective action at Los Alamos National Laboratory. The purposes of the Consent Order are (1) to define the nature and extent of releases of contaminants at, or from, the facility; (2) to identify and evaluate, where needed, alternatives for corrective measures to clean up contaminants in the environment and prevent or mitigate the migration of contaminants at, or from, the facility; and (3) to implement such corrective measures. The Consent Order supersedes the corrective action requirements previously specified in Module VIII of the Laboratory's Hazardous Waste Facility Permit.

conceptual model—See site conceptual model.

confined—Pertaining to groundwater in an artesian aquifer.

confluence—A place where two or more streams or canyons meet; the point where a tributary meets the main stream.

Consent Order—See Compliance Order on Consent.

consolidated unit—A group of solid waste management units (SWMUs), or SWMUs and areas of concern, which generally are geographically proximate and have been combined for the purposes of investigation, reporting, or remediation.

construction worker scenario—A land-use condition that evaluates exposures to a human receptor throughout a construction project. The activities typically involve substantial short-term on-site exposures.

contaminant—(1) Chemicals and radionuclides present in environmental media or on debris above background levels. (2) According to the March 1, 2005, Compliance Order on Consent (Consent Order), any hazardous waste listed or identified as characteristic in 40 Code of Federal Regulations (CFR) 261 (incorporated by 20.4.1.200 New Mexico Administrative Code [NMAC]); any hazardous constituent listed in 40 CFR 261 Appendix VIII (incorporated by 20.4.1.200 NMAC) or 40 CFR 264 Appendix IX (incorporated by 20.4.1.500 NMAC); any groundwater contaminant listed in the Water Quality Control Commission (WQCC) Regulations at 20.6.3.3103 NMAC; any toxic pollutant listed in the WQCC Regulations at 20.6.2.7 NMAC; explosive compounds; nitrate; and perchlorate. (Note:

Under the Consent Order, the term “contaminant” does not include radionuclides or the radioactive portion of mixed waste.)

corrective action—(1) In the Resource Conservation and Recovery Act, an action taken to rectify conditions potentially adverse to human health or the environment. (2) In the quality assurance field, the process of rectifying and preventing nonconformances.

corrective measure—An action taken at a solid waste management unit or area of concern to protect human health or the environment in the event of a release of contaminants into the environment, or to prevent a release of contaminants into the environment.

corrective measure evaluation—An evaluation of potential remedial alternatives undertaken to identify a preferred remedy that will be protective of human health and the environment and that will attain appropriate cleanup goals.

corrective measures study—A formal process for identifying and evaluating alternative remedies for releases at a facility.

cumulative risk—The evaluation of a simultaneous exposure of a receptor to multiple media, pathways, and contaminants in order to estimate the resulting health and environmental effects.

data validation—A systematic process that applies a defined set of performance-based criteria to a body of data and that may result in the qualification of the data. The data-validation process is performed independently of the analytical laboratory that generates the data set and occurs before conclusions are drawn from the data. The process may include a standardized data review (routine data validation) and/or a problem-specific data review (focused data validation).

detect (detection)—An analytical result, as reported by an analytical laboratory, that denotes a chemical or radionuclide to be present in a sample at a given concentration.

detection limit—The minimum concentration that can be determined by a single measurement of an instrument. A detection limit implies a specified statistical confidence that the analytical concentration is greater than zero.

discharge—The accidental or intentional spilling, leaking, pumping, pouring, emitting, emptying, or dumping of hazardous waste into, or on, any land or water.

disposal—The discharge, deposit, injection, dumping, spilling, leaking, or placing of any solid waste or hazardous waste into, or on, any land or water so that such solid waste or hazardous waste or any constituent thereof may enter the environment or be emitted into the air or discharged into any waters, including groundwaters.

dissolved oxygen—The amount of oxygen dissolved in water, in parts per million (ppm) by weight or in milligrams per liter (mg/L) by volume.

drilling fluid—The fluid used to lubricate a bit and to convey drill cuttings to the surface with rotary drilling equipment. Usually composed of bentonite slurry or muddy water. The fluid can become contaminated, lead to cross-contamination, and may require special disposal.

Environmental Restoration Project—A Los Alamos National Laboratory project established in 1989 as part of a U.S. Department of Energy nationwide program, and precursor of today’s Environmental Remediation and Surveillance (ERS) Program. This program is designed (1) to investigate hazardous and/or radioactive materials that may be present in the environment as a result of past Laboratory operations, (2) to determine if the materials currently pose an unacceptable risk to human health or the environment, and (3) to remediate (clean up, stabilize, or restore) those sites where unacceptable risk is still present.

ephemeral—Pertaining to a stream or spring that flows only during, and immediately after, periods of rainfall or snowmelt.

ER identification (ER ID) number—A unique identifier assigned by the Environmental Remediation and Surveillance Program's Records Processing Facility to each document when it is submitted as a final record.

facility—All contiguous land (and structures, other appurtenances, and improvements on the land) used for treating, storing, or disposing of hazardous waste. A facility may consist of several treatment, storage, or disposal operational units. For the purpose of implementing a corrective action, a facility is all the contiguous property that is under the control of the owner or operator seeking a permit under Subtitle C of the Resource Conservation and Recovery Act.

fault—A fracture, or zone of fractures, in rock along which vertical or horizontal movement has taken place and adjacent rock layers or bodies have been displaced.

gamma radiation—A form of electromagnetic, high-energy ionizing radiation emitted from a nucleus. Gamma rays are essentially the same as x-rays (though at higher energy) and require heavy shielding, such as concrete or steel, to be blocked.

geohydrology—The science that applies hydrologic methods to the understanding of geologic phenomena.

grab sample—A specimen collected by a single application of a field sampling procedure to a target population (e.g., the surface soil from a single hole collected after the spade-and-scoop sampling procedure, or a single air filter left in the field for three months).

groundwater—Interstitial water that occurs in saturated earth material and is capable of entering a well in sufficient amounts to be used as a water supply.

grout—Cement or bentonite mixtures used for sealing boreholes and wells and for zone isolation. Only Portland Type I or II cement is approved for use at investigative sites.

hazard index—The sum of hazard quotients for multiple contaminants to which a receptor may have been exposed.

hazardous constituent (hazardous waste constituent)—According to the March 1, 2005, Compliance Order of Consent (Consent Order), any constituent identified in Appendix VIII of Part 261, Title 40 Code of Federal Regulations (CFR) (incorporated by 20.4.1.200 New Mexico Administrative Code [NMAC]) or any constituent identified in 40 CFR 264, Appendix IX (incorporated by 20.4.1.500 NMAC).

hazardous waste—(1) Solid waste that is listed as a hazardous waste, or exhibits any of the characteristics of hazardous waste (i.e., ignitability, corrosivity, reactivity, or toxicity, as provided in 40 CFR, Subpart C). (2) According to the March 1, 2005, Compliance Order of Consent (Consent Order), any solid waste or combination of solid wastes that, because of its quantity, concentration, or physical, chemical, or infectious characteristics, meets the description set forth in New Mexico Statutes Annotated 1978, § 74-4-3(K) and is listed as a hazardous waste or exhibits a hazardous waste characteristic under 40 CFR 261 (incorporated by 20.4.1.200 New Mexico Administrative Code).

Hazardous Waste Facility Permit—The authorization issued to Los Alamos National Laboratory (the Laboratory) by the New Mexico Environment Department that allows the Laboratory to operate as a hazardous waste treatment, storage, and disposal facility.

hydraulic conductivity—(1) A coefficient of proportionality that describes the rate at which a fluid can move through a permeable medium. The rate is a function of both the medium and the fluid flowing through it. (2) The quantity of water that will flow through a unit of cross-sectional area of a porous material per unit time under a hydraulic gradient of 1.00 (measured at right angles to the direction of flow) at a specified temperature.

hydraulic gradient—The rate of change in hydraulic head per unit of distance in the direction of groundwater flow.

hydraulic head—The elevation of the water table or potentiometric surface as measured in a well.

hydrogen-ion activity (pH)—The effective concentration (activity) of dissociated hydrogen ions (H+); a measure of the acidity or alkalinity of a solution that is numerically equal to 7 for neutral solutions, increases with alkalinity, and decreases as acidity increases.

hydrogeology—The science dealing with the occurrence of surface water and groundwater, their uses, and their functions in modifying the earth, primarily by erosion and deposition.

hypothesis—A tentative explanation that accounts for a set of data and that can be tested by further investigation.

industrial scenario—A land-use condition in which current Los Alamos National Laboratory operations or industrial/commercial operations within Los Alamos County are continued or planned. Any necessary remediation involves cleanup to standards designed to ensure a safe and healthy work environment for workers.

infiltration—(1) The penetration of water through the ground surface into subsurface soil. (2) The technique of applying large volumes of wastewater to land to penetrate the surface and percolate through the underlying soil.

interflow—A runoff process that involves lateral subsurface flow within the soil zone.

interim measure—An action that can be implemented to minimize or prevent the migration of contaminants and to minimize or prevent actual or potential human or ecological exposure to contaminants, while long-term final corrective action remedies are evaluated and, if necessary, implemented.

intermittent stream—A stream that flows only in certain reaches as a result of the channel bed's losing and gaining characteristics.

logging run—A single data-collecting pass with a logging tool as the tool moves up or down in the borehole or a portion of the borehole. A logging operation generally consists of a main run and one or more repeat runs with each logging tool.

logging tool—A device that is run in a borehole to make borehole logging measurements.

Los Alamos unlimited release (LA-UR) number—A unique identification number required for all documents or presentations prepared for distribution outside Los Alamos National Laboratory (the Laboratory). LA-UR numbers are obtained by filling out a technical information release form (http://enterprise.lanl.gov/alpha.htm) and submitting the form together with 2 copies of the document to the Laboratory's Classification Group (S-7) for review.

material disposal area (MDA)—A subset of the solid waste management units at Los Alamos National Laboratory (the Laboratory) that include disposal units such as trenches, pits, and shafts. Historically, various disposal areas (but not all) were designated by the Laboratory as MDAs.

matrix—Relatively fine material in which coarser fragments or crystals are embedded; also called “ground mass” in the case of igneous rocks.

maximum contaminant level (MCL)—Under the Safe Drinking Water Act, the maximum permissible level of a contaminant in water that is delivered to any user of a public water system serving 15 or more connections and 25 or more people. MCLs are enforceable standards and take into account the feasibility and cost of attaining the standards.

medium (environmental)—Any material capable of absorbing or transporting constituents. Examples of media include tuffs, soils and sediments derived from these tuffs, surface water, soil water, groundwater, air, structural surfaces, and debris.

medium (geological)—The solid part of the hydrogeological system; may be unsaturated or saturated.

migration—The movement of inorganic and organic chemical species through unsaturated or saturated materials.

mitigation—(1) Minimizing environmental impacts by limiting the degree or magnitude of an action and its implementation, (2) Rectifying an environmental impact by repairing, rehabilitating, or restoring the affected environment, (3) Reducing or eliminating an environmental impact over time by preservation and maintenance operations during the life of the action, (4) Compensating for an environmental impact by replacing or providing substitute resources or environments.

model—A schematic description of a physical, biological, or social system, theory, or phenomenon that accounts for its known or inferred properties and may be used for the further study of its characteristics.

Module VIII—Module VIII of the Los Alamos National Laboratory (the Laboratory) Hazardous Waste Facility Permit. This permit allows the Laboratory to operate as a hazardous-waste treatment, storage, and disposal facility. From 1990 to 2005, Module VIII included requirements from the Hazardous and Solid Waste Amendments. These requirements have been superceded by the March 1, 2005, Compliance Order on Consent (Consent Order).

monitoring well—(1) A well used to obtain water-quality samples or to measure groundwater levels, (2) A well drilled at a hazardous waste management facility or Superfund site to collect groundwater samples for the purpose of physical, chemical, or biological analysis and to determine the amounts, types, and distribution of contaminants in the groundwater beneath the site.

National Pollutant Discharge Elimination System (NPDES) —The national program for issuing, modifying, revoking and reissuing, terminating, monitoring, and enforcing permits to discharge wastewater or storm water, and for imposing and enforcing pretreatment requirements under the Clean Water Act.

non-ER data—Data derived from samples collected by, and paid for by, sources other than the Environmental Remediation and Surveillance Program.

operable units (OUs)—At Los Alamos National Laboratory, 24 areas originally established for administering the Environmental Remediation and Surveillance Program. Set up as groups of potential release sites, the OUs were aggregated according to geographic proximity for the purposes of planning and conducting Resource Conservation and Recovery Act (RCRA) facility assessments and RCRA facility investigations. As the project matured, it became apparent that there were too many areas to allow efficient communication and to ensure consistency in approach. In 1994, the 24 OUs were reduced to 6 administrative field units.

outfall—A place where effluent is discharged into receiving waters.

perched water—A zone of unpressurized water held above the water table by impermeable rock or sediment.

permit—An authorization, license, or equivalent control document issued by the U.S. Environmental Protection Agency or an approved state agency to implement the requirements of an environmental regulation.

population—(1) A group of interbreeding organisms occupying a particular space. (2) The number of humans or other living creatures in a designated area.

porosity—The degree to which soil, gravel, sediment, or rock is permeated with pores or cavities through which water or air can move.

porphyritic—Pertaining to the texture of an igneous rock in which larger crystals (phenocrysts) are set in a finer ground mass or matrix**.**

potential release site—A term for a potentially contaminated site at Los Alamos National Laboratory that refers to solid waste management units and areas of concern.

preliminary remediation goals—Acceptable exposure levels (protective of human health and the environment) that are used as a risk-based tool for evaluating remedial alternatives.

preliminary risk assessment—A risk assessment that is conducted using conservative assumptions and scenarios and that assumes no mitigating or corrective measures beyond those already in place.

qualifications—The requisites (e.g., education, training, skills, or experience) that equip an individual for a professional position, such as assessor or lead assessor.

quality assessment—A system of activities whose purpose is to provide assurance that overall quality control is being executed effectively. Quality assessment involves a continuing evaluation of a production system's products and performance.

quality-assessment sample—A sample submitted for analysis, the data from which are used to assess the performance quality of a sampling or analysis process. May include performance-evaluation samples, field duplicates, or field blanks.

quality-assurance project plan—A formal document that describes, in comprehensive detail, the necessary quality assurance, quality control, and other technical activities that must be implemented to ensure that results of work performed will satisfy stated performance criteria.

quality assurance/quality control—A system of procedures, checks, audits, and corrective actions set up to ensure that all U.S. Environmental Protection Agency research design and performance, environmental monitoring and sampling, and other technical and reporting activities are of the highest achievable quality.

quality control—See quality assurance/quality control.

quality-control sample—A specimen that, upon analysis, is intended to provide information that is useful for adjusting, controlling, or verifying the continuing acceptability of sampling and/or analysis activities in progress.

quality indicators—Quantitative statistics and qualitative descriptors for interpreting the degree of acceptability or utility of data to the user. Indicators of quality include precision, bias, representativeness, reproducibility, comparability, and statistical confidence.

quality level 1—The highest level assigned to a document or activity. At this level, documents and activities must meet applicable requirements of a quality management plan and/or a quality assurance project plan.

quality level 2—A level that is assigned to those documents or activities that require good management, engineering, or laboratory practices, and that may follow the requirements in U.S. Department of Energy orders or the Los Alamos National Laboratory's Laboratory implementation requirements.

quality management—The portion of an organization's overall management system that determines and implements the quality policy. Quality management includes strategic planning, allocation of resources, and other systematic activities (e.g., planning implementation and assessment) pertaining to an organization's quality standards.

quality management plan (QMP)—A document providing a framework for planning, implementing, and assessing work performed by an organization and for carrying out required quality assurance/quality control. A QMP is part of an organization's structured and documented management system that describes the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan for ensuring quality in work processes, products, and services.

quality procedure—A document that describes the process, method, and responsibilities for performing, controlling, and documenting any quality-affecting activity governed by a quality management plan.

Quaternary—The second period of the Cenozoic Era, following the Tertiary, and including the last two to three million years of earth history.

radiation—A stream of particles or electromagnetic waves emitted by atoms and molecules of a radioactive substance as a result of nuclear decay. The particles or waves emitted can consist of neutrons, positrons, alpha particles, beta particles, or gamma radiation.

radioactive material—For purposes of complying with U.S. Department of Transportation regulations, any material having a specific activity (activity per unit mass of the material) greater than 2 nanocuries per gram (nCi/g) and in which the radioactivity is evenly distributed.

radioactivity (radioactive decay; radioactive disintegration)—The spontaneous change in an atom by the emission of charged particles and/or gamma rays.

radionuclide—Radioactive particle (human-made or natural) with a distinct atomic weight number.

RCRA facility assessment (RFA)—Usually the first step in the Resource Conservation and Recovery Act (RCRA) corrective action process. The RFA includes the identification of potential and actual releases from solid waste management units and preliminary determinations about releases and the need for corrective action and stabilization measures.

RCRA facility investigation (RFI)—A Resource Conservation and Recovery Act (RCRA) investigation that determines if a release has occurred and characterizes the nature and extent of contamination at a hazardous waste facility. The RFI is generally equivalent to the remedial investigation portion of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) process.

reach—A specific length of a canyon that is treated as a single unit for sampling and analysis. Reaches tend to be internally uniform with respect to geomorphic setting and land use.

reamer—A type of drill bit that is used specifically for enlarging a borehole.

receptor—A person, other animal, plant, or geographical location that is exposed to a chemical or physical agent released to the environment by human activities.

recharge—The process by which water is added to a zone of saturation, usually by percolation from the soil surface (e.g., the recharge of an aquifer).

record—Any book, paper, map, photograph, machine-readable material, or other documentary material, regardless of physical form or characteristics.

recreational scenario—A land-use condition under which individuals may be exposed to contaminants for a limited amount of time as a result of outdoor activities such as hiking, camping, hunting, or fishing.

redox potential (Eh)—Chemical reactions whereby a participating element changes its valence state by losing or gaining orbital electrons. This may also be referred to as oxidation-reduction potential.

reference set—A hard-copy compilation of reference items cited in Environmental Remediation and Surveillance Program documents.

regional aquifer—Geologic material(s) or unit(s) of regional extent whose saturated portion yields significant quantities of water to wells, contains the regional zone of saturation, and is characterized by the regional water table or potentiometric surface.

regulatory standard—Media-specific contaminant concentration levels of potential concern that are mandated by federal or state legislation or regulation (e.g., the Safe Drinking Water Act, New Mexico Water Quality Control Commission regulations).

relative percent difference (RPD)—The measure used to assess the precision between parent results and their associated duplicate results. The RPD is calculated as follows:

$$RPD = \frac{S - R}{\left(\frac{S + R}{2}\right)} \times 100$$

where RPD = relative percent difference,

S = parent sample result, and

R = duplicate sample result.

The Environmental Remediation and Surveillance Program criteria for the RPD are less than 20% for aqueous samples and less than 35% for soil samples when the sample concentrations are greater than, or equal to, five times the method detection limit (MDL). For samples with concentrations less than five times the MDL, but greater than the MDL, the control is +/-MDL. No precision criterion applies to samples with concentrations less than the MDL.

release—Any spilling, leaking, pumping, pouring, emitting, emptying, discharging, injecting, escaping, leaching, dumping, or disposing of hazardous waste or hazardous constituents into the environment.

remediation—(1) The process of reducing the concentration of a contaminant (or contaminants) in air, water, or soil media to a level that poses an acceptable risk to human health and the environment. (2) The act of restoring a contaminated area to a usable condition based on specified standards.

remediation waste—All solid wastes and hazardous wastes, and all media (including groundwater, surface water, soils, and sediments) and debris, that are managed for implementing cleanup.

replicate measurement—A reanalysis (remeasurement) of a prepared sample.

reporting limit (RL)—The numerical value that an analytical laboratory (in conjunction with its client) selects for determining if a target analyte has been detected. Results below the RL are considered to be undetected, but results above the RL are considered to be detected. The RLs are not necessarily based on instrument sensitivity. RLs can be established at the instrument detection limit, method detection limit, estimated quantitation limit, or contract-required detection limit.

representativeness—The degree to which data accurately and precisely represent a characteristic of a population or an environmental condition.

residential scenario—The land use condition under which individuals may be exposed to contaminants as a result of living on or near contaminated sites.

Resource Conservation and Recovery Act—The Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 (Public Law [PL] 94-580, as amended by PL 95-609 and PL 96-482, United States Code 6901 et seq.).

restricted area—Any area to which access is controlled by a licensee to protect individuals from exposure to radiation and radioactive materials. The "restricted area" shall not include areas used as residential quarters, although a separate room or rooms in a residential building may be set apart as a restricted area.

retention time window criteria—The x-axis on a chromatogram represents retention time. A retention time window is a specified time range on this axis. If a target analyte is detected within its retention time window, it is considered detected. The retention time window criteria are the exact time windows on the chromatogram defining a given target analyte and are method-specific.

rill erosion—An erosion process in which numerous small channels several inches deep are formed by concentrated runoff that flows during and immediately after rain storms or snowmelt.

rinsate blank—See equipment blank.

risk—A measure of the probability that damage to life, health, property, and/or the environment will occur as a result of a given hazard.

risk analysis—In the quality assurance field, a qualitative evaluation of the probability and the potential consequences associated with noncompliant documents or work activities.

risk assessment—See baseline risk assessment.

risk-based end state—The post-remediation vision for the planned future land use of a specific U.S. Department of Energy property.

risk characterization—The last phase in the risk assessment process which estimates the potential for adverse health or ecological effects to occur as a result of exposure to a stressor, and which evaluates the uncertainty involved.

risk management—The process of evaluating and selecting alternative regulatory and nonregulatory responses to risk. The selection process necessarily requires the consideration of legal, economic, and behavioral factors.

routine analysis—The analysis categories of inorganic compounds, organic compounds, metals, radiochemistry, and high explosives, as defined in a contract laboratory's statement of work.

routine data—Data generated using analytical methods that are identified as routine methods in the current Environmental Remediation and Surveillance Program statement of work for analytical services.

routine data validation—The process of reviewing analytical data relative to quantitative routine acceptance criteria. The objective of routine data validation is two-fold—

- to estimate the technical quality of the data relative to minimum national standards adopted by the Environmental Remediation and Surveillance Program, and
- to indicate to data users the technical data quality at a gross level by assigning laboratory qualifiers to environmental data whose quality indicators do not meet acceptance criteria.

runoff—The portion of the precipitation on a drainage area that is discharged from the area.

run-on—Surface water that flows onto an area as a result of runoff occurring higher up on a slope.

sample—A portion of a material (e.g., rock, soil, water, or air), which, alone or in combination with other portions, is expected to be representative of the material or area from which it is taken. Samples are typically either sent to a laboratory for analysis or inspection or are analyzed in the field. When referring to samples of environmental media, the term field sample may be used.

sample matrix—In chemical analysis, that portion of a sample that is exclusive of the analytes of interest. Together, the matrix and the analytes of interest form the sample.

screening action level (SAL)—A radionuclide's medium-specific concentration level; it is calculated by using conservative criteria below which it is generally assumed that no potential exists for a dose that is unacceptable to human health. The derivation of a SAL is based on conservative exposure and on land-use assumptions. However, if an applicable regulatory standard exists that is less than the value derived, it is used in place of the SAL.

screening risk assessment—A risk assessment that is performed with few data and many assumptions in order to identify exposures that should be evaluated more carefully for potential risk.

sediment—(1) A mass of fragmented inorganic solid that comes from the weathering of rock and is carried or dropped by air, water, gravity, or ice. (2) A mass that is accumulated by any other natural agent and that forms in layers on the earth's surface (e.g., sand, gravel, silt, mud, fill, or loess). (3) A solid material that is not in solution and is either distributed through the liquid or has settled out of the liquid.

sensitivity—An indication of the lowest analyte concentration that can be measured with a specified degree of confidence.

serial dilution sample—A requirement of the U.S. Environmental Protection Agency (EPA) Method 6010B (Inductively Coupled Plasma-Atomic Emission Spectroscopy). Serial dilutions are made by performing a series of dilutions on an aliquot taken from a stock solution for a target analyte. The first dilution of the original stock solution serves as the stock solution for the second dilution, and the second dilution serves as the stock solution for the third dilution, and so on. To meet the requirement of EPA Method 6010B, one serial dilution analysis must be performed for each matrix in every sample batch, with a minimum of 1 serial dilution sample per 20 samples.

simple random sample—A sampling design in which every possible sample (sample unit) has an equal probability of being selected.

single blind sample—A performance-evaluation sample submitted for analysis whose sample identity is known to the analyst, but whose composition is known to the submitter and not to the analyst.

site characterization—Defining the pathways and methods of migration of hazardous waste or constituents, including the media affected; the extent, direction and speed of the contaminants; complicating factors influencing movement; or concentration profiles.

site conceptual model—A qualitative or quantitative description of sources of contamination, environmental transport pathways for contamination, and receptors that may be impacted by contamination and whose relationships describe qualitatively or quantitatively the release of contamination from the sources, the movement of contamination along the pathways to the exposure points, and the uptake of contaminants by the receptors.

site-specific health and safety plan (SSHASP)—A health and safety plan that has been tailored to a site or to an Environmental Remediation and Surveillance (ERS) Program field activity and that has been approved by an ERS health and safety representative. A SSHASP contains information specific to the project, including the scope of work, relevant history, descriptions of hazards from activity associated with the project site(s), and techniques for exposure mitigation (e.g., personal protective equipment and hazard mitigation).

slope—A ratio of units of elevation change to units of horizontal change, usually expressed in degrees.

soil—(1) A material that overlies bedrock and has been subject to soil-forming processes. (2) A sample media group that includes naturally occurring and artificial fill materials.

soil gas—Gaseous elements and compounds in the small spaces between particles of the earth and soil. Such gases can be moved or driven out under pressure.

soil hygrometer—An instrument that measures soil moisture.

soil moisture—The water contained in the pore space of the unsaturated zone.

soil screening level (SSL)—The concentration of a chemical (inorganic or organic) below which no potential for unacceptable risk to human health exists. The derivation of an SSL is based on conservative exposure and land-use assumptions, and on target levels of either a hazard quotient of 1.0 for a noncarcinogenic chemical or a cancer risk of 10-5 for a carcinogenic chemical.

soil water—Water in the unsaturated zone, regardless of whether it occurs in soil or rock.

solid waste—Any garbage, refuse, or sludge from a waste treatment plant, water supply treatment plant, or air-pollution control facility, and other discarded material, including solid, liquid, semisolid, or contained gaseous material resulting from industrial, commercial, mining, and agricultural operations and from community activities. Solid waste does not include solid or dissolved materials in domestic sewage; solid or dissolved materials in irrigation return flows; industrial discharges that are point sources subject to permits under section 402 of the Federal Water Pollution Control Act, as amended; or source, special nuclear, or byproduct material as defined by the Atomic Energy Act of 1954, as amended.

solid waste management unit (SWMU)—(1) Any discernible site at which solid wastes have been placed at any time, whether or not the site use was intended to be the management of solid or hazardous waste. SWMUs include any site at a facility at which solid wastes have been routinely and systematically released. This definition includes regulated sites (i.e., landfills, surface impoundments, waste piles, and land treatment sites), but does not include passive leakage or one-time spills from production areas and sites in which wastes have not been managed (e.g., product storage areas). (2) According to the March 1, 2005, Compliance Order on Consent (Consent Order), any discernible site at which solid waste has been placed at any time, and from which the New Mexico Environment Department determines there may be a risk of a release of hazardous waste or hazardous waste constituents (hazardous constituents), whether or not the site use was intended to be the management of solid or hazardous waste. Such sites include any area in Los Alamos National Laboratory at which solid wastes have been routinely and systematically released; they do not include one-time spills.

specific (electrical) conductance—A measure of the ease with which a conduction current flows through a substance under the influence of an applied electric field. Specific conductance is dependant upon the presence of ions (total and relative concentrations, valence, and mobility) and temperature. It is the reciprocal of resistivity and is measured in either siemens (S) or micro-ohms per centimeter (µohm/cm) at 25°C.

split sample—A sample that has been divided into two or more portions that are expected to be of the same composition; used to characterize within-sample heterogeneity, sample handling, and measurement variability.

split-spoon sampler—A hollow, tubular sampling device below a drill stem that is driven by a weight to retrieve soil samples. The core barrel can be opened to remove samples. This is a sampling method commonly used with auger drilling. The split-spoon sampler can be driven into the ground or can be advanced inside hollow-stem augers.

spring—Groundwater seeping out of the earth where the water table intersects the ground surface.

standard operating procedure—A document that details the officially approved method(s) for an operation, analysis, or action, with thoroughly prescribed techniques and steps.

stratification—The process of separating into layers.

stratified sample—A sample that includes one or more specimens from each of several subpopulations within a target population. (Note: If the specimens are selected from within each subpopulation using a simple random sample, the sample is called a stratified random sample.)

stratigraphy—The study of the formation, composition, and sequence of sediments, whether consolidated or not.

subsample—See aliquot.

Superfund—Another term for the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The two terms are used interchangeably.

surface sample—A sample taken at a collection depth that is (or was) representative of the medium's surface during the period of investigative interest. A typical depth interval for a surface sample is 0 to 6 in. for mesa-top locations, but may be up to several feet in sediment-deposition areas within canyons.

surrogate (surrogate compound)—An organic compound used in the analyses of organic target analytes that is similar in composition and behavior to the target analytes but is not normally found in field samples. Surrogates are added to every blank and spike sample to evaluate the efficiency with which analytes are being recovered during extraction and analysis.

target analyte—A chemical or parameter, the concentration, mass, or magnitude of which is designed to be quantified by a particular test method.

technical area (TA)—At Los Alamos National Laboratory, an administrative unit of operational organization (e.g., TA-21).

technical notebook—A record of the methodology, observations, and results of technical activity investigations.

tentatively identified compound (TIC)—A chemical compound detected in a sample that is not a target analyte, internal standard, or surrogate. Up to 30 chromatographic peaks may be subject to mass spectral matching for identification as TICs.

topography—The physical or natural features of an object or entity and their structural relationships.

total propagated uncertainty (TPU)—The range of concentrations (expressed as ± the measured concentration) that includes the theoretical or true concentration of an analyte with a specific degree of confidence. Radiochemical results are required to be accompanied by sample-specific uncertainty bounds that reflect the 67% confidence level (1-sigma TPU). The TPU includes not only the measurement or counting error but the technique-specific error term that includes uncertainty values for each contributing measurement process and a sample-specific contribution reflecting the specific chemical recoveries or detectors used. All radiochemical result uncertainties incorporate terms for technique-related and sample-specific measurement errors.

toxic pollutant—A water contaminant or combination of water contaminants in concentration(s) that, upon exposure, ingestion, or assimilation, either directly from the environment or indirectly by ingestion through food chains, will unreasonably threaten to injure the health of humans, or the health of other animals or plants that are commonly hatched, bred, cultivated, or protected for use by humans for food or economic benefit.

transport (transportation)—(1) The movement of a hazardous waste by air, rail, highway, or water. (2) The movement of a contaminant from a source through a medium to a receptor.

treatment—Any method, technique, or process, including elementary neutralization, designed to change the physical, chemical, or biological character or composition of any hazardous waste so as to neutralize such waste, recover energy or material resources from the waste, or to render such waste nonhazardous or less hazardous; safer to transport, store, or dispose of; or amenable for recovery or storage; or reduced in volume.

treatment, storage, and disposal facility—An interim-status or permitted facility in which hazardous waste is treated, stored, or disposed.

tremie pipe—A small-diameter pipe used to carry sand pack, bentonite, or grouting materials to a borehole's bottom. Materials are pumped under pressure or poured to the hole bottom through the pipe. The pipe is retracted as the annular space is filled.

trip blank—A sample of analyte-free medium taken from a sampling site and returned to an analytical laboratory unopened, along with samples taken in the field; used to monitor cross contamination of samples during handling and storage both in the field and in the analytical laboratory.

tuff—Consolidated volcanic ash, composed largely of fragments produced by volcanic eruptions.

turbidity (nephelometric)—A measure of the intensity of light scattered by sample particulates relative to a standard reference suspension. The range of water turbidity is measured between 0 and 40 nephelometric turbidity units (NTU).

unconfined aquifer—An aquifer containing water that is not under pressure; the water level in a well is the same as the water table outside the well.

underflow—Groundwater flow beneath the bed of a nonflowing stream. Such water is often perched in the channel alluvium atop the bedrock surface.

unsaturated zone—The area above the water table where soil pores are not fully saturated, although some water may be present.

upper acceptance limit (UAL)—The highest limit that is acceptable, based on the quality control (QC) criteria for a specific QC sample for a specific method. Any results greater than the UAL are qualified.

upper confidence limit—The statistic that represents the upper bound of the arithmetic mean (usually 95%) of the measured data and that is used in a risk assessment as the reasonable maximum exposure point concentration.

upper tolerance limit—A statistical measure of the upper end of a distribution. The 95th percentile upper tolerance limit, which is the 95% upper percentile of the 95^{th} percentile of the data distribution, is the background value used to represent the background data distribution for an inorganic chemical or naturally occurring radionuclide.

U.S. Department of Energy—The federal agency that sponsors energy research and regulates nuclear materials for weapons production.

U.S. Environmental Protection Agency (EPA)—The federal agency responsible for enforcing environmental laws. Although state regulatory agencies may be authorized to administer some of this responsibility, EPA retains oversight authority to ensure the protection of human health and the environment.

vadose zone—The zone between the land surface and the water table within which the moisture content is less than saturation (except in the capillary fringe) and pressure is less than atmospheric. Soil pore space also typically contains air or other gases. The capillary fringe is included in the vadose zone.

verification—A test or tests, generally performed before and after logging in lieu of a calibration, to ascertain whether the logging system is operating properly. Verification differs from calibration in that it does not provide updated system calibration values.

water content—The amount of water in an unsaturated medium, expressed as the ratio of the weight of water in a sample to the weight of the oven-dried sample (often expressed as a percentage).

watercourse—Any river, creek, arroyo, canyon, draw, wash, or other channel that has definite banks and beds and provides visual evidence of the occasional flow of water.

watershed—A region or basin drained by, or contributing waters to, a river, stream, lake, or other body of water and separated from adjacent drainage areas by a divide, such as a mesa, ridge, or other geologic feature.

water table—The top of the regional saturated zone; the piezometric surface associated with an unconfined aquifer.

welded tuff—A volcanic deposit hardened by the action of heat, pressures from overlying material, and hot gases.

well casing—A solid piece of pipe, typically steel or polyvinyl chloride (PVC) plastic, used to keep a well open in either unconsolidated materials or unstable rock and as a means to contain zone-isolation materials such as cement grout or bentonite.

well screen—A perforated wire-wrapped casing that allows fluids, but not solid material, to enter a well.

work plan—A document that specifies the activities to be performed when implementing an investigation or remedy. At a minimum, the work plan should identify the scope of the work to be performed, specify the procedures to be used to perform the work, and present a schedule for performing the work. The work plan may also present the technical basis for performing the work.

A-3.0 METRIC CONVERSION TABLE

Multiply SI (Metric) Unit	by	To Obtain US Customary Unit
kilometers (km)	0.622	miles (mi)
kilometers (km)	3281	feet (ft)
meters (m)	3.281	feet (ft)
meters (m)	39.37	inches (in.)
centimeters (cm)	0.03281	feet (ft)
centimeters (cm)	0.394	inches (in.)
millimeters (mm)	0.0394	inches (in.)
micrometers or microns (µm)	0.0000394	inches (in.)
square kilometers (km^2)	0.3861	square miles (mi^2)
hectares (ha)	2.5	acres
square meters (m^2)	10.764	square feet (ft^2)
cubic meters (m^3)	35.31	cubic feet (ft^3)
kilograms (kg)	2.2046	pounds (lb)
grams (g)	0.0353	ounces (oz)
grams per cubic centimeter (g/cm^3)	62.422	pounds per cubic foot (lb/ft^3)
milligrams per kilogram (mg/kg)	1	parts per million (ppm)
micrograms per gram (µg/g)	1	parts per million (ppm)
liters (L)	0.26	gallons (gal.)
milligrams per liter (mg/L)	1	parts per million (ppm)
degrees Celsius (°C)	9/5 + 32	degrees Fahrenheit (°F)

A-4.0 DATA QUALIFIER DEFINITIONS

Data Qualifier	Definition
U	The analyte was analyzed for but not detected.
J	The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.
J+	The analyte was positively identified, and the result is likely to be biased high.
J-	The analyte was positively identified, and the result is likely to be biased low.
UJ	The analyte was not positively identified in the sample, and the associated value is an estimate of the sample-specific detection or quantitation limit.
R	The data are rejected as a result of major problems with quality assurance/quality control (QA/QC) parameters.

Appendix B-1

Media Laboratory Testing
Results Report: Batch and Column Studies

B1-1.0 INTRODUCTION

Shallow groundwater and surface water within the Cañon de Valle alluvial system at Los Alamos National Laboratory (LANL or the Laboratory) Technical Area 16 (TA-16) exceed New Mexico Water Quality Control Commission (WQCC) standards for barium and the high explosive (HE), 1,3,5-trinitro-hexahydro-s-triazine (RDX). The corrective measures study (CMS) identified installation of permeable reactive barriers (PRBs) as the preferred remedial alternative for the Cañon de Valle alluvial system (LANL 2003, 085531). The New Mexico Environment Department (NMED) selected PRBs as the remedy for alluvial groundwater in the Cañon de Valle alluvial system and approved the installation of a pilot system (NMED 2006, 095631). The primary remedial objective for these PRBs is to reduce RDX and barium concentrations in alluvial groundwater to below their respective groundwater standards, which, in turn, will reduce the concentrations of contaminants in groundwater infiltrating to intermediate and regional groundwater zones.

Laboratory studies were conducted to support the field remediation effort in Cañon de Valle. The goals of these laboratory studies were to evaluate performance of prospective reactive media that could be used in the proposed PRBs, The tests used site-specific groundwater. These laboratory studies include: (1) ultrafiltration of site-specific alluvial groundwater and chemical analysis of the sample splits to determine partitioning of barium between solution and colloidal material; (2) isothermal batch sorption studies, and (3) isothermal flow-through column studies. The latter two types of studies were to determine the ability of various media to remove barium and RDX from site groundwater. Six types of reactive media were evaluated, including: activated granular carbon, zero-valent iron, apatite II, clinoptilolite, gypsum, and Bandelier Tuff.

Initial results from the filtration and batch sorption experiments are presented below. Preliminary results from column experiments are also described, but these experiments are ongoing.

B1-2.0 MATERIALS

B1-2.1 Description of Tested Media

Candidate PRB reactive media for the treatment of RDX are granular activated carbon (GAC) for sorption of RDX and zero-valent iron (ZVI) for reductive destruction of RDX. ZVI is known to efficiently destroy RDX through a process of reductive denitrification (Comfort et al. 2003, 095746; Park et al. 2004, 095745). Rather than destroy RDX, activated carbon adsorbs it (Morley and Speitel 1999, 095744), which means that disposal of the spent carbon with sorbed RDX will eventually be required. When potential RDX treatment technologies are identified and evaluated, RDX destruction is preferable to the transfer of RDX to another medium, such as adsorption onto carbon (LANL 2003, 085531). Candidate PRB reactive media for barium include calcium sulfate (gypsum), the zeolite clinoptilolite, and fish-bone apatite (apatite II). These media were selected because they are known to have a high affinity for removing barium from groundwater.

GAC, ZVI, calcium sulfate, clinoptilolite, and apatite II were examined in batch sorption and/or flow-through column experiments to evaluate their effectiveness in removing barium and RDX from alluvial groundwater at TA-16. In addition to these reactive media, a sample of Bandelier Tuff was also evaluated in an initial attempt to determine the potential for attenuation of barium as groundwater flows through tuff units. Brief descriptions of the tested media are presented below along with scanning electron microscope (SEM) photos of each material (see Figures B1-1 through B1-6).

Granular activated carbon was purchased from Alltech Associates (part number 5772). The sieved, sized fraction between 40/60 mesh (0.25–0.42 mm) was used for batch and flow-through experiments.

ZVI was obtained from Peerless Metal Powders & Abrasive, Detroit, MI. The fractional size was broad, ranging from a 5 to 80 mesh size. For the laboratory studies, the material was sieved to a size between 0.1–0.5 mm with fines removed by rinsing with a cleaning alcohol mix of methanol and ethanol, followed by placement in a vacuum (~18" Hg) oven that was heated to 100^{o} C for 1 week.

Apatite II was obtained from PIMS NW, Inc., Carlsbad, NM. The material is a biological noncrystalline form of apatite derived from a patented heat treatment of fish bones. The material was crushed in a mechanical pulverizer followed by sieving to a size of 0.1–0.5mm. Fines were removed by rinsing the material in deionized water, which was then dried in a vacuum (~18" Hg) oven heated to 40^{o} C.

Clinoptilolite was obtained from the St. Cloud Mining Company, Winston, NM. The company reports 75% to 80% of the material as pure clinoptilolite but doesn't list the impurities. XRD analysis is in process. The zeolite was received in a large heterogeneous range of grain sizes that was reduced by crushing with a mechanical pulverizer followed by sieving to a size of 0.1–0.5mm. Fines were removed by rinsing in deionized water then the material dried in a vacuum (~18" Hg) oven heated to 40^{o} C.

Gypsum was obtained from a mine near Bingham, NM, owned by the Portales Mining Company. The material was a high-grade, transparent, selenite form of gypsum. The crystals were crushed with a mechanical pulverizer, followed by sieving to a size of 0.1–0.5mm. Fines were removed by rinsing in deionized water then the material was dried in a vacuum (~18" Hg) oven heated to 40^{o} C.

Bandelier Tuff was collected from unit 4 of the Tshirege Member from an outcrop in Mortandad Canyon near TA-48. The sample is a moderately welded devitrified ignimbrite. Phenocrysts and pumice comprise approximately 10% of the sample. Lithic clasts comprise less than 1 volume percent. Phenocrysts in unit 4 are dominantly quartz (bipyramidal) and sanidine, with minor plagioclase and altered mafic minerals. Mafic phenocrysts are small (<1mm) and comprise only 1 volume percent of a thin section of the sample. The remaining volume of the sample is the matrix composed of ash, devitrified glass shards, small pumice fragments, and minute phenocryst fragments. The primary vapor-phase mineralogy is cristobalite, tridymite, and sanidine. Small patches of yellow clay occur in the groundmass. Secondary iron-oxides are sparse, and some of the mafic minerals are locally altered to brown clay. As with some of the other media, the tuff was crushed with a mechanical pulverizer followed by sieving to a size of 0.1–0.5 mm. Fines were removed by rinsing in deionized water then the tuff was dried in a vacuum (~18" Hg) oven heated to 40^{o} C.

B1-2.2 Alluvial Groundwater Samples

Groundwater from TA-16 was obtained from well purges collected between October 2006 and February 2007. The proposed location of the PRB is within Cañon de Valle where most water samples were taken; however, material was also collected at well CdV-16-6295, which is located in Martin Canyon south of Cañon de Valle. Waters were collected at well CdV-16-02657, located about one-half mile up Cañon de Valle from the proposed PRB site and from well CdV-16-02659, located about one-half mile down the canyon from well CdV-16-02657. Water was also collected from Well CdV-16-02658, located close to the planned installation site of the PRB; this well contains the highest barium concentration of the groundwater samples collected. This water (termed high-barium) was used for the batch studies as well as for the filtration studies.

Approximately 2 L of water from well CdV-16-6295 was used to serially dilute water from well CdV-16-02658, which contains "high-Ba" concentrations (7.3 ppm), by a third to produce the water termed “mid-Ba” (5.1ppm), and again by another third to create the “low-Ba” (2.7 ppm) water. These three waters were used in the batch studies. After producing these, all of the remaining waters were combined to produce the water labeled, “PWW16-mix.” It was necessary to combine the samples to ensure that a sufficient volume of water was available for columns studies. Water volumes collected are listed in Table B1-1 and major cation concentrations are provided in Table B1-2.

B1-3.0 METHODS

B1-3.1 Analytical Methods

Major cations were analyzed by inductively coupled plasma optical emission spectrometry (ICP-OES) using the Perkin Elmer Optima 2100 DV and EPA Method 200.7 in the Earth and Environmental Sciences (EES-6) laboratory at Los Alamos National Laboratory. Ultrahigh-purity nitric acid (Fisher Trace Metal Grade) was used in sample and calibration preparation prior to sample analysis. An internal standard (5 mg/L Sc) was added to both samples and standards to correct for matrix effects which can result in differing introduction rates. Standard Reference Material (SRM) 1640, Trace Elements in Natural Water, was used to check the accuracy of the multi-element calibration. Parameters were as follows: 1300 W forward power, 15 mL/min cooling gas, 0.2 mL/min auxiliary flow; 0.8 mL/min nebulizer flow; and 1.5 mL/min sample uptake. Major cation concentrations for the two groundwater samples (CdV-16-02658 and CdV-16-6295) are given in Table B1-2.

Samples were analyzed for RDX by high-performance liquid chromatography (HPLC) using a Dionex DX 600 system, PDA-100 Photodiode Array Detector, and U.S. Environmental Protection Agency (EPA) Method 8330 in the EES-6 laboratory. The column was an Acclaim 120 C-18 (4.6 x 250 mm). The following analytical parameters were used: 50/50 v/v methanol/water; 25ºC; 1.25 mL/min flow rate; 50 µL injection volume; and analyte detection at 254 nm.

Radionuclide activities were determined using a Packard 2500 Tri-Carb liquid scintillation counter (LSC) in the EES-6 laboratories at TA-48. Twenty mL plastic translucent LSC vials were used with 6 mL of sample and 14 mL of Packard UltimaGold AB Scintillant. Counting was duplicated and statistically averaged with two 5-min counting periods. Quench curves for the two radioisotopes, tritiated water (HTO), and barium-133, were created from the isotopes and used to quench correct all resulting counts using the counter’s quench-deriving parameter.

B1-3.2 Filtration

Samples of the high-barium water from well 16-02658 were filtered to determine if barium occurred in solution, was found as a colloid, or was bound to colloidal material. If barium was present as a colloid or adsorbed onto colloidal material, it could be removed by filtration. One filtration study used a Whatman, Anotop 25 (catalog number 6809-2002) 0.02-µ syringe filter. A second method used a 76 mm Millipore Ultrafiltration Stirred Cell with a 500,000 NMWL Biomax PBVK filter (catalog number PBVK-076-10). Analytical results for the filtered samples were obtained using ICP-OES and are presented in Table B1-2.

B1-3.3 Batch Sorption

Batch sorption studies were performed with the reactive media using site-specific alluvial groundwater obtained at TA-16. Natural groundwater containing elevated levels of barium (CdV-16-02658) were diluted using groundwater with background levels of barium (CdV-16-6295) to produce water with barium concentration progressively decreased by thirds creating “high-Ba” (7.3mg/L), “mid-Ba” (5.1mg/L) and “low-Ba” (2.7 mg/L) (Table B1-2). For all batch experiments, the reactive media was placed in plastic vials with one of the three initial solution concentrations (low-, mid-, and high- barium.) with 2 g of media to 100 mL of solution for a 1:50 ratio. Duplicates were run for each of the batch experiments. Samples of each of the three initial solutions containing no reactive media were run as controls. The samples were agitated on an orbital shaker at 120 revolutions per min. Five mL aliquots were removed at 8, 24, 56 and 100 hr and centrifuged at 28,175 relative centrifugal force for 1 hr with resulting supernate analyzed for barium concentration by ICP-OES. RDX sorption experiments were performed similarly but these were performed using only the “high-Ba” water because it also contains the highest levels of RDX (~15 ppb) of the available samples, and thus provides maximum analytical sensitivity.

Distribution coefficients were determined by calculating the ratio of the amount of contaminant sorbed by the reactive media to the amount of contaminant remaining in solution (Freeze and Cherry 1979, 088742, p. 403):

$$K_d = \frac{dS}{dC}$$

Where K_d = distribution coefficient

S = Mass of the solute sorbed by reactive media

C = Solute concentration remaining in solution

B1-3.4 Column Experiments

Column studies using the reactive media were performed to assess the potential of the several media to retard or break down barium and RDX in the PRB. In every column the reactive media was mixed with an equal volume of sand, as this is the material expected to be used in the proposed PRB. The sand is “Colorado Silica Sand” and was obtained from Oglebay Norton Company. The sand was received in a large 10/20 sieved fraction that required reducing. The sand was crushed and sieved to a 0.1–0.5mm grain size, followed by rinsing with deionized water and drying in a vacuum (~18” Hg) oven at 40^{o} C.

In total, three sets of column experiments were performed. The first set used 1 x 20 cm Economy Flex Columns from Kontes Glass with a total material volume of 16 mL (Figure B1-7). The second and third column experiment sets used similar but smaller 1 x 10 cm columns with 8 mL total volume of material. All column experiments used the natural groundwater PWW16-mx containing 6.51 ppm barium and 15 ppb RDX. Duplicates of each column were used throughout the experiments. Columns were packed using dry media that was gently poured by sections, lightly tapped to induce compaction of the media, and weighed. The columns were purged of atmospheric gasses and saturated with deionized water under vacuum. The saturated columns will be reweighed to determine column porosity after experiments are completed.

Hydraulic conductivity measurements were made for all the column assemblies except for column set two (Table B1-3). The procedure for measuring hydraulic conductivity followed the EPA Method 9100 using the “constant head” formula:

$$K = {QL}/{\Delta hA}$$

Where K = hydraulic conductivity

Q = flow volume over time

Δh = head distance

A = cross sectional area of column

L = length of column

Column hydraulic conductivity measurements will also be determined at the end of the column tests to evaluate potential plugging or degrading of the media within the PRB, which will be useful in predicting performance of the proposed PRB.

The first set of column experiments consisted of four columns, representing two different media combinations each run in duplicate. Columns 1 and 2 were prepared with ZVI comprising the bottom of the column and clinoptilolite the top. Columns 3 and 4 were packed with gypsum on the bottom and ZVI on the top. The media were divided into equal volumes separated by a thin layer of glass wool. This experiment was run at a flow rate of 1 mL/hr and collection interval of 6 mL. Pore volumes were approximately 8 to 9 mL.

Columns for the second set of column experiments were prepared using GAC to examine potential RDX breakthrough. For this experiment, the high-barium groundwater with RDX concentration of approximately 15 ppb was continuously flushed through the two columns. Flow rate was 1 mL/hr and the collection interval was 5 mL. Pore volumes were estimated to be 5 mL. The effluent was analyzed for RDX by HPLC.

The third column set consisted of eight columns loaded with four different reactive media: apatite II, clinoptilolite, gypsum, and Bandelier Tuff, and each was run in duplicate. As in the other column sets, high–barium groundwater was used; however, for this column set the water was spiked with HTO as well as barium-133. The use of the two radioactive tracers allows hydrodynamic modeling of the columns as well as providing a retardation and distribution coefficient from resulting differences in breakthrough of the conservative and reactive tracer. Approximately five pore-volumes of the spiked groundwater were injected, followed by flow from natural high-barium groundwater free of any added radionuclides. Total activity of the tracer was approximately 580,000 disintegrations per minute (dpm) of HTO and 270,000 dpm of barium-133 for each column. The flow rate was set to 0.6 mL/hr and collection intervals were progressively increased from initial collections of 0.3 mL, for early HTO breakthrough resolution, to 6 mL. Pore-volumes were approximately 5 mL.

B1-4.0 RESULTS AND DISCUSSION

B1-4.1 Filtration Experiments

Analytical results for filtration studies (Table B1-2) show that barium concentrations, as well as other major cations, agree within analytical uncertainty (although the elevated concentration of potassium of 1.89 mg/L is unexplained). There is no significant difference between filtration methods. These data indicate that barium, as well as other major cations, occur predominantly as ionic solutes and are not in colloidal form.

B1-4.2 Batch Sorption Experiments

Distribution coefficients for barium and different media are averaged for the duplicates and are given in Table B1-4 and shown graphically in Figures B1-8 through B1-10. Gypsum has the highest K_ds with values up to approximately 1951 mL/g. Clinoptilolite has the second highest K_ds with values up to approximately 1827 mL/g and apatite II has the third highest with a K_ds up to approximately 1151 mL/g.

The distribution coefficients for all the media except the tuff increase with time suggesting that the media haven't reached sorption equilibrium after 100 hr. Therefore, it is likely that all media, except the tuff, can be expected to have higher K_ds when equilibration is reached.

Bandelier Tuff was tested to evaluate the potential for natural retardation of barium as groundwater flows through the tuff. Distribution coefficients for the sample of Bandelier Tuff demonstrate a lack of significant change over time, which implies that equilibrium has been achieved. This media has the lowest K_d of those tested, with values between 72 mL/g and 79 mL/g. Nonetheless, these values are sufficiently large such that significant natural retardation of barium is expected. This particular tuff has small amounts of clays and oxides, which tend to have higher capacity to sorb metals when compared to the tuff matrix and phenocrysts. It is likely that more altered tuff units or other units with greater amounts of clays and oxides (e.g., the Puye Formation) will retard barium to an even greater extent than predicted with this particular sample.

Batch sorption used GAC, ZVI, and apatite II to evaluate RDX uptake/breakdown and were performed similarly to the experiments used to examine barium uptake. The high-barium groundwater, which also has the highest RDX concentration, was used. These experiments show that all the material removed RDX to below detection (Table B1-5). The results of these experiments cannot be used to provide kinetic isotherms of RDX reduction as the contaminant was removed or degraded rapidly below detection levels.

B1-4.3 Column Experiments

In the first set of column experiments, gas was generated within the columns after two weeks (approximately 35 pore volumes). It is assumed that ZVI oxidation consumed available oxygen within the system resulting in breakdown of water bonds as a continued oxygen source, which also results in generation of hydrogen gas. Similar hydrogen generation from oxidation of ZVI has been reported by Zhang and Gillham (2005, 095712). Reduced hydraulic conductivity from gas development caused all column pumps to fail roughly 50 to 60 pore-volumes into these experiments. Before the end of the experiment, gas within the columns produced flow channels reducing surface contact between the reactive media and the barium-bearing groundwater. Despite this reduction in available surface area, breakthrough of barium was not detected in any of the four columns (Table B1-6).

The pH of the solution was expected to increase through the columns under the reducing conditions from ZVI corrosion. However, pH remained steady with inlet water averaging 8.0 and effluents averaging 8.1. It is possible that pH was buffered by the calcite precipitation reaction:

$$Ca_2 + HCO_3^- = CaCO_3(s) + H+$$

Consumption of H+ by the reduction reaction raises the pH and causes the reaction to shift to the right. But the precipitation also releases H+ which may help to buffer the solution.

Major cations were measured on the inlet groundwater and the column effluent (Table B1-6). Cation concentrations in Table B1-6 are the averages of the two duplicate columns. In all of the columns, up to 95% of the barium was removed from solution, with concentrations reduced from 6.5 mg/L to roughly 0.03mg/L. The calcium concentration decreased through the clinoptilolite column but substantially increased in the gypsum columns. The outlet tubing of the gypsum columns clouded with a white precipitate during the column experiment. Submerging a section of this tubing in 1.5 molar hydrochloric acid after the experiments rapidly dissolved the precipitate. These observations strongly suggest that calcium carbonate precipitated in the outlet of the gypsum column. This finding further suggests that precipitates may be a concern for plugging of the PRB, an issue that may warrant further consideration.

The second set of columns, listed as columns 5 and 6 (Table B1-3), have currently flowed approximately 70 pore-volumes of approximately 15 ppb RDX water. RDX has not yet been detected in the effluent.

Breakthrough curves (BTCs) for the third set of radionuclide columns, listed as columns 7 through 14 of Table B1-3 are shown in Figures B1-11 through B1-14. All the columns have high HTO mass recoveries ranging from a low of 85% to a high of 92%. In general, BTCs for duplicate columns are similar, with only slight differences in final arrivals. The BTCs are also generally square-shaped, indicating little hydrodynamic dispersion in the column. However, some tailing is evident in the clinoptilolite, gypsum, and Bandelier Tuff columns, which may indicate a small amount of dual porosity behavior.

As of the date of this publication, approximately 28 pore-volumes have been flushed through the radionuclide columns. A very small breakthrough of barium-133 was detected at 9 pore-volumes in the two gypsum columns. This breakthrough was very small in concentration with C/Co of 0.001 and has been observed to be declining after approximately 28 pore-volumes to concentrations near background values. The reason for this early breakthrough of barium is unclear. Continued monitoring of these columns may help to better explain this issue. Barium-133 has not been detected in any of the other columns; these columns are also continuing to run.

B1-5.0 CONCLUSIONS AND RECOMMENDATIONS

Batch and flow-through column experiments were conducted to evaluate materials being considered for a PRB in Cañon de Valle. Several conclusions can be reached from the batch and preliminary column experimental data.

Barium concentrations in samples filtered using a 0.02μ filter and 500,000 dalton filter remained statistically indistinguishable from concentrations in unfiltered samples. These results indicate that barium occurs as a solute rather than in a colloidal form greater than these size ranges. It would be useful to carry these investigations further to include filtration to finer sizes and/or ultracentrifugation to determine if barium might be carried on finer particles.

The reactive media used for the batch sorption studies demonstrate significant sorption behavior from all the media tested (Table B1-4). Gypsum yielded the highest distribution coefficient for barium sorption, averaging 1809 mL/g at 100 hr for all three barium waters. Clinoptilolite was the second highest, averaging 1672 mL/g at at 100 hr and apatite II was third averaging 1020 mL/g. These high K_ds exceeded the sample of Bandelier Tuff by a large margin, averaging 75 mL/g. None of the batch sorption studies, with the exception of those using the tuff, were continued long enough to allow equilibration between the media and the groundwater (i.e., the distribution coefficients continued to increase through time). This indicates that the reported distribution coefficients for all media other than the tuff are minimum values and could potentially be considerably higher.

Batch sorption studies of Bandelier Tuff show equilibrium sorption coefficients between 72 mL/g and 79 mL/g at 100 hr. These results indicate that barium will be naturally retarded by flow through tuff units. The tuff studied is not significantly altered and contains few phases such as clays that are likely to have a higher sorption affinity for barium. The studied tuff unit is one of many volcanic and sedimentary units through which alluvial groundwater must flow to reach the regional aquifer. Many of these units contain greater amounts of clay than the tested tuff. Thus, it is likely that natural retardation of barium will be greater than predicted based on the distribution coefficients determined in this study. However, it would also be important for long-term risk assessment to determine the amount of barium that will be retarded versus the amount that will be permanently removed from solution from irreversible sorption or precipitation. This information could potentially be obtained through additional laboratory studies.

All column experiments showed substantial retardation of barium. Columns using radioactive barium-133 are continuing to run and are expected to yield defensible retardation factors under flow-through conditions. The gypsum columns, loaded with barium-133 demonstrated a very slight but apparent early breakthrough of barium. Although the reasons for this behavior are unclear, possible explanations include colloidal transport as a result of barite mineralization or dissolution of gypsum from which barium may have adsorbed or exchanged with calcium. High calcium concentration in the effluent of some columns, as well a visible white precipitate generated by the gypsum columns, suggests that dissolution and remineralization may be possible in a PRB, and the implications of this process should be evaluated.

Both batch and column studies showed complete removal of RDX from solution. However, the tested solution had small RDX concentrations (approximately 15 ppb) and complete removal (at least to below detection) renders determination of transport parameters impossible. Improved assessment of remediation media can be achieved by spiking the natural groundwater with RDX so that concentrations are sufficient to evaluate uptake.

B1-6.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

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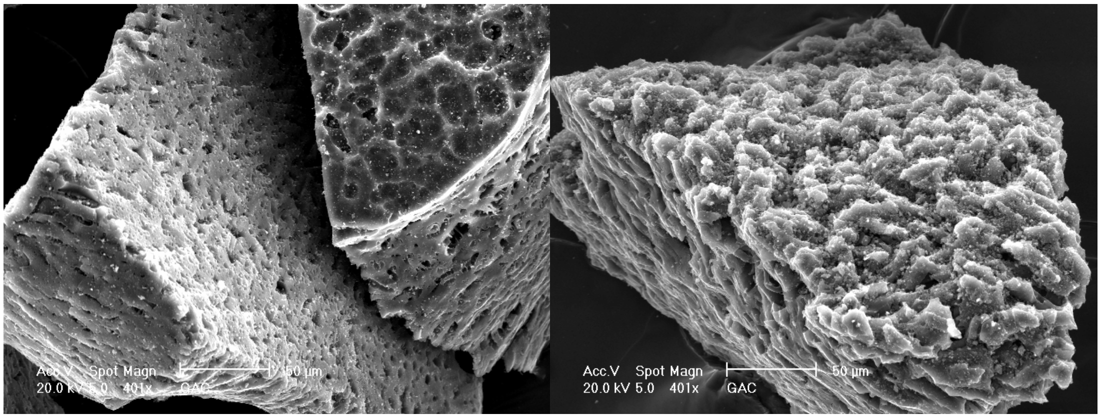


Figure B1-1 SEM images of the GAC

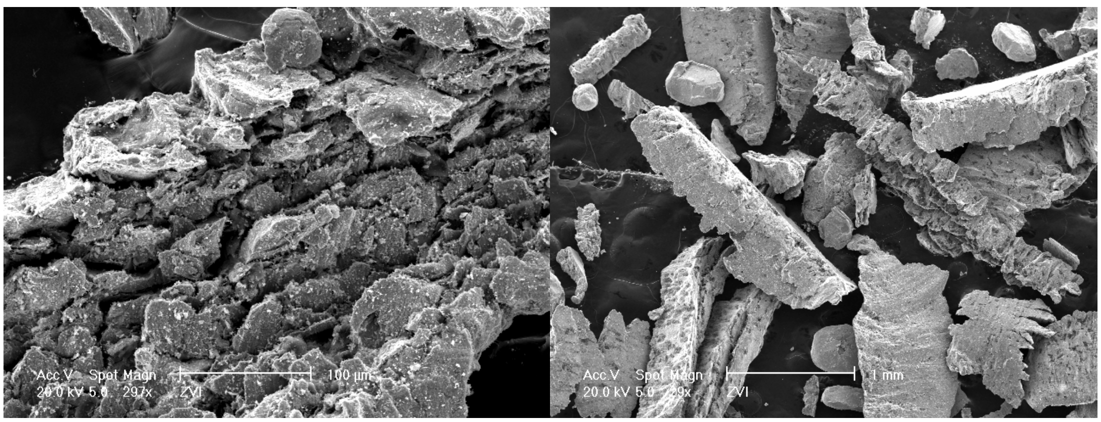


Figure B1-2 SEM image of the ZVI

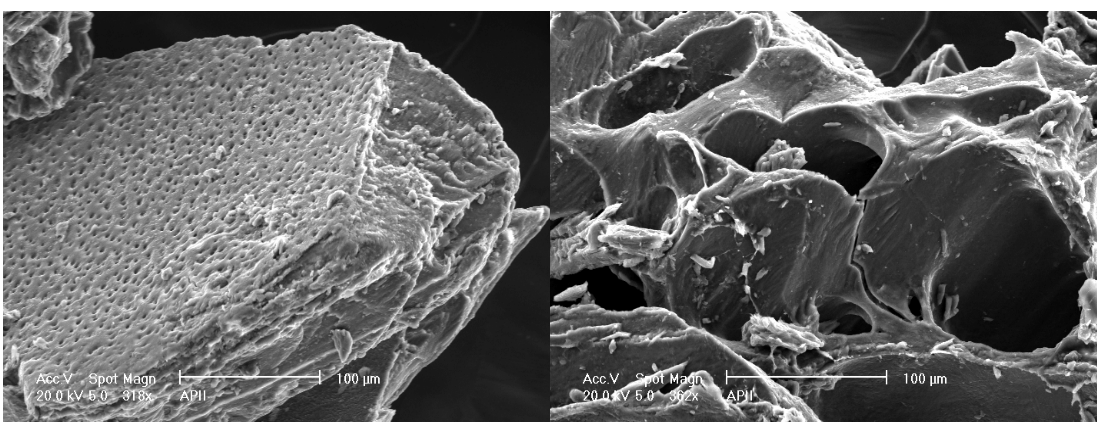


Figure B1-3 SEM image of the apatite II

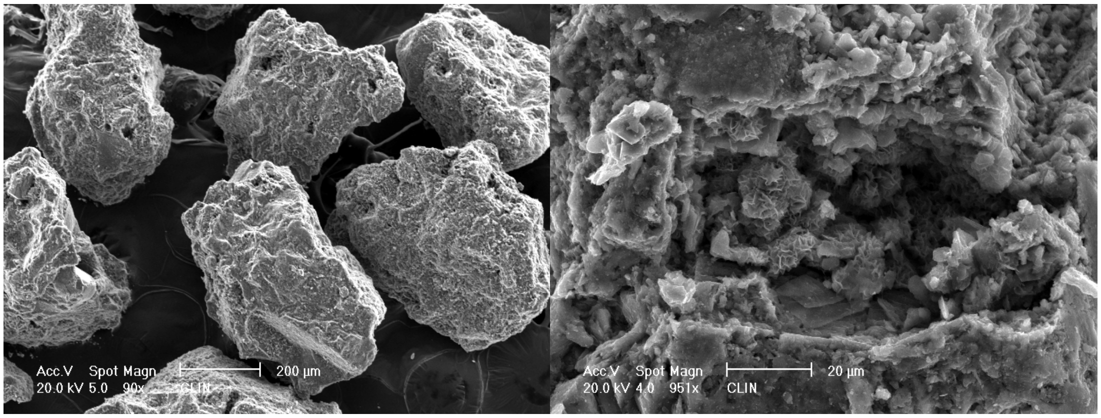


Figure B1-4 SEM image of the clinoptilolite

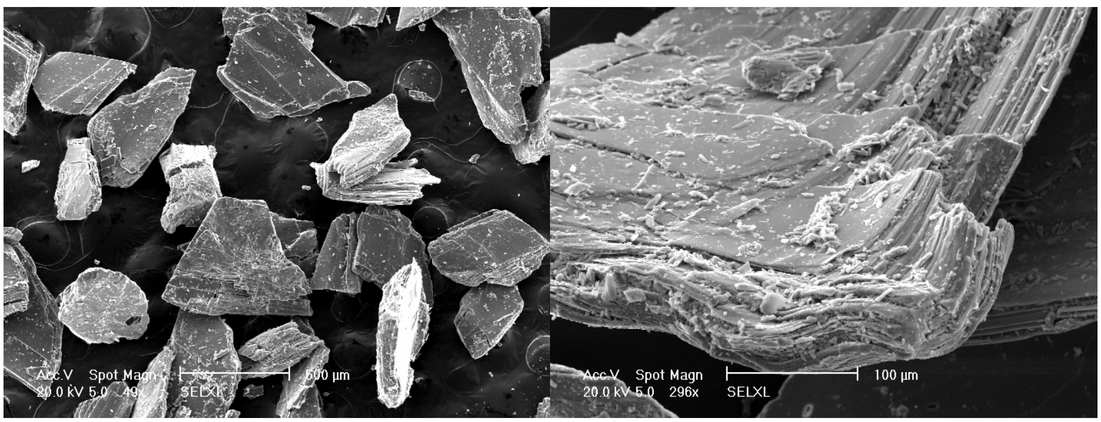


Figure B1-5 SEM image of the gypsum

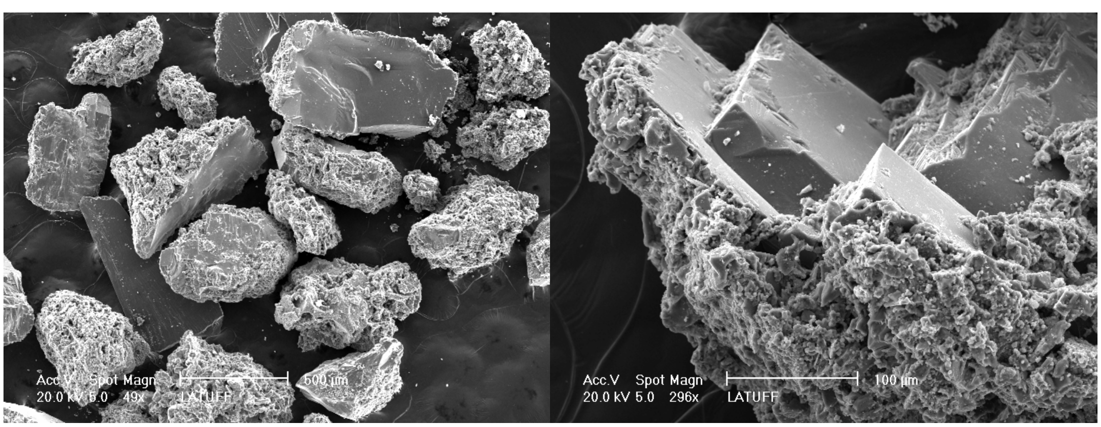


Figure B1-6 SEM image of the Bandelier Tuff

Figure B1-7 Photograph of columns 1–4 from the first set of column experiments. Note that columns are packed with two different reactive media in each.

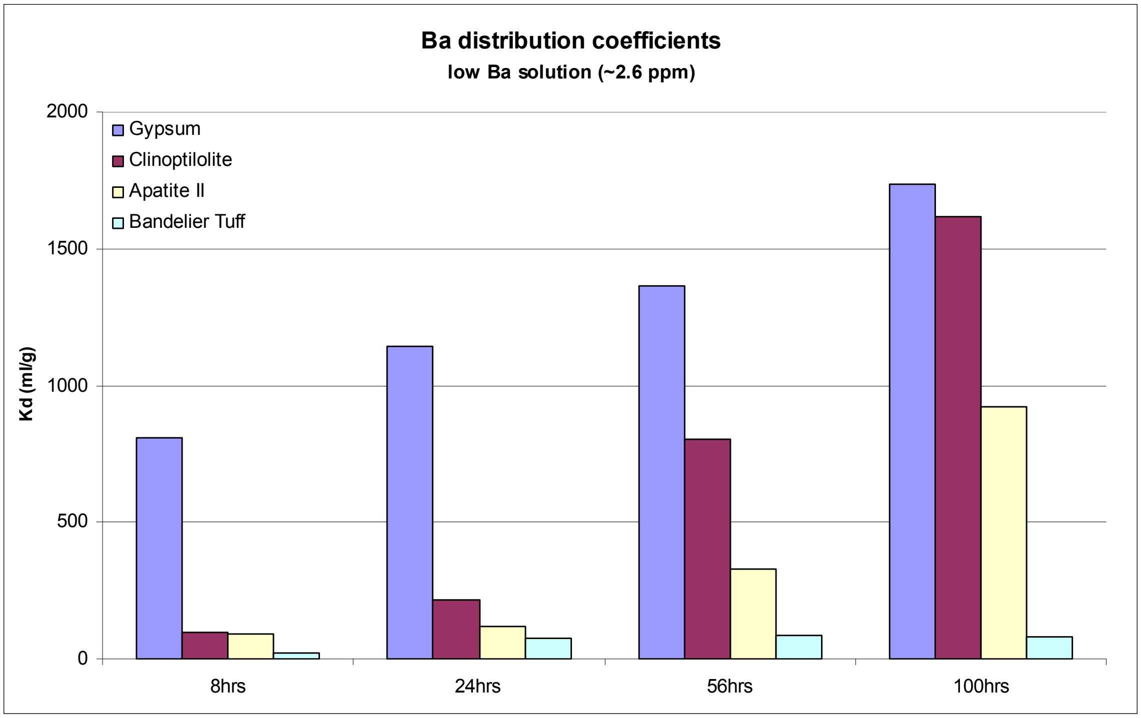


Figure B1-8 Distribution coefficients for different time intervals for Ba using low-Ba water

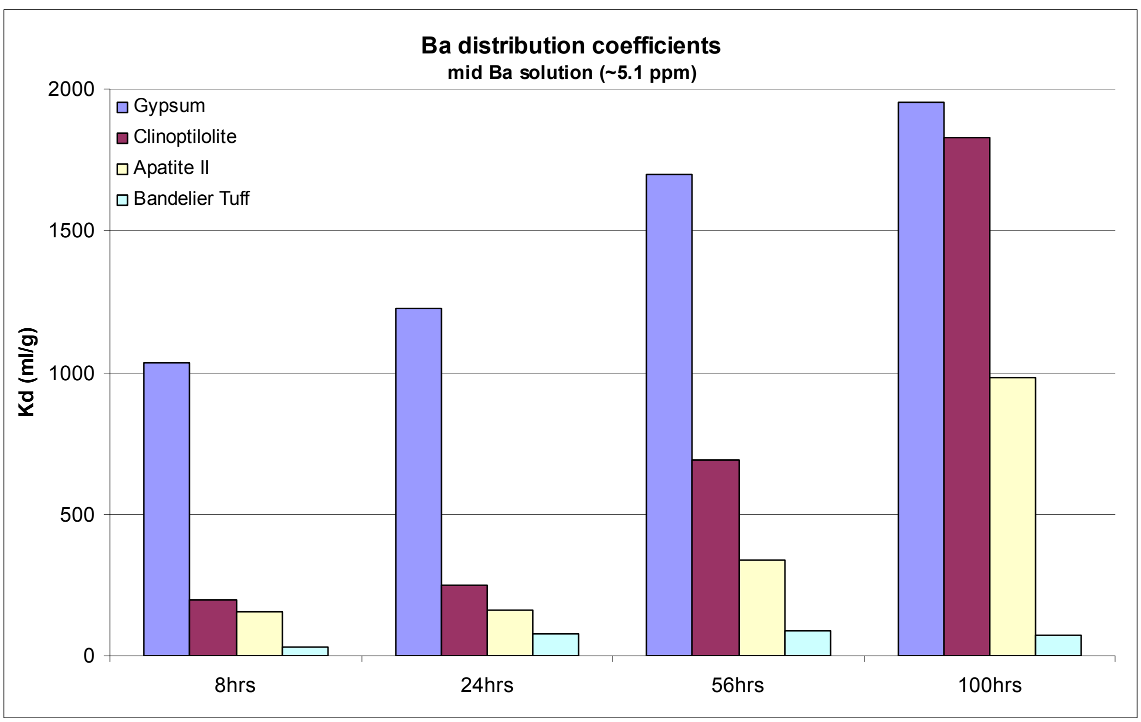


Figure B1-9 Distribution coefficients for different time intervals for Ba using mid-Ba water

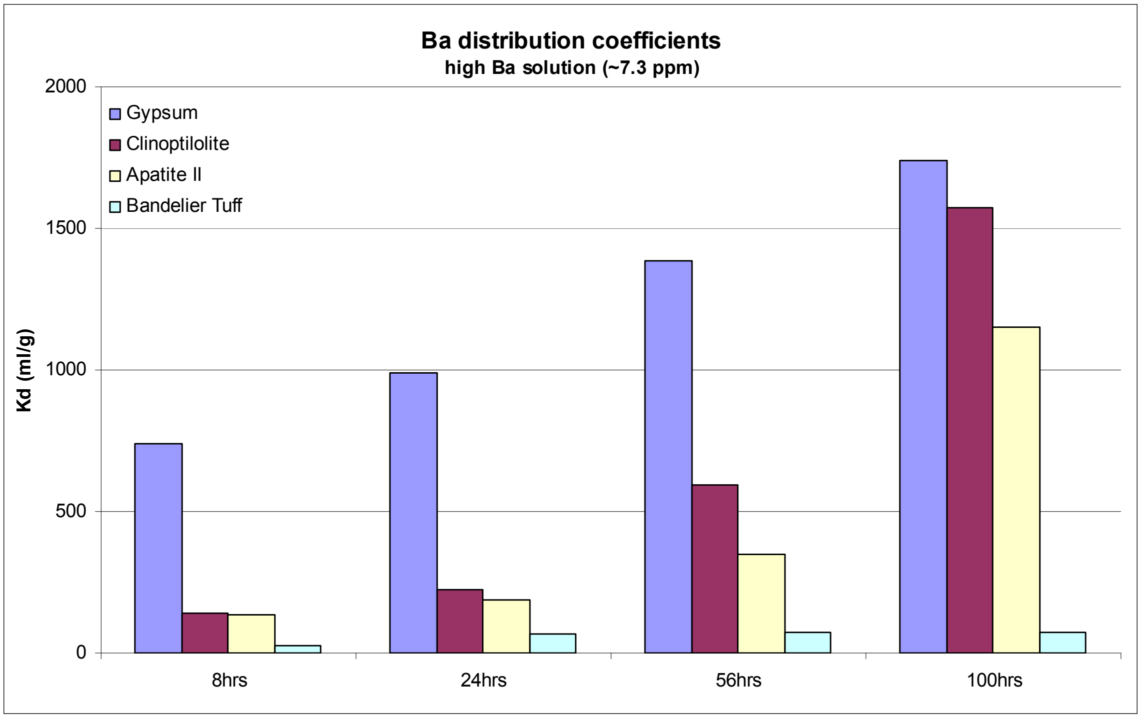


Figure B1-10 Distribution coefficients for different time intervals for Ba using high-Ba water

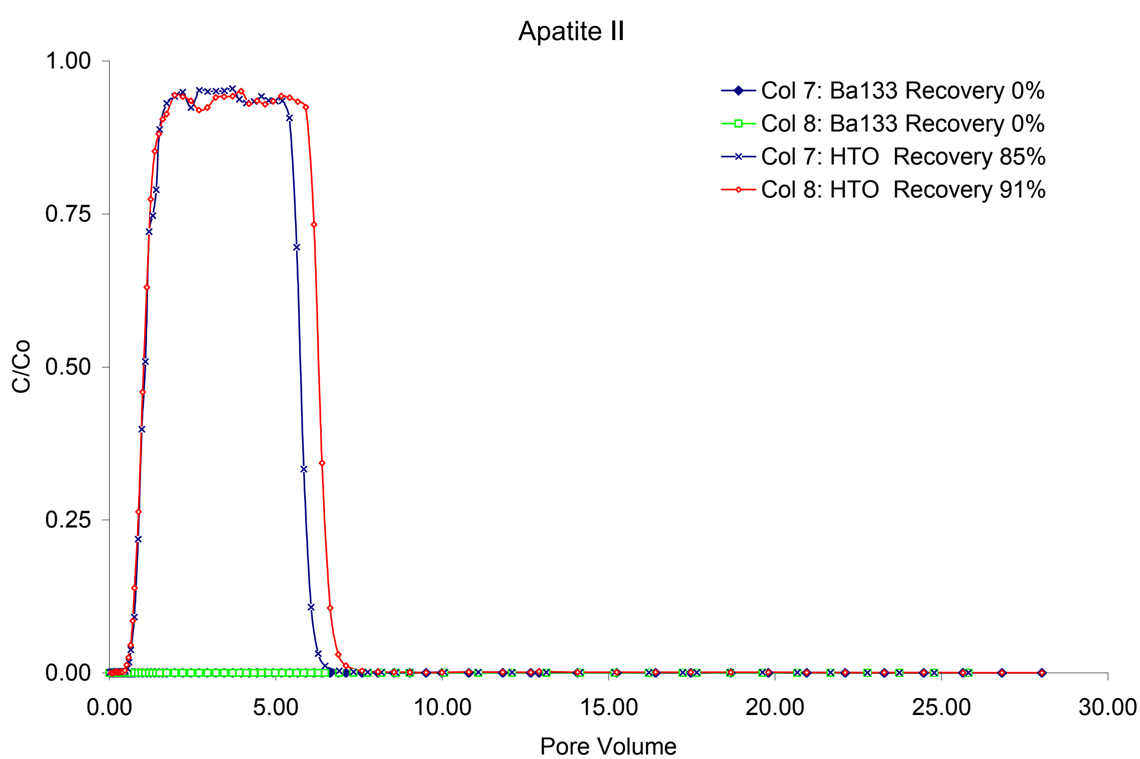


Figure B1-11 Breakthrough curves for apatite II columns

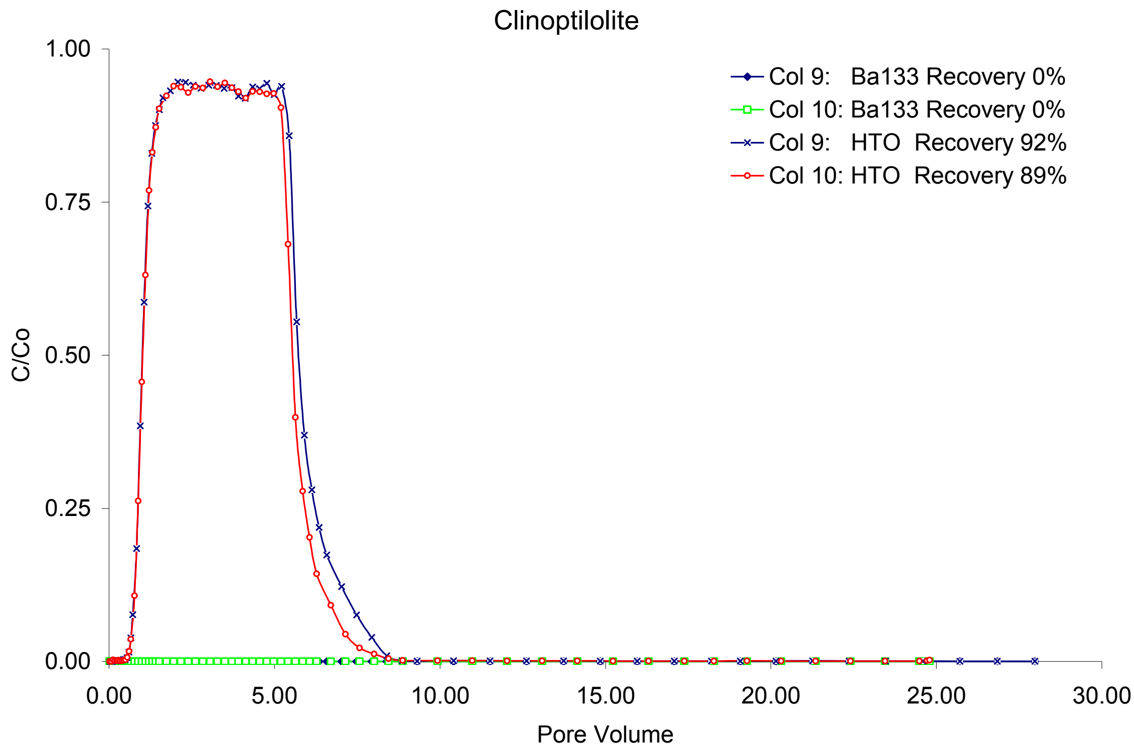


Figure B1-12 Breakthrough curves for clinoptilolite columns

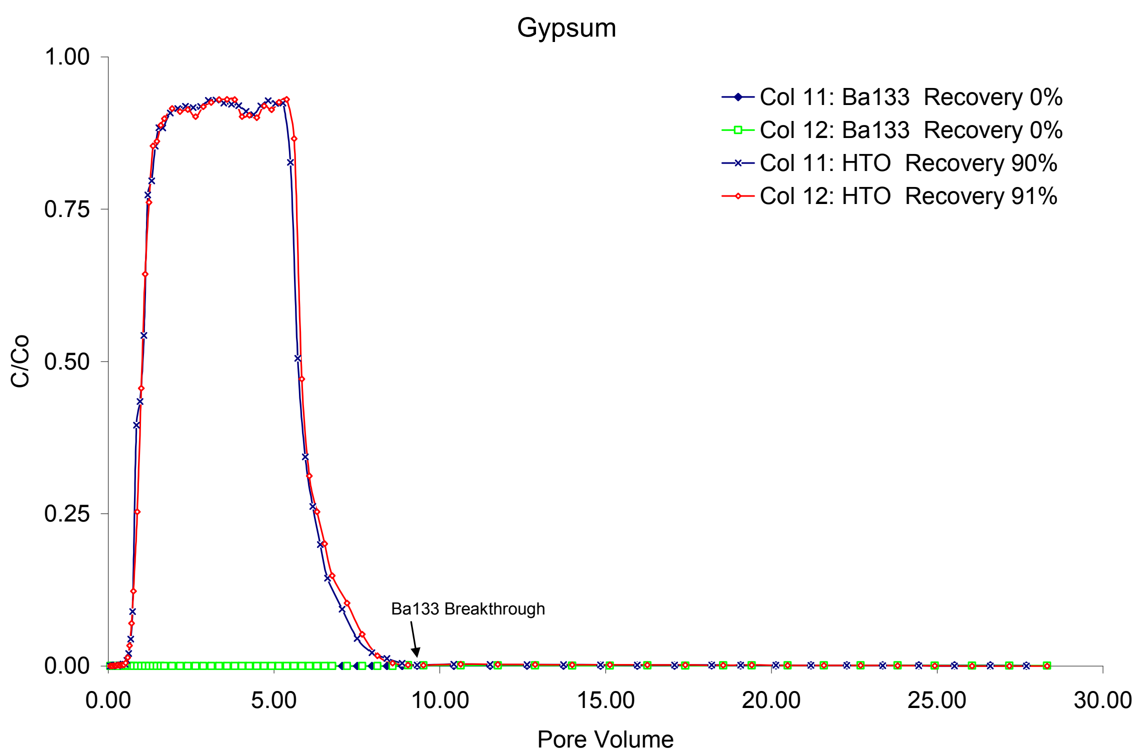


Figure B1-13 Breakthrough curves for gypsum columns

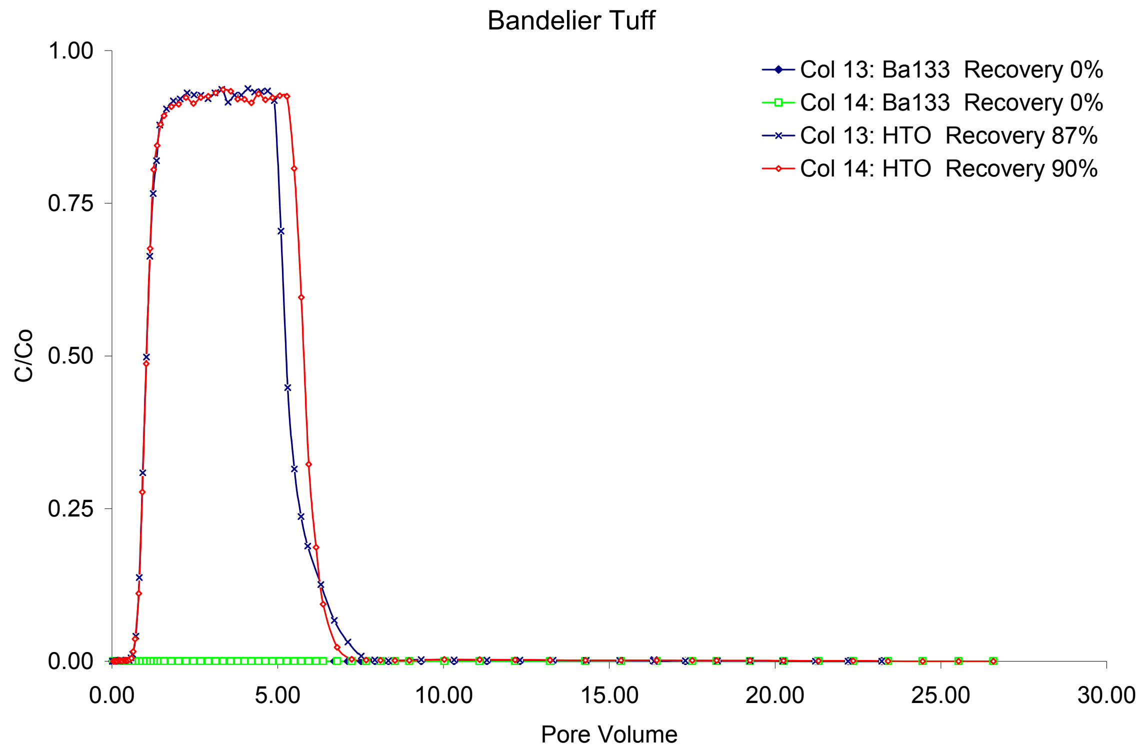


Figure B1-14 Breakthrough curves for Bandelier Tuff columns

Table B1-1
Groundwater Samples and Volumes Collected

Well ID	Collection (Liters)
CDV-16-02657	5
CDV-16-02658	58
CDV-16-02659	12
CDV-16-6295	5

Table B1-2
Major Cation Concentrations in Groundwater, Filtered Water, and Dilutions Used in Batch Sorption Tests

Sample ID	Ba (mg/L)	Ca (mg/L)	Mg (mg/L)	Na (mg/L)	K (mg/L)	Si (mg/L)	Sr (mg/L)
CDV-16-02658 (High-Ba)	7.58	18.3	5.68	16.2	1.89	19.1	0.156
CDV-16-02658 (High-Ba duplicate)	7.17	17.2	5.66	14.5	0.85	18.4	0.150
CDV-16-6295 (Water used for dilution)	0.14	16.7	3.70	15.1	3.20	15.1	0.112
Mid-Ba	5.15	17.8	5.22	14.5	1.28	17.7	0.138
Low-Ba	2.70	17.5	4.67	14.5	1.84	16.6	0.122
PWW16-mix	6.51	18.8	5.04	15.32	1.3	18.3	0.17
CDV-16-02658 (0.02µ filter)	7.25	17.7	5.87	15.2	0.91	19.2	0.154
CDV-16-02658 (500,000 NMWL filter)	7.56	18.1	5.85	15.8	0.86	18.8	0.158

Table B1-3
Hydraulic Conductivity of the Columns

Column Number	Media	Column Dimension (cm)	Hydraulic Conductivity (cm/min)
1	ZVI & Clinoptilolite	1 x 20	1.00
2	ZVI & Clinoptiolite	1 x 20	1.11
3	ZVI & Gypsum	1 x 10	1.26
4	ZVI & Gypsum	1 x 10	1.38
5	GAC	1 x 10	Not determined
6	GAC	1 x 10	Not determined
7	ApatiteII	1 x 10	1.53
8	ApatiteII	1 x 10	0.99
9	Clinoptilolite	1 x 10	1.08
10	Clinoptilolite	1 x 10	1.38
11	Gypsum	1 x 10	1.19
12	Gypsum	1 x 10	1.40
13	Bandelier Tuff	1 x 10	2.46
14	Bandelier Tuff	1 x 10	1.14

Table B1-4
Distribution Coefficients in mL/g for Barium

Media	8 hr	24 hr	56 hr	100 hr	Ba Concentration
Gypsum	806	1144	1366	1736	2.6 mg/L (low)
Clinoptilolite	95	217	803	1616	2.6 mg/L (low)
Apatite II	93	121	328	924	2.6 mg/L (low)
Bandelier Tuff	20	76	88	79	2.6 mg/L (low)
Gypsum	1034	1226	1699	1951	5.1 mg/L (mid)
Clinoptilolite	196	247	691	1827	5.1 mg/L (mid)
Apatite II	158	162	336	984	5.1 mg/L (mid)
Bandelier Tuff	34	76	88	72	5.1 mg/L (mid)
Gypsum	738	988	1383	1740	7.3 mg/L (high)
Clinoptilolite	140	222	593	1574	7.3 mg/L (high
Apatite II	134	186	348	1151	7.3 mg/L (high
Bandelier Tuff	25	68	70	75	7.3 mg/L (high

Table B1-5
RDX Batch Results

Media	0 hr	7.5 hr	22 hr	47 hr
GAC	15 ppb	<1ppb	<1ppb	<1ppb
ZVI	15 ppb	<1ppb	<1ppb	<1ppb
Apatite II	15 ppb	<1ppb	<1ppb	<1ppb

Table B1-6
ICP-OES Major Element Analysis of ZVI – Clinoptilolite and ZVI – Gypsum Column Elutants

Elements	High-Ba Water (inlet)	Column 1 ZVI & Clinoptilolite	Column 2 ZVI & Clinoptilolite	Column 3 ZVI & Gypsum	Column 4 ZVI & Gypsum	Averaged ZVI & Clinoptilolite	Averaged ZVI & Gypsum
Al (mg/L)	<0.02	0.026	0.018	0.011	0.009	0.022	0.010
B (mg/L)	<0.02	<0.005	<0.005	<0.005	<0.005	NA*	NA
Ba (mg/L)	**6.51**	**0.074**	**0.066**	**0.026**	**0.026**	**0.070**	**0.026**
Ca (mg/L)	18.8	9.50	8.12	250	260	8.809	255.109
Fe (mg/L)	<0.1	<0.03	<0.03	<0.03	<0.03	NA	NA
K (mg/L)	1.30	1.49	1.25	0.87	0.84	1.368	0.856
Li (mg/L)	<0.01	<0.003	<0.003	<0.003	<0.003	NA	NA
Mg (mg/L)	5.04	2.06	1.96	2.03	1.98	2.008	2.006
Mn (mg/L)	<0.01	0.041	0.061	0.027	0.032	0.051	0.030
Na (mg/L)	15.32	6.42	6.16	7.01	6.79	6.290	6.904
Si (mg/L)	18.30	0.33	0.47	0.39	0.61	0.399	0.502
Sr (mg/L)	0.17	0.031	0.026	0.42	0.40	0.028	0.411
Ti (mg/L)	<0.01	<0.003	<0.003	<0.003	<0.003	NA	NA
Zn (mg/L)	<0.01	<0.003	<0.004	<0.005	<0.006	NA	NA

Note: Barium is bolded because it is the contaminant of most significant concern in these studies.
*NA = Not analyzed.

Appendix B-2

Slug Test Analysis for Cañon de Valle and Martin Spring Canyon Alluvial Wells

B2-1.0 INTRODUCTION

Slug tests were performed on five alluvial monitoring wells in Cañon de Valle and two alluvial monitoring wells in Martin Spring Canyon (Figure B2-1) to support the corrective measures implementation (CMI) for Consolidated Unit 16-021(c)-99 at Los Alamos National Laboratory (LANL or the Laboratory). In Cañon de Valle, one 2-in.-diameter and four 4-in.-diameter wells were tested. In Martin Spring Canyon, two 4-in.-diameter wells were tested. All wells were completed in 12.5-in.-diameter boreholes. The well screens were prepacked with 30-70 grade silica sand and the borehole annulus was filled with 20-40 grade silica sand. Total depths of the wells are approximately 5–7 ft below ground surface. The boreholes were drilled into tuff and wells were installed with the bottom of the screen set approximately at the base of the alluvium (with the exception of wells 16-02658 and 16-02659 for which the screens extend 1.5 ft and 0.9 ft into tuff, respectively). Complete details of well installation and borehole logs can be found in the Resource Conservation and Recovery Act (RCRA) facility investigation (RFI) Phase II and Phase III reports for Consolidated Unit 16-021(c)-99 (LANL 1998, 059891; LANL 2003, 077965). Table B2-1 lists the well locations, well construction details, and initial water levels observed during testing. All field work for these slug tests was conducted between November 15 and November 20, 2006.

B2-2.0 GENERAL FIELD PROCEDURES

B2-2.1 Field Personnel

Slug testing included the following field team members:

Field Team Member	Role(s)	Organization
Don Hickmott	LANS Technical Representative	LANL EES-6
Mike Alexander	LANS Technical Representative	EP-WSP
Peter Gram	TPMC Program Manager	TPMC
Kevin Reid	TPMC Project Manager	TPMC
Robert Gray	Hydrologist	Daniel B. Stephens and Associates
Zack Leonard	Environmental Scientist	TPMC

B2-2.2 Health and Safety

The principal activities, work steps, hazards, and hazard controls associated with slug testing are set forth in the Technical Area (TA) 16 integrated work document (IWD) and the TA-16 site-specific health and safety plan (SSHASP).

Before starting fieldwork, all active field personnel are required to sign a statement acknowledging they have read, understood, and agree to abide by the TA-16 IWD and SSHASP and that all training requirements have been met.

Per the SSHASP, daily tailgate safety meetings are conducted before any fieldwork begins to ensure the scheduled field activities of the day are understood, all potential hazards are identified, and all appropriate hazard controls are defined and in place.

B2-3.0 METHODS

B2-3.1 Field Methods

The wells were tested following the procedures outlined in Standard Operating Procedure (SOP) 0 7.03, Rev. 1. The basic procedure is to quickly lower or remove a slug of known volume into the well and measure the water level recovery response. Water levels during each test were continuously measured using a pressure transducer. Tubular slugs constructed from polyvinyl chloride pipe filled with sand were used. For the 4-in.-diameter wells, 2-in.-diameter-slugs were used, and for the 2-in.-diameter well, 1-in.-diameter slugs were used. Depending on the height of the water column in each well, a 2-ft, 3-ft, or 4-ft-length slug was used. Table B2-2 lists the slug dimensions and volumes used for the tests. Both rising head and falling head tests were conducted in each well by inserting or extracting the slug from the water column. Where possible, multiple tests were performed using two different-sized slugs in each well. The initial test for each well was repeated to assess data consistency.

Usually (with a few exceptions), the larger slug was first immersed in the water column and the falling head was monitored. After the water recovered to its static level, the slug was quickly removed, and data for the rising head test were collected. After static water level reached equilibrium, a second test was conducted by inserting and removing a different size slug while monitoring the falling and rising heads. To conclude, the larger slug was then introduced again for both rising head and falling head tests. To ensure that water levels returned to near the original static levels before conducting an additional test, a 90% recovery rate was calculated. The next test was (generally) not conducted until the water level had recovered to at least 90% of the initial displacement. Water levels and measurement times were recorded by a pressure transducer and downloaded to a laptop computer.

B2-3.2 Equipment

In-Situ, Inc., miniTROLL model SSP-100 pressure transducers with vented cables were used to measure water levels for all tests. A laptop computer with Win-Situ 4.57 software was used to program the tests and download the test results. The transducers were programmed to collect water-level measurements at time intervals based on a logarithmic scale. Using this setting, water levels during the early part of the test were initially recorded at 0.3-s intervals, with logarithmically increasing intervals after the initial test period, up to a maximum interval of 10 s. In cases where wells exhibited a very slow recovery rate, the 10-s interval data were collected for approximately 10 min, then the transducer was reprogrammed to collect data at 5-min intervals for the remainder of the recovery period. Static groundwater levels were measured using a Solinst water-level meter.

B2-3.3 Analytical Methods

Estimation of the hydraulic conductivity of the screened formation was made based on fitting the water-level recovery hydrograph to a theoretical curve based on an equation representing well hydraulics. All water-level recovery results were plotted and analyzed for data accuracy and consistency. Data series were reviewed to ensure there were no anomalies. Predicted displacements were calculated for each slug and compared to the measured water-level displacements. Falling head tests and rising head tests were normalized to initial displacements and plotted on the same graph to ensure consistency of response.

For each analyzed test, the static water level, initial displacement, aquifer and well characteristics (screen length, casing radius, effective well radius, filter-pack porosity, saturated thickness, aquifer thickness) and water-level recovery data were input to calculate hydraulic conductivity using HydroSOLVE, Inc., software

AQTESOLV for Windows Professional (v. 3.50). Hydraulic conductivity was calculated using the (Bouwer and Rice 1976, 064056) method for an unconfined aquifer. This method uses a plot of the logarithm of measured head against time in which the theoretical type curve plots along a straight line. The test data were fitted to the type curves computed by AQTESOLV.

B2-3.4 Waste Management

The only waste stream generated was contact investigation-derived waste (IDW) that included used personal protective equipment and paper towels. All contact IDW is characterized as solid industrial waste in accordance with the waste characterization strategy form.

B2-4.0 RESULTS

The test names and slug sizes used at each well along with test durations are listed in Table B2-3. The estimated hydraulic conductivities determined for each test and the average hydraulic conductivity rate for each well are listed in Table B2-4. Because of the limited stresses induced in the aquifer by the slug-test method, these results should be considered a lower bound on the hydraulic conductivity of the aquifer in the immediate vicinity of the tested wells.

In Cañon de Valle, the lower canyon alluvial wells, 16-02659 and 16-02660, exhibited the highest average hydraulic conductivity rates among the tested wells (1.80E-02 cm/s and 3.79E-02 cm/s, respectively). For comparison, a rate of 1E-02 cm/s is representative of clean sand (Freeze and Cherry 1979, 088742). Wells 16-02656 and 16-02658 yielded average hydraulic conductivity rates of 1.15E-03 cm/s and 2.72E-04 cm/s, respectively, rates that typically correspond to that of a silty sand (Freeze and Cherry 1979, 088742). Well 16-02657 exhibited the lowest average hydraulic conductivity rate among the tested wells (6.74E-07 cm/s). Incomplete water-level recovery during the lengthy tests performed in this well (Table B2-3) suggests poor well screen communication with the aquifer; consequently, the test results for well 16-02657 may be suspect.

The lower well in Martin Spring Canyon (16-06295) exhibited an average hydraulic conductivity of 1.15E-02 cm/s and the middle well (16-06294) yielded an average hydraulic conductivity of 3.69E-04 cm/s. These rates correspond to published values for clean sand and silty sand respectively (Freeze and Cherry 1979, 088742).

Attachment B2-1 includes plots of the water-level recovery responses and normalized recovery data for each test. Attachment B2-2 includes the AQTESOLV curve matching plots used to calculate the conductivities of each test for each well.

Deviations

For well 16-02658, falling head test 1 and falling head test 3 were excluded from analysis because the slug endcaps were not completely water tight, and escaping air bubbles were noticed during testing immediately after the slug's initial submergence. Wells 16-02659 and 16-02660 had just over 2 ft of standing water and only permitted use of the 2-ft slug for testing. Two rising head and two falling head tests using the 2-ft slug were thus conducted at each well. Well 16-02657 exhibited an extremely slow recovery. The duration of the rising head test was approximately 20 hr and the duration of the falling test was approximately 75 hr. Because of the slow response time, only one rising head test and one falling head test was completed. Also, the water did not recover to its original static level in this well. Inconsistent normalized response hydrographs suggest that the well may not have been adequately developed or sediment may be clogging the well screen. The first falling head test for well 16-02656 was excluded from analysis because the slug did not reach the bottom of the well and the cable was moved during the test. For the other tests at well 16-02656, the normalized response hydrographs were not consistent for each rising and falling head test. This 2-in.-diameter well was installed in a 12.5-in.-diameter borehole, and the inconsistent recovery results suggest that the well may not have been fully developed or some inefficiency may be occurring from sediment clogging the well screen. Well 16-06293, the uppermost well in Martin Spring Canyon, had only 0.5 ft of standing water, which is not enough to conduct a valid test. The first two tests at Martin Spring Canyon well 16-06295 were invalid because of an obstruction in the well casing. The obstruction was removed, and three tests were conducted without complication.

B2-5.0 SUMMARY

Average hydraulic conductivities were calculated for each of the five alluvial monitoring wells in Cañon de Valle and for two alluvial monitoring wells in Martin Spring Canyon. The average results ranged from about 1E-02 cm/s to 3E-04 cm/s for six of the seven tested wells. These rates fall within the typical range for clean to silty, unconsolidated sands (Freeze and Cherry 1979, 088742). The analysis of test data from well 16-02657 yielded an apparent hydraulic conductivity of 6.74E-07 cm/s, but this well possibly has a clogged screen. Overall, the test results reflect the natural heterogeneity of the canyon-bottom alluvial sediments and are within the range of expected values based on published data and other studies conducted in alluvial aquifers on the Pajarito Plateau.

B2-6.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

Bouwer, H., and R.C. Rice, June 1976. "A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers With Completely or Partially Penetrating Wells," Water Resources Research, Vol. 12, No. 3, pp. 423-428. (Bouwer and Rice 1976, 064056)

Freeze, R.A., and J.A. Cherry, January 1979. Groundwater, Prentice-Hall, Inc., Englewood Cliffs, New Jersey. (Freeze and Cherry 1979, 088742)

LANL (Los Alamos National Laboratory), September 1988. "Phase II RFI Report for Potential Release Site 16-021(c)," Los Alamos National Laboratory document LA-UR-98-4101, Los Alamos, New Mexico. (LANL 1998, 059891)

LANL (Los Alamos National Laboratory), September 2003. "Phase III RFI for Solid Waste Management Unit 16-021(c)-99," Los Alamos National Laboratory document LA-UR-03-5248, Los Alamos, New Mexico. (LANL 2003, 077965)

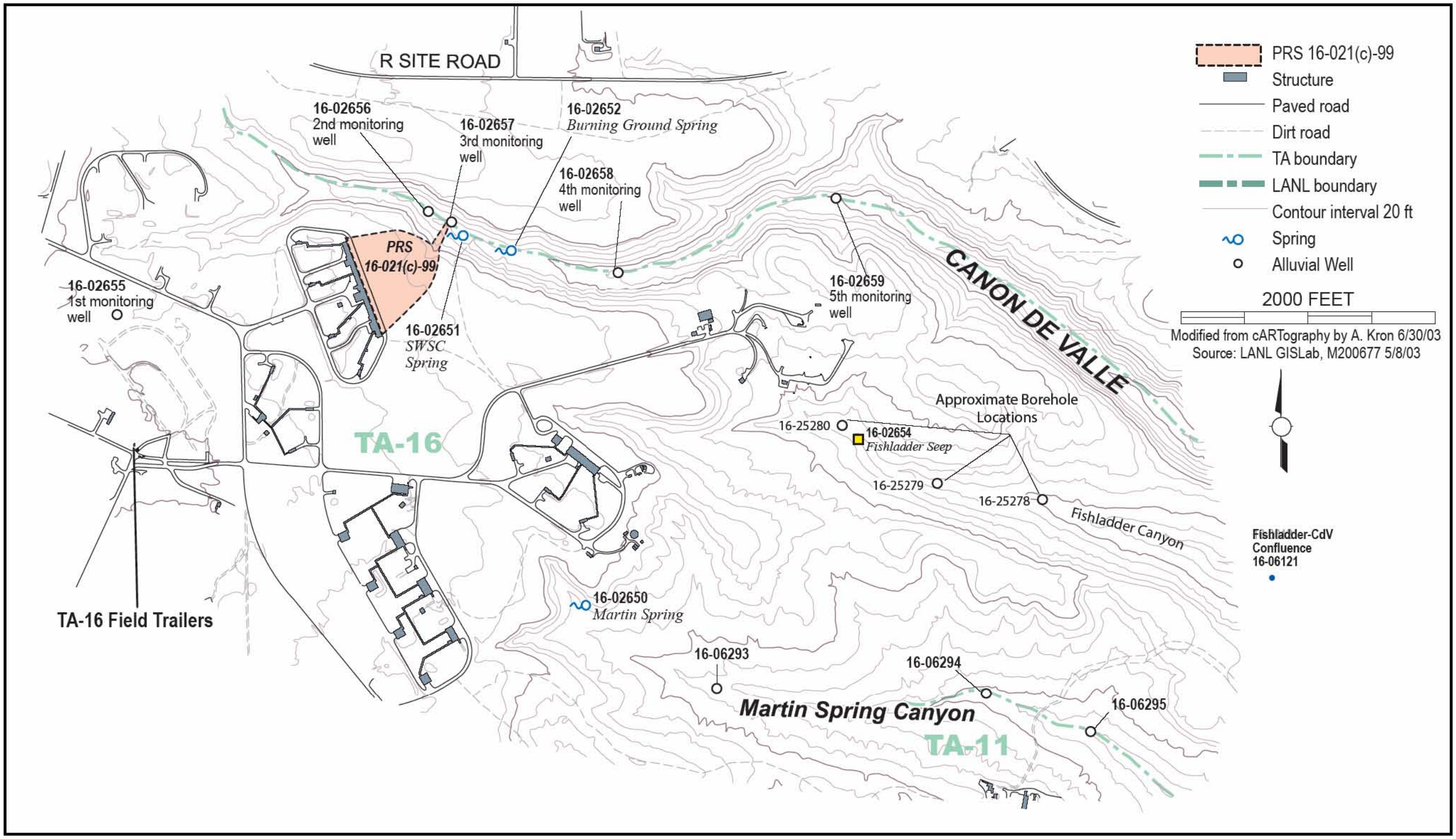


Figure B2-1 Map showing alluvial well locations in Cañon de Valle and Martin Spring Canyon

Table B2-1
Alluvial Well Characteristics

Well Location and ID	Well Diameter (in.)	Screen Length (ft)	Total Depth (ft bgs)	Screened Interval (ft bgs)	Depth to Water (ft bgs)	Saturated Thickness (ft)*	Date
Cañon de Valle							
16-02656	2	5	8.3	3.0–8.0	3.94	4.36	11/16/06
16-02657	4	5	5.7	0.4–5.4	2.55	3.15	11/16/06
16-02658	4	5	7.2	1.9–6.9	2.40	4.80	11/15/06
16-02659	4	5	7.0	1.7–6.7	4.59	2.41	11/16/06
16-02660	4	5	6.9	1.6–6.6	4.51	2.39	11/16/06
Martin Spring Canyon							
16-06294	4	5	7.6	2.3–7.3	2.22	5.38	11/17/06
16-06295	4	5	6.9	1.6–6.6	1.72	5.18	11/17/06

*Saturated thickness was computed assuming screen bottom is at base of saturation.

Table B2-2
Slug Dimensions

Slug (Length x Diameter)	Volume (ft^3)
2 ft x 1 in	0.01962
3 ft x 1 in	0.02872
2 ft x 2 in	0.05613
3 ft x 2 in	0.08313
4 ft x 2 in	0.11135

Table B2-3
Test Implementation Data

Well Location and ID	Test Name	Slug Size	Duration (min)	Comments
Cañon de Valle				
16-02656	Falling Head 1	3 ft x 1 in.	25.6	Slug did not reach well bottom; transducer was moved. FH1 data excluded from results because of anomalous recovery behavior.
	Rising Head 1	3 ft x 1 in.	8.1	
	Falling Head 2	2 ft x 1 in.	6.6	
	Rising Head 2	2 ft x 1 in.	7.9	Water did not recover to static level. RH2 data excluded from results because of anomalous recovery behavior.
	Falling Head 3	3 ft x 1 in.	9.1	
	Rising Head 3	3 ft x 1 in.	7.6	
16-02657	Falling Head 1	3 ft x 2 in.	1223	Water did not recover to static level.
	Rising Head 1	3 ft x 2 in.	4487	Water did not recover to static level.
16-02658	Falling Head 1	3 ft x 2 in.	39.6	Test data compromised by air escaping from slug. Data excluded from results because normalized displacement plots indicated anomalous recovery behavior.
	Rising Head 1	3 ft x 2 in.	31.3	
	Falling Head 2	2 ft x 2 in.	40.8	
	Rising Head 2	2 ft x 2 in.	963	
	Falling Head 3	3 ft x 2 in.	31.3	Test data compromised by air escaping from slug. Data excluded from results because normalized displacement plots indicated anomalous recovery behavior.
	Rising Head 3	3 ft x 2 in.	181	
16-02659	Falling Head 1	2 ft x 2 in.	11.9	Low saturation level precluded use of multiple-size slugs.
	Rising Head 1	2 ft x 2 in.	4.9	
	Falling Head 2	2 ft x 2 in.	9.3	
	Rising Head 2	2 ft x 2 in.	5.5	
16-02660	Falling Head 1	2 ft x 2 in.	2.8	Low saturation level precluded use of multiple-size slugs.
	Rising Head 1	2 ft x 2 in.	5.6	
	Falling Head 2	2 ft x 2 in.	6.5	
	Rising Head 2	2 ft x 2 in.	5.5	

Table B2-3 (continued)

Well Location and ID	Test Name	Slug Size	Duration (min)	Comments
Martin Spring Canyon				
16-06294	Falling Head 1	4 ft x 2 in.	84.9	
	Rising Head 1	4 ft x 2 in.	52.6	
	Falling Head 2	3 ft x 2 in.	84.9	Water did not recover to static level. FH2 data excluded from results because of anomalous recovery behavior (water level failed to recover to static level).
	Rising Head 2	3 ft x 2 in.	4,014	
	Falling Head 3	4 ft x 2 in.	67.9	
	Rising Head 3	4 ft x 2 in.	83.9	
16-06295	Falling Head 1	3 ft x 2 in.	8.1	Incomplete slug submergence due to obstruction in well. Data excluded from results.
	Rising Head 1	3 ft x 2 in.	8.6	Incomplete slug submergence due to obstruction in well. Data excluded from results.
	Falling Head 2	4 ft x 2 in.	8.8	Incomplete slug submergence due to obstruction in well. Data excluded from results.
	Falling Head 3	3 ft x 2 in.	7.6	
	Rising Head 3	3 ft x 2 in.	5.8	
	Falling Head 4	4 ft x 2 in.	11.9	
	Rising Head 4	4 ft x 2 in.	9.8	
	Falling Head 5	3 ft x 2 in.	10.5	
	Rising Head 5	3 ft x 2 in.	9.6	

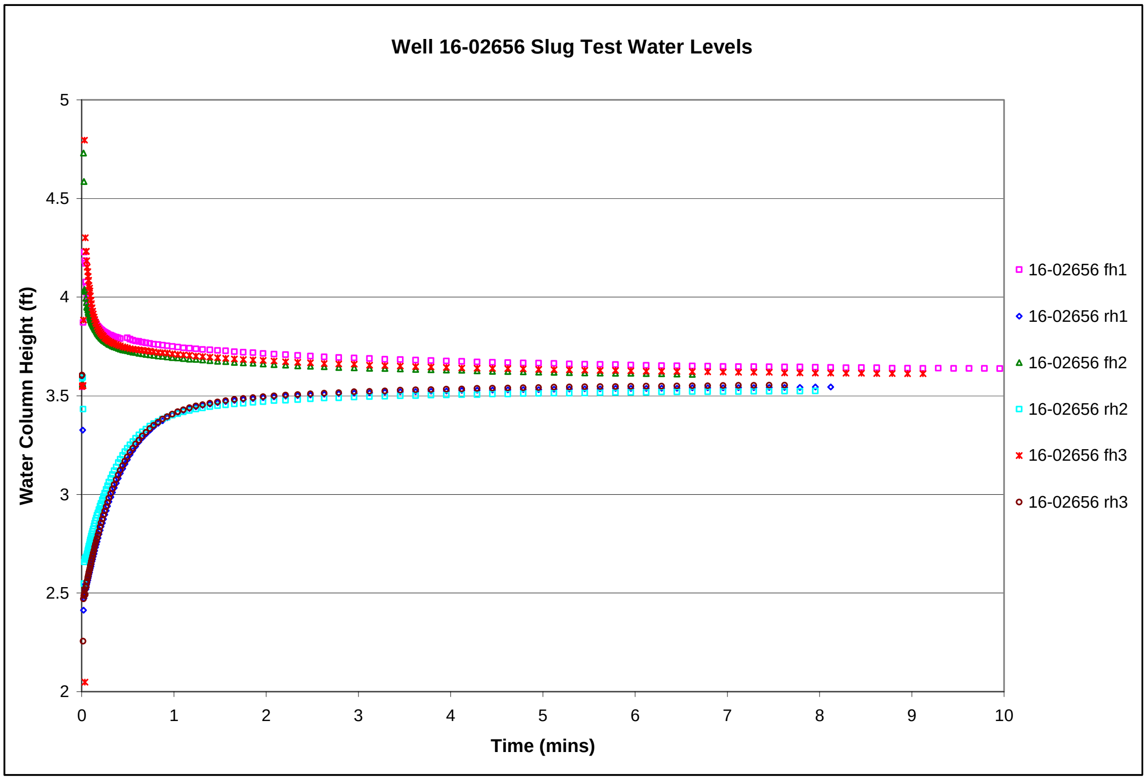
Note: Blank cells indicate no comment.

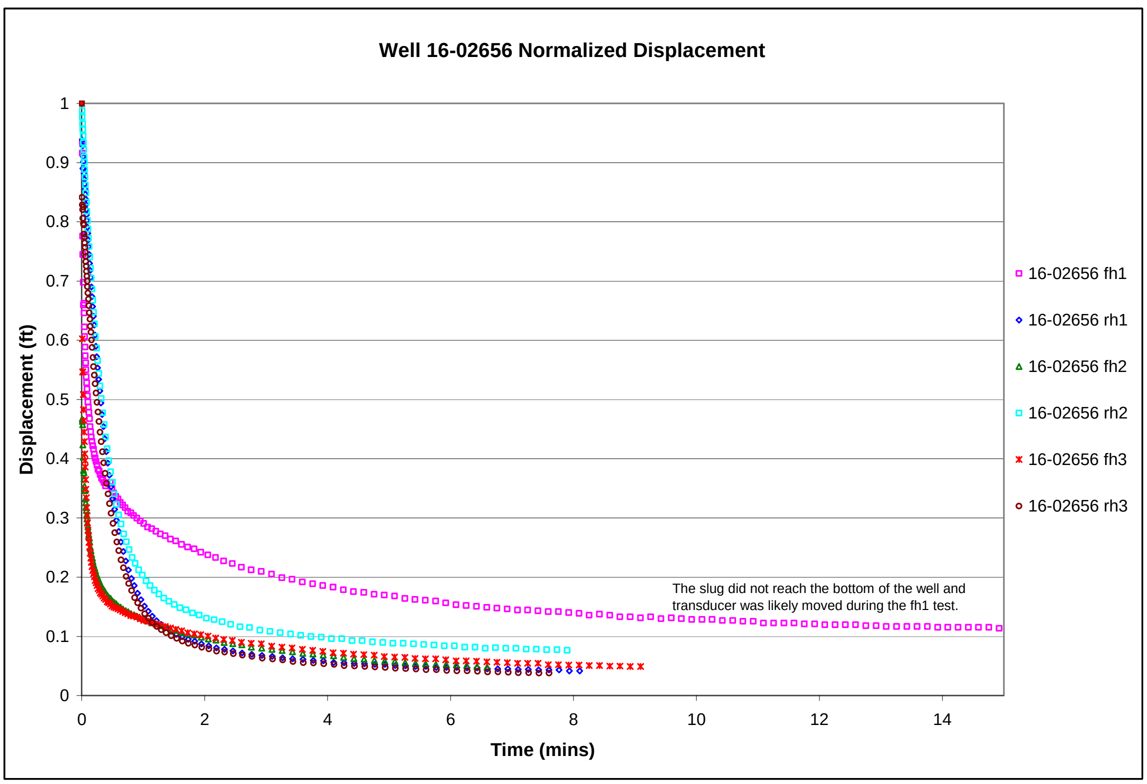
Table B2-4
Slug Test Analysis Results

Well No.	Test No.	Test Type	Hydraulic Conductivity (cm/s)	Average Hydraulic Conductivity (cm/s)
Cañon de Valle				
16-02656	RH 1	Rising Head	1.134E-03	1.15E-03
	FH 2	Falling Head	1.288E-03	
	FH 3	Falling Head	1.073E-03	
	RH 3	Rising Head	1.111E-03	
16-02657	FH 1	Falling Head	1.283E-06	6.74E-07
	RH 1	Rising Head	6.467E-08	
16-02658	RH 1	Rising Head	2.523E-04	2.72E-04
	FH 2	Falling Head	3.041E-04	
	RH 2	Rising Head	3.544E-04	
	RH 3	Rising Head	1.762E-04	
16-02659	FH 1	Falling Head	1.945E-02	1.80E-02
	RH 1	Rising Head	1.524E-02	
	FH 2	Falling Head	1.950E-02	
	RH 2	Rising Head	1.798E-02	
16-02660	FH 1	Falling Head	3.681E-02	3.79E-02
	RH 1	Rising Head	3.809E-02	
	FH 2	Falling Head	3.868E-02	
	RH 2	Rising Head	3.809E-02	
Martin Spring Canyon				
16-06294	FH 1	Falling Head	7.717E-04	3.69E-04
	RH 1	Rising Head	1.075E-04	
	RH 2	Rising Head	1.175E-04	
	FH 3	Falling Head	7.339E-04	
	RH 3	Rising Head	1.141E-04	
16-06295	FH 3	Falling Head	1.040E-02	1.15E-02
	RH 3	Rising Head	1.214E-02	
	FH 4	Falling Head	1.100E-02	
	RH 4	Rising Head	1.191E-02	
	FH 5	Falling Head	1.141E-02	
	RH 5	Rising Head	1.203E-02	

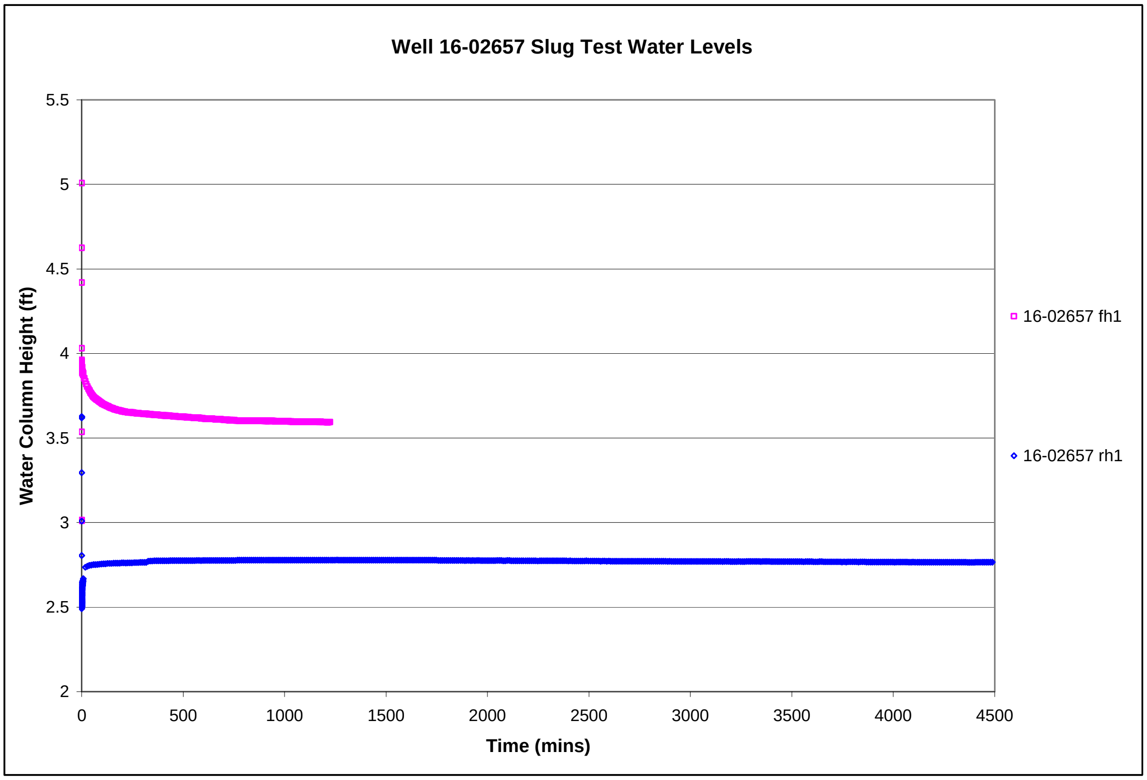
Attachment B2-1

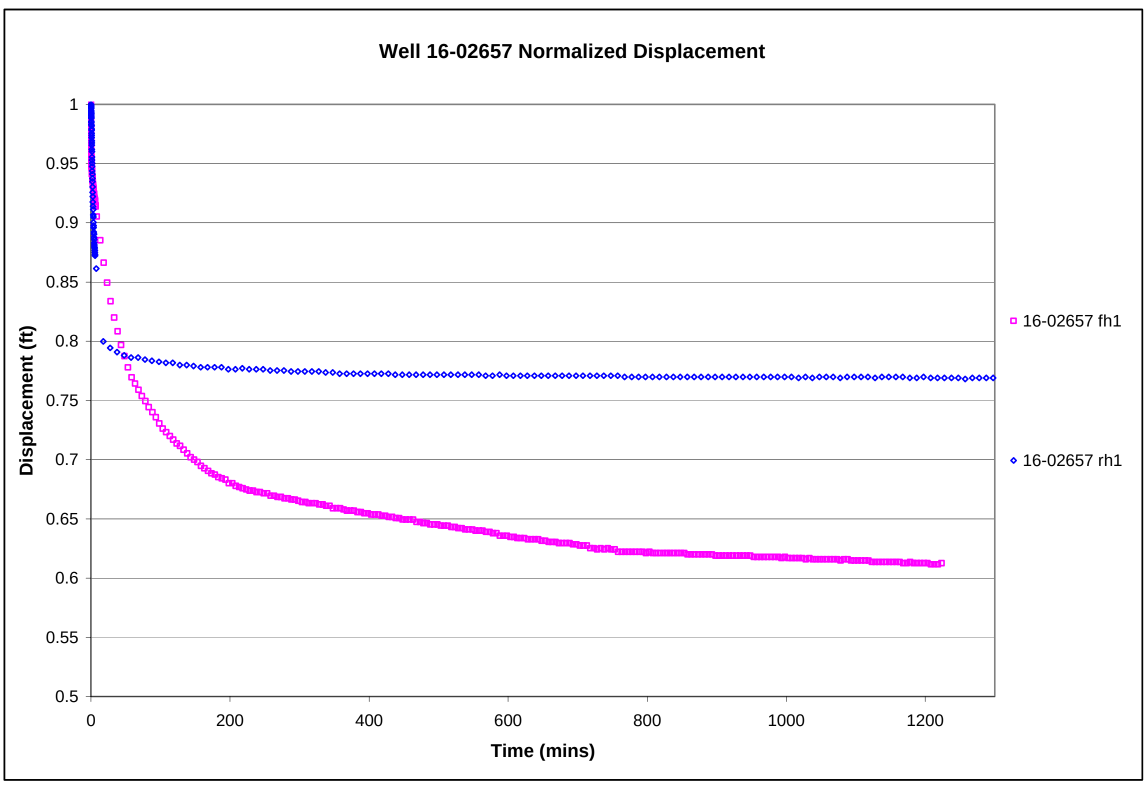
Water Level & Displacement Plots





Well 16-02656 slug test water levels and normalized displacement





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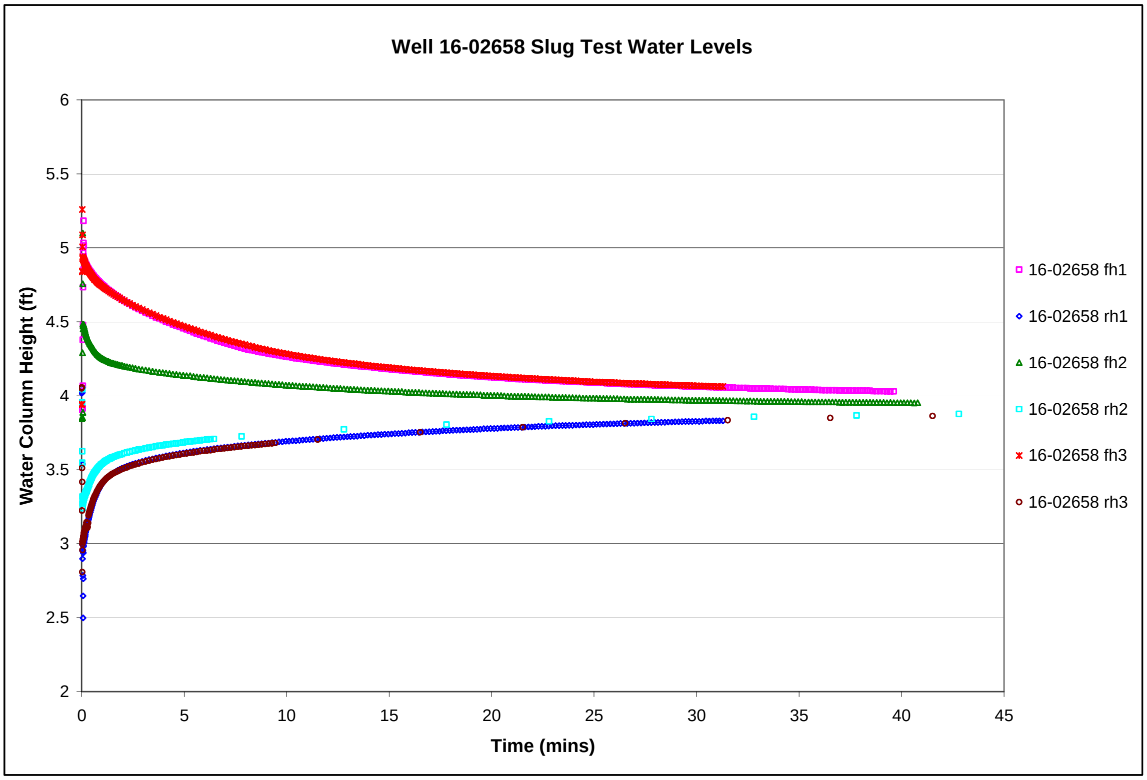

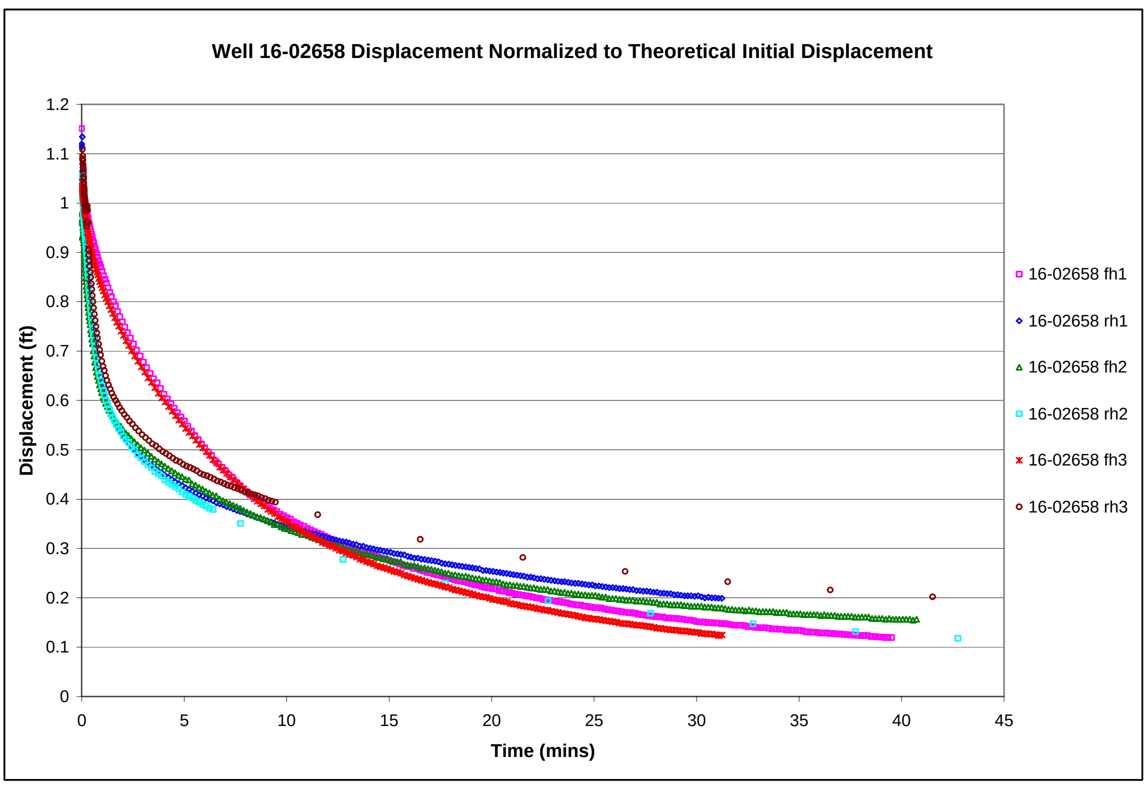

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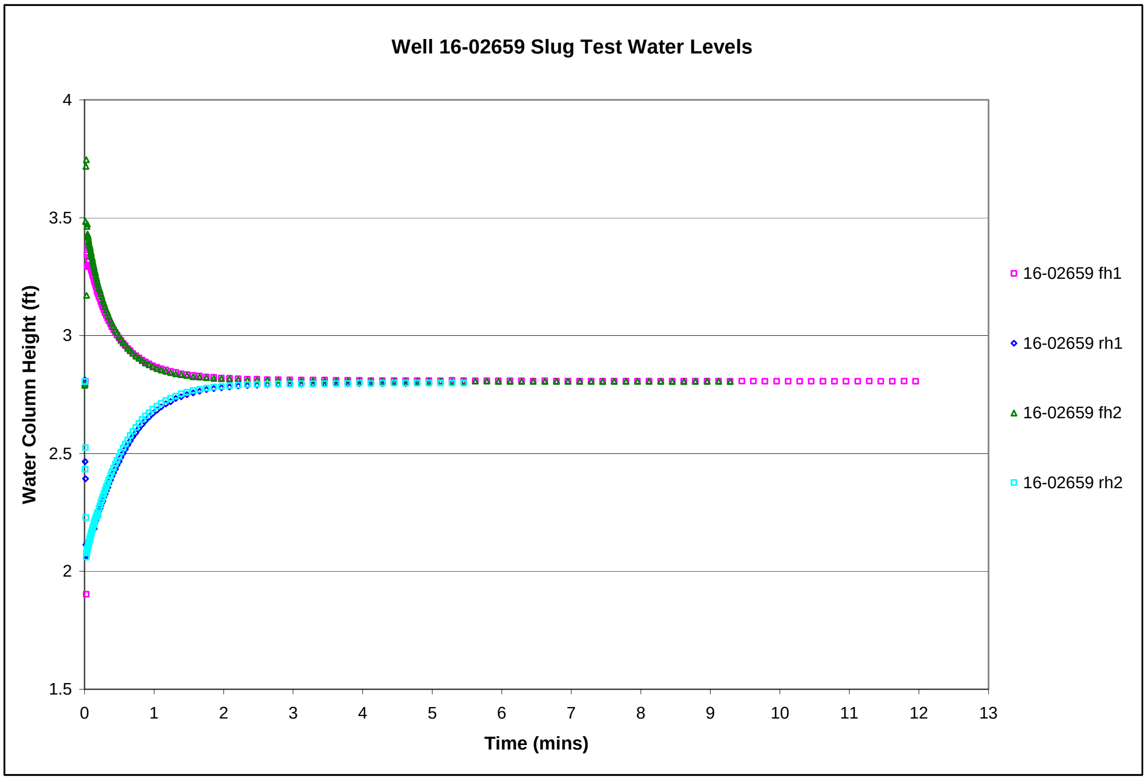
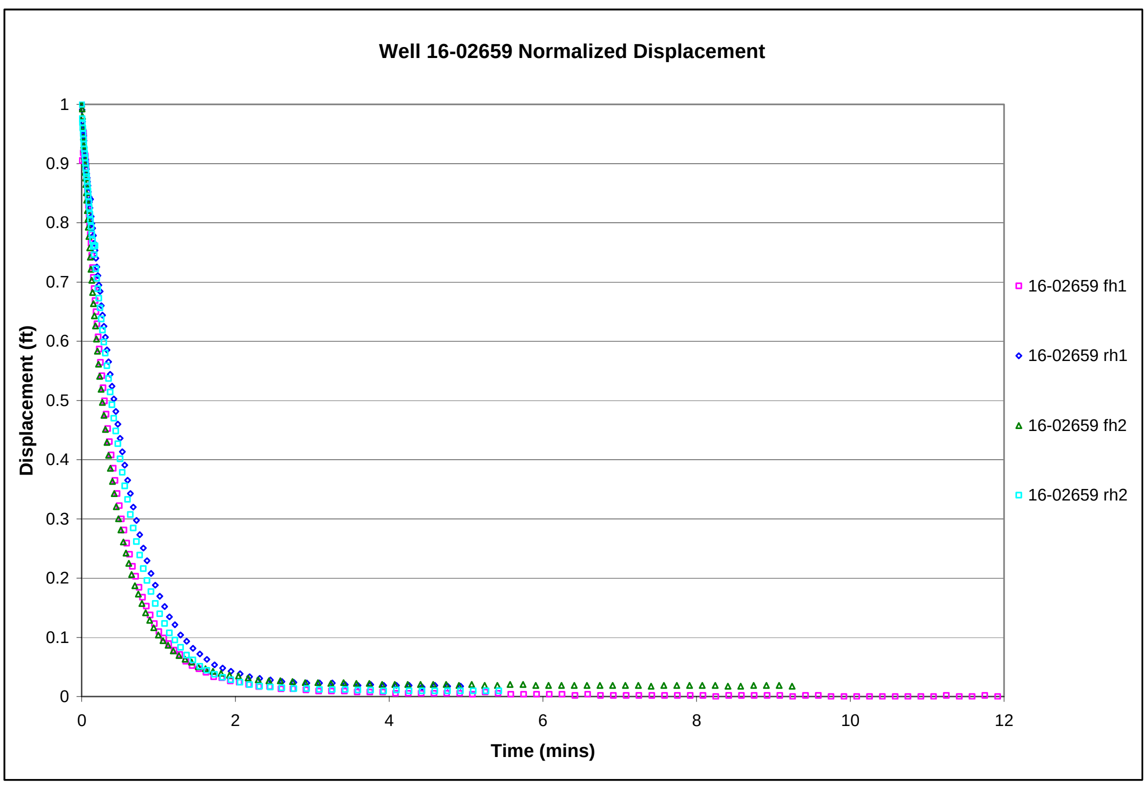
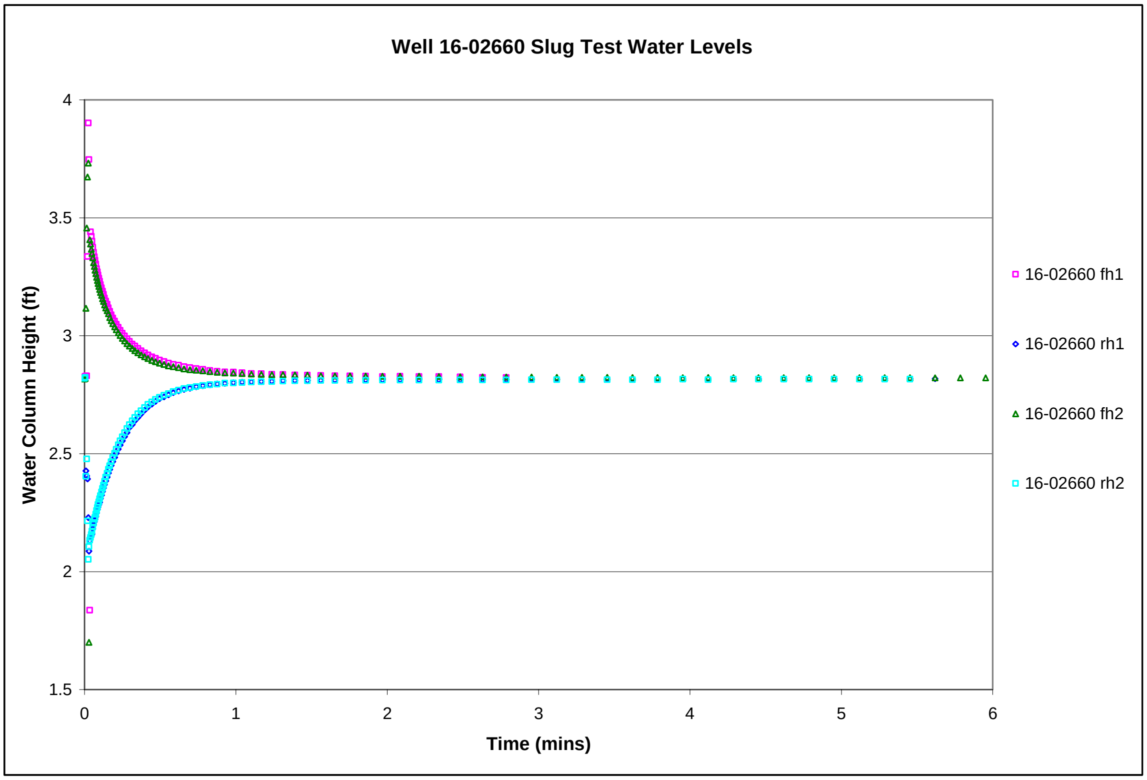
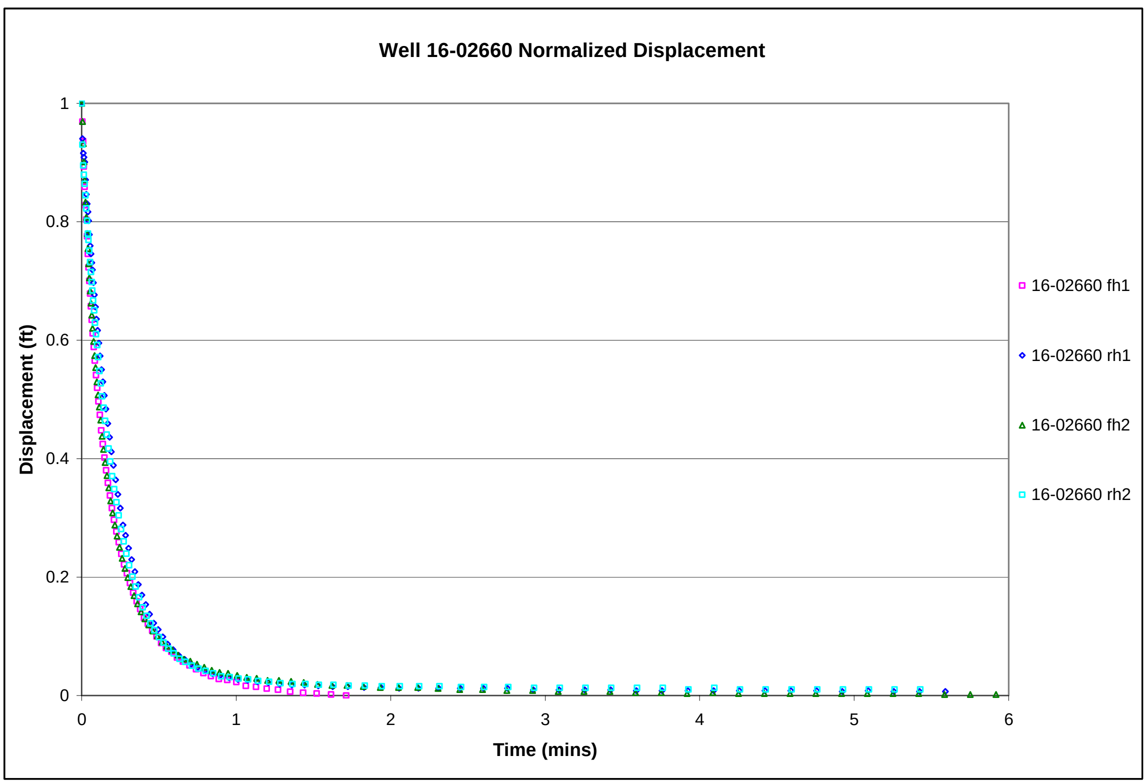


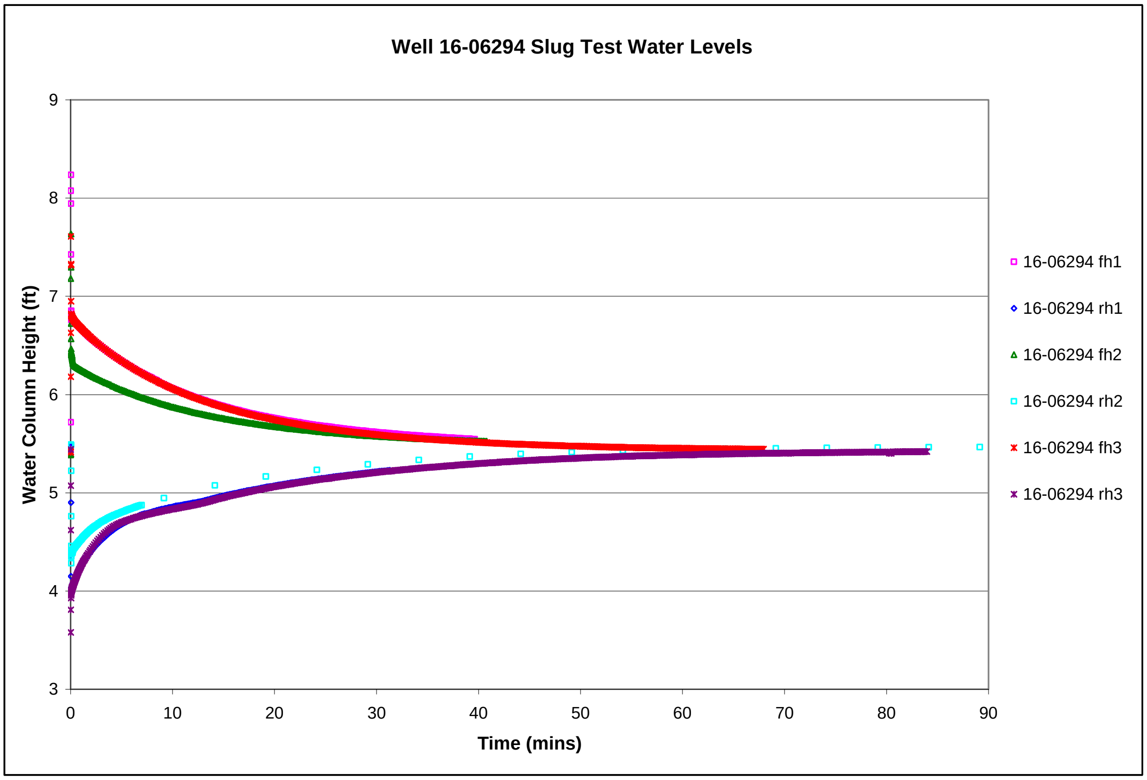


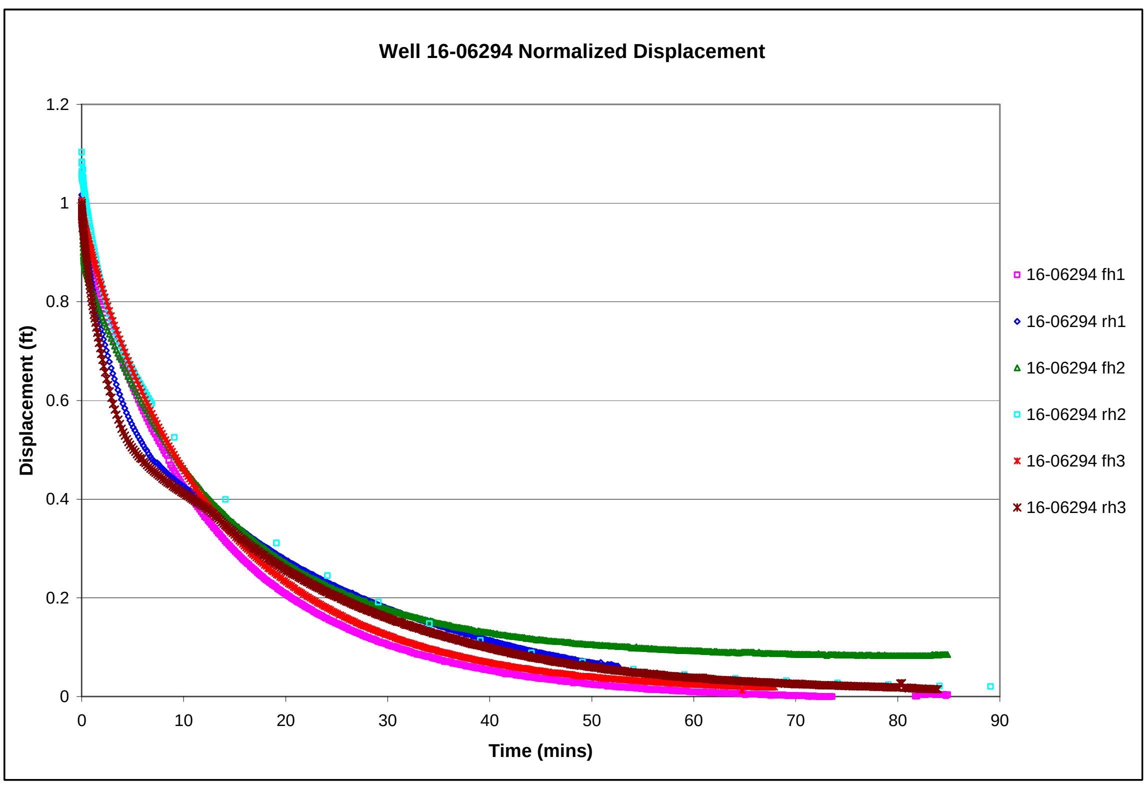
Well 16-02659 slug test water levels and normalized displacement



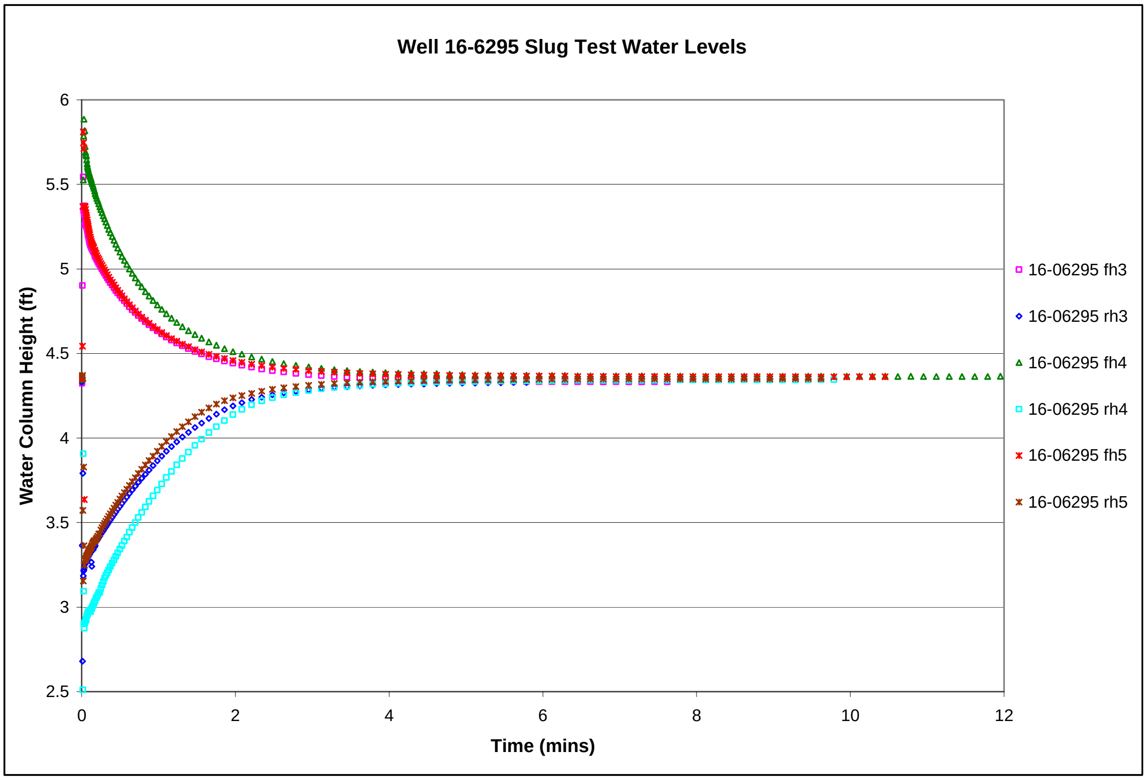


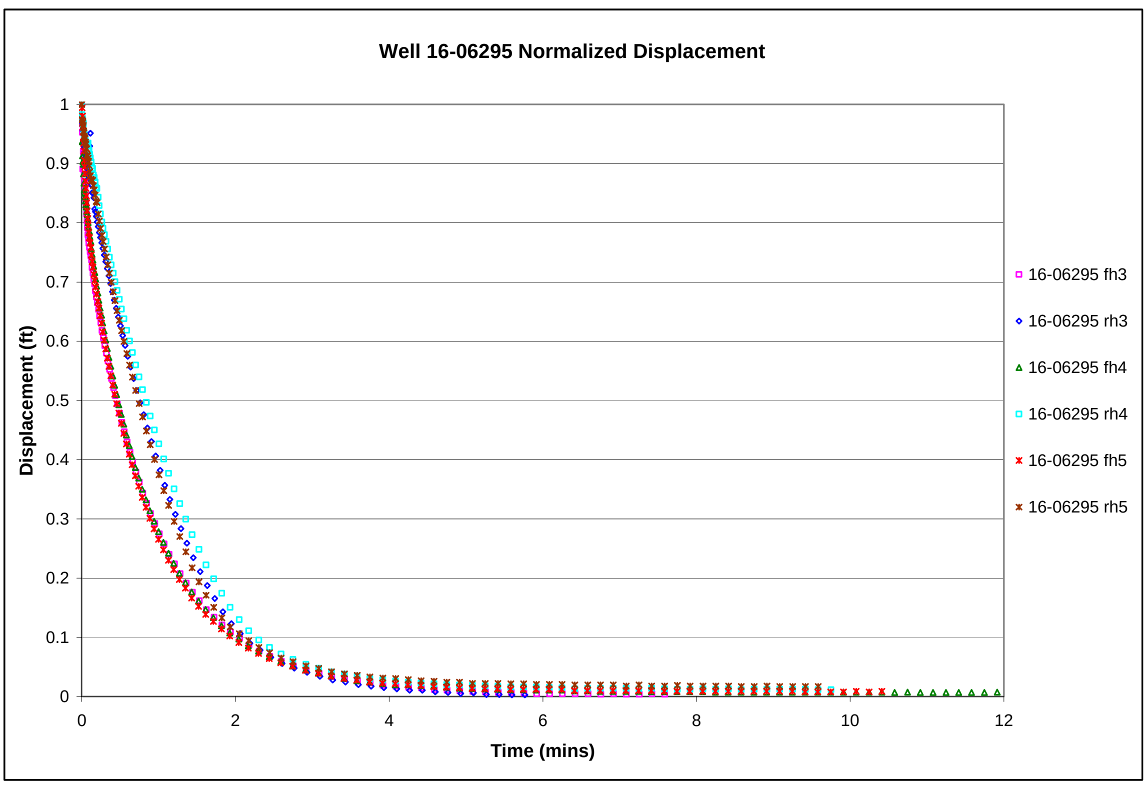
Well 16-02660 slug test water levels and normalized displacement





Well 16-06294 slug test water levels and normalized displacement





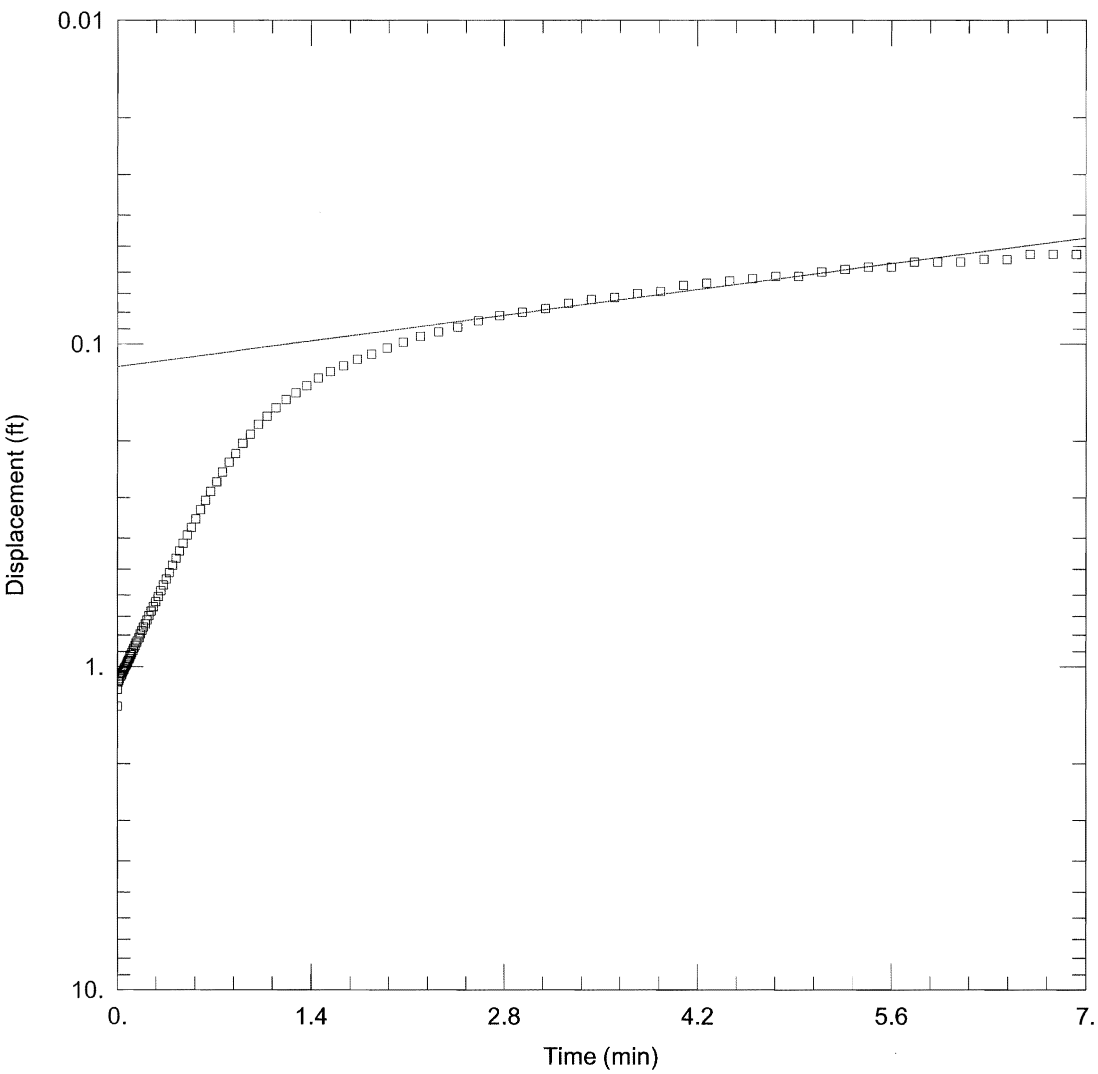
Well 16-06295 slug test water levels and normalized displacement

Attachment B2-2

AQTESOLV Plots

Well 16-2656 Rising Head Test 1

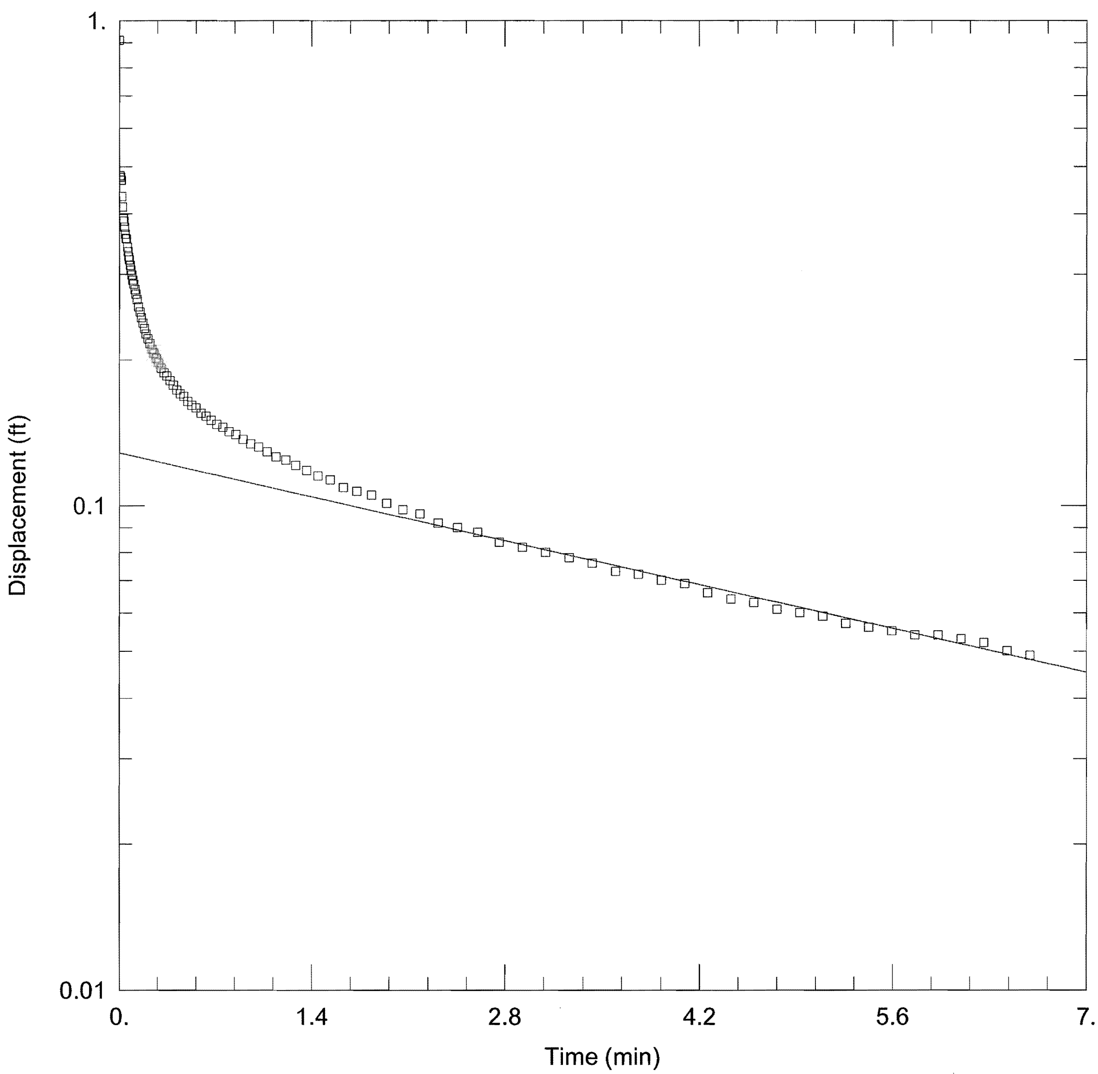
Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION	WELL DATA (CDV-16-2656)
Aquifer Model: Unconfined	Initial Displacement: 1.33 ft
Solution Method: Bouwer-Rice	Static Water Column Height: 3.59 ft
K = 0.001134 cm/sec y0 = 0.1179 ft	Total Well Penetration Depth: 3.59 ft
	Screen Length: 5. ft
	Casing Radius: 0.083 ft
	Wellbore Radius: 0.51 ft
	Gravel Pack Porosity: 0.44

Well 16-2656 Falling Head Test 2

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

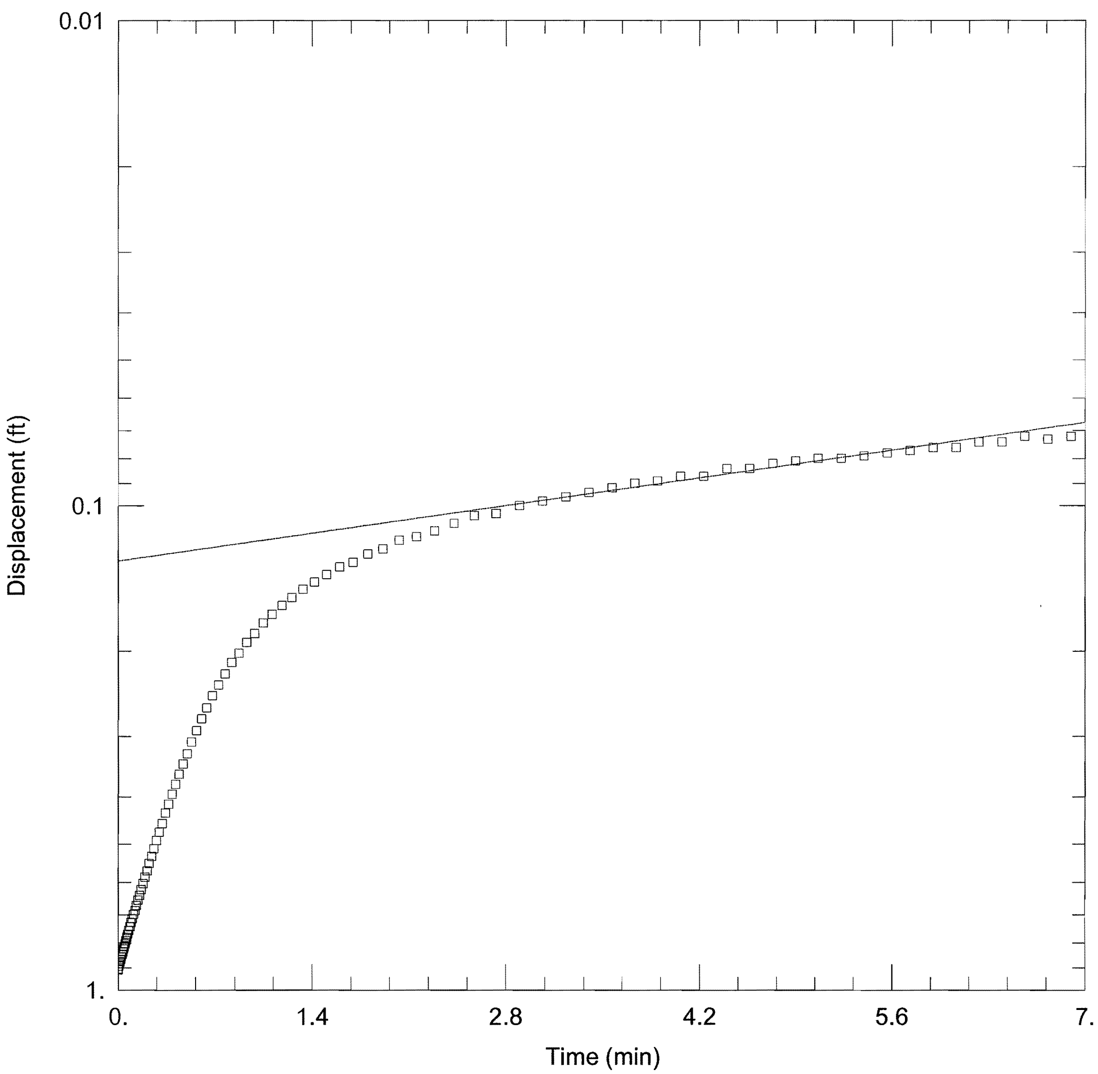
K = 0.001288 cm/sec y0 = 0.1284 ft

WELL DATA (CDV-16-2656)

Initial Displacement: 0.91 ft
Static Water Column Height: 3.56 ft
Total Well Penetration Depth: 3.56 ft
Screen Length: 5. ft
Casing Radius: 0.083 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2656 Rising Head Test 2

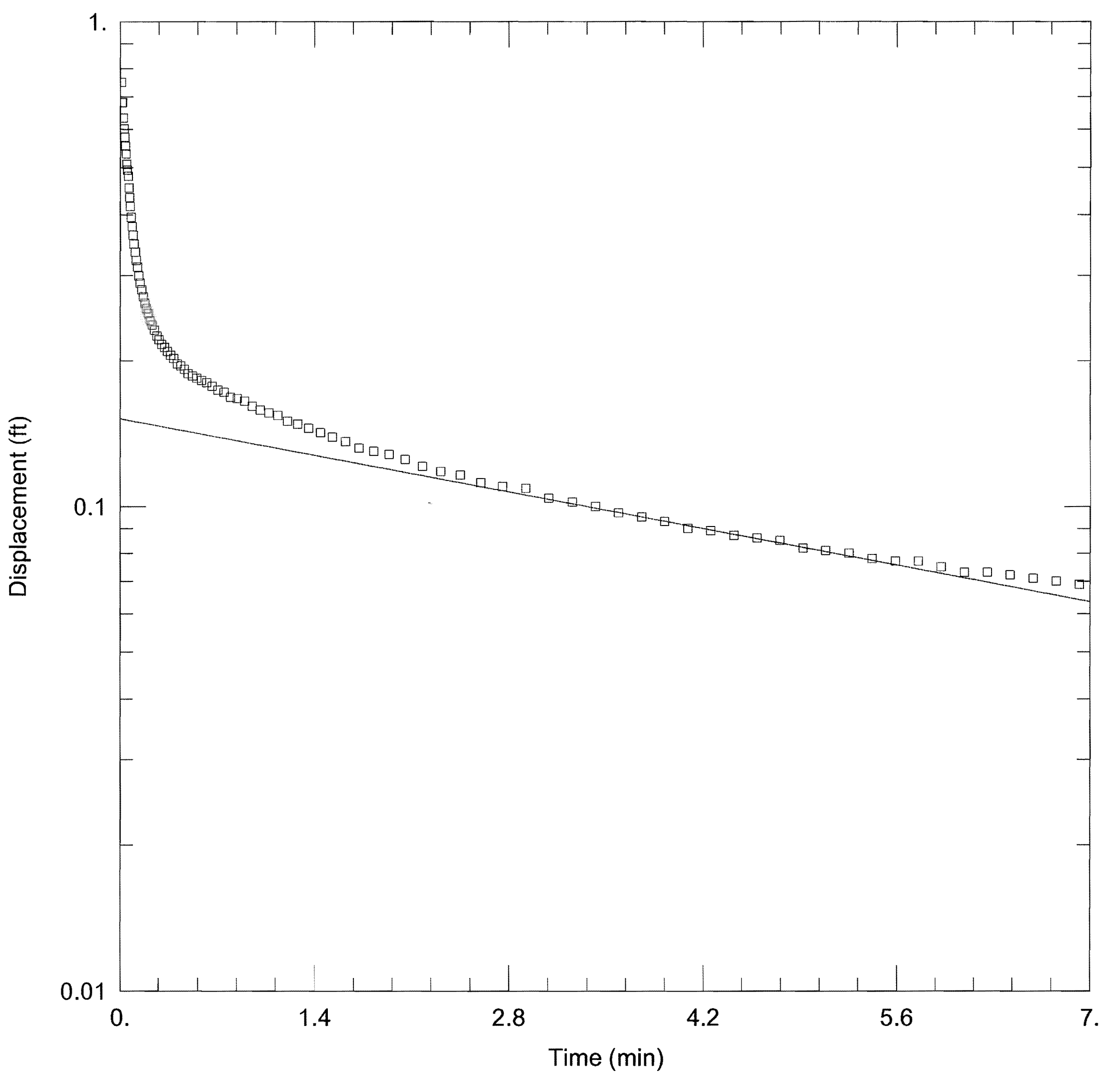
Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION	WELL DATA (CDV-16-2656)
Aquifer Model: Unconfined	Initial Displacement: 0.91 ft
Solution Method: Bouwer-Rice	Static Water Column Height: 3.59 ft
K = 0.0008147 cm/secy0 = 0.1303 ft	Total Well Penetration Depth: 3.59 ft
	Screen Length: 5. ft
	Casing Radius: 0.083 ft
	Wellbore Radius: 0.51 ft
	Gravel Pack Porosity: 0.44

Well 16-2656 Falling Head Test 3

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

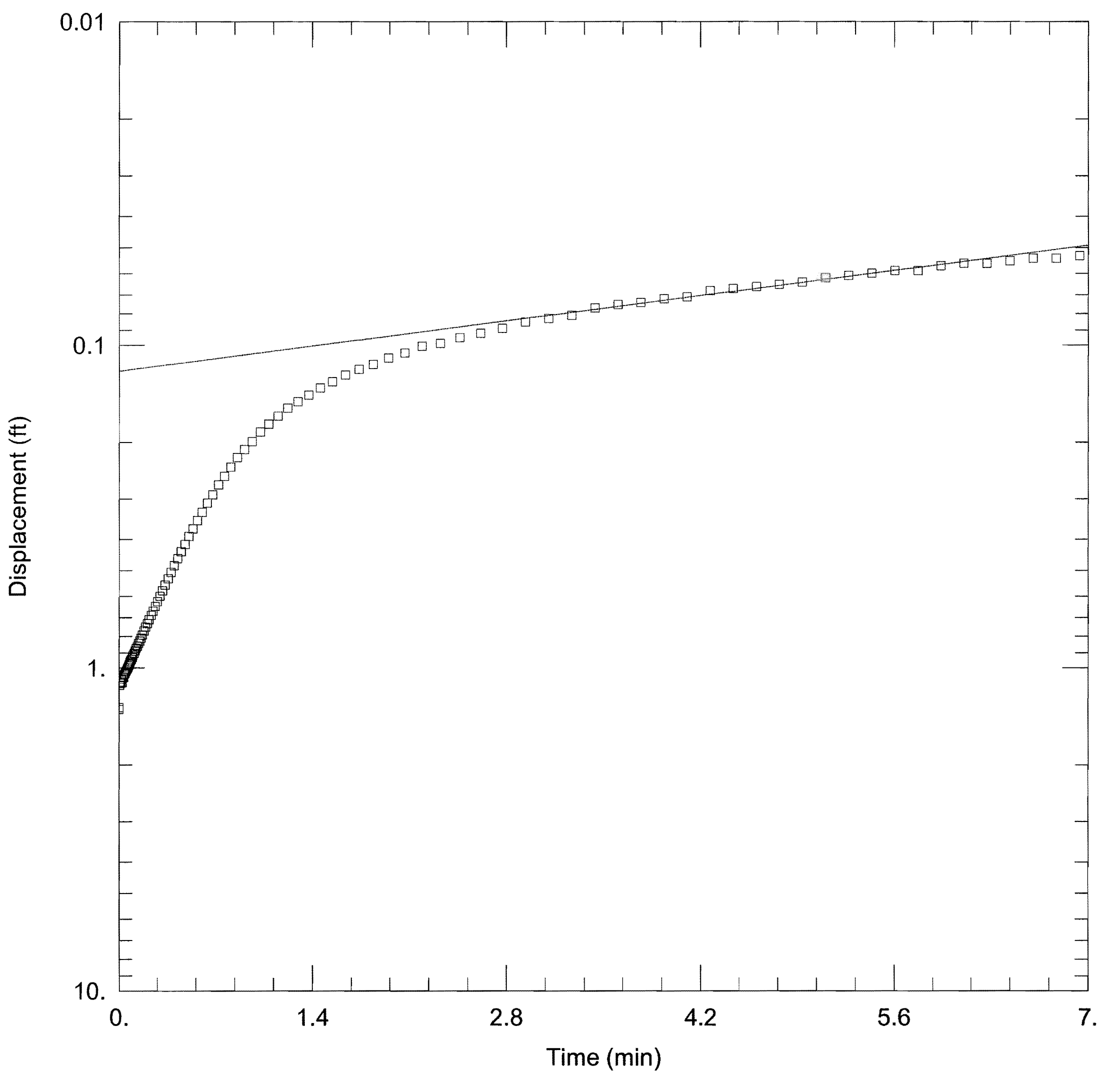
K = 0.001073 cm/sec y0 = 0.1517 ft

WELL DATA (CDV-16-2656)

Initial Displacement: 1.33 ft
Static Water Column Height: 3.55 ft
Total Well Penetration Depth: 3.55 ft
Screen Length: 5. ft
Casing Radius: 0.083 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2656 Rising Head Test 3

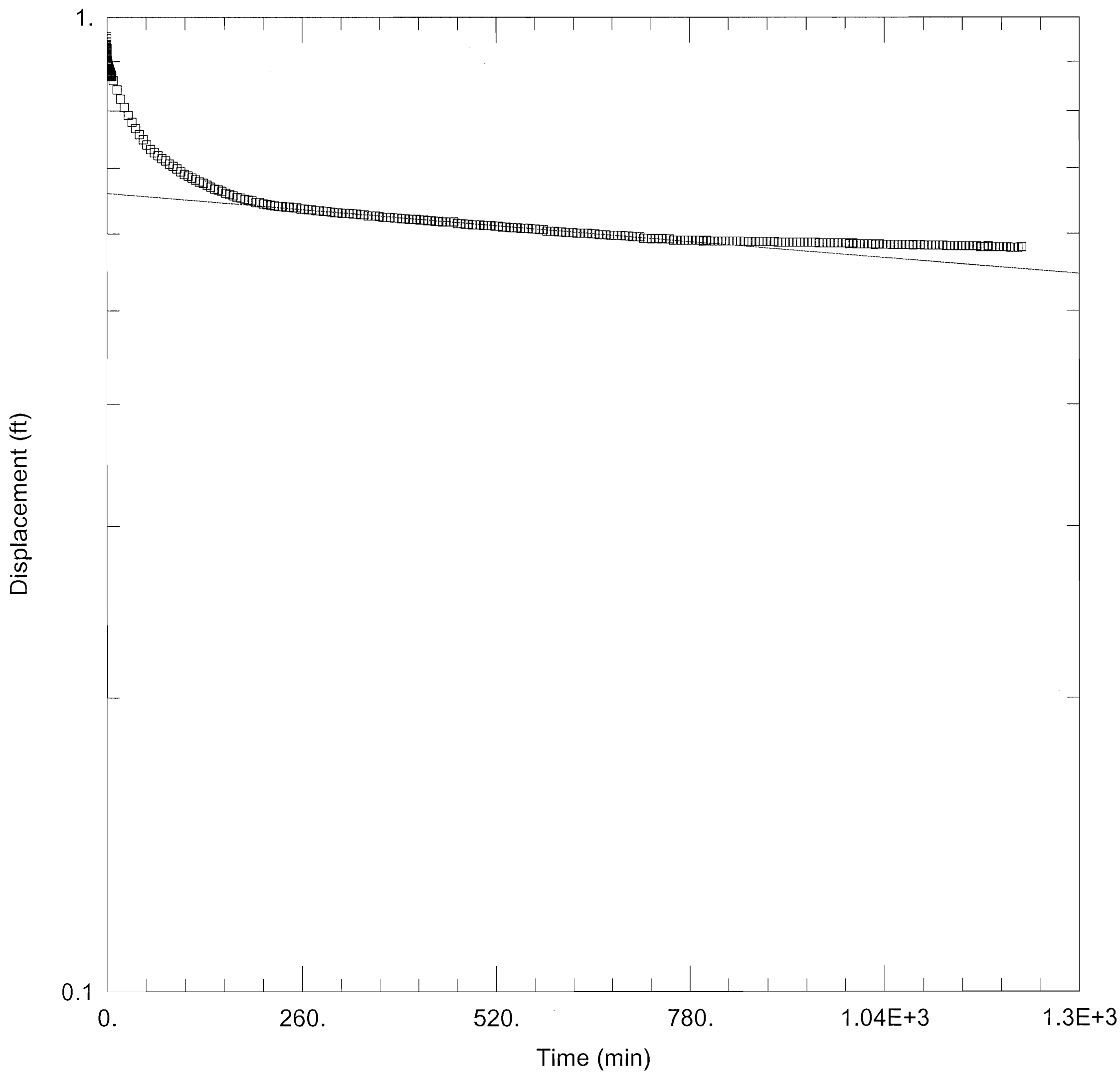
Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION	WELL DATA (CDV-16-2656)
Aquifer Model: Unconfined	Initial Displacement: 1.33 ft
Solution Method: Bouwer-Rice	Static Water Column Height: 3.6 ft
K = 0.001111 cm/sec y0 = 0.1207 ft	Total Well Penetration Depth: 3.6 ft
	Screen Length: 5. ft
	Casing Radius: 0.083 ft
	Wellbore Radius: 0.51 ft
	Gravel Pack Porosity: 0.44

Well 16-2657 Falling Head Test 1

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 1.283E-6 cm/sec   y0 = 0.6597 ft

WELL DATA (CDV-16-2657)

Initial Displacement: 0.955 ft

Static Water Column Height: 3.012 ft

Total Well Penetration Depth: 3.012 ft

Screen Length: 5. ft

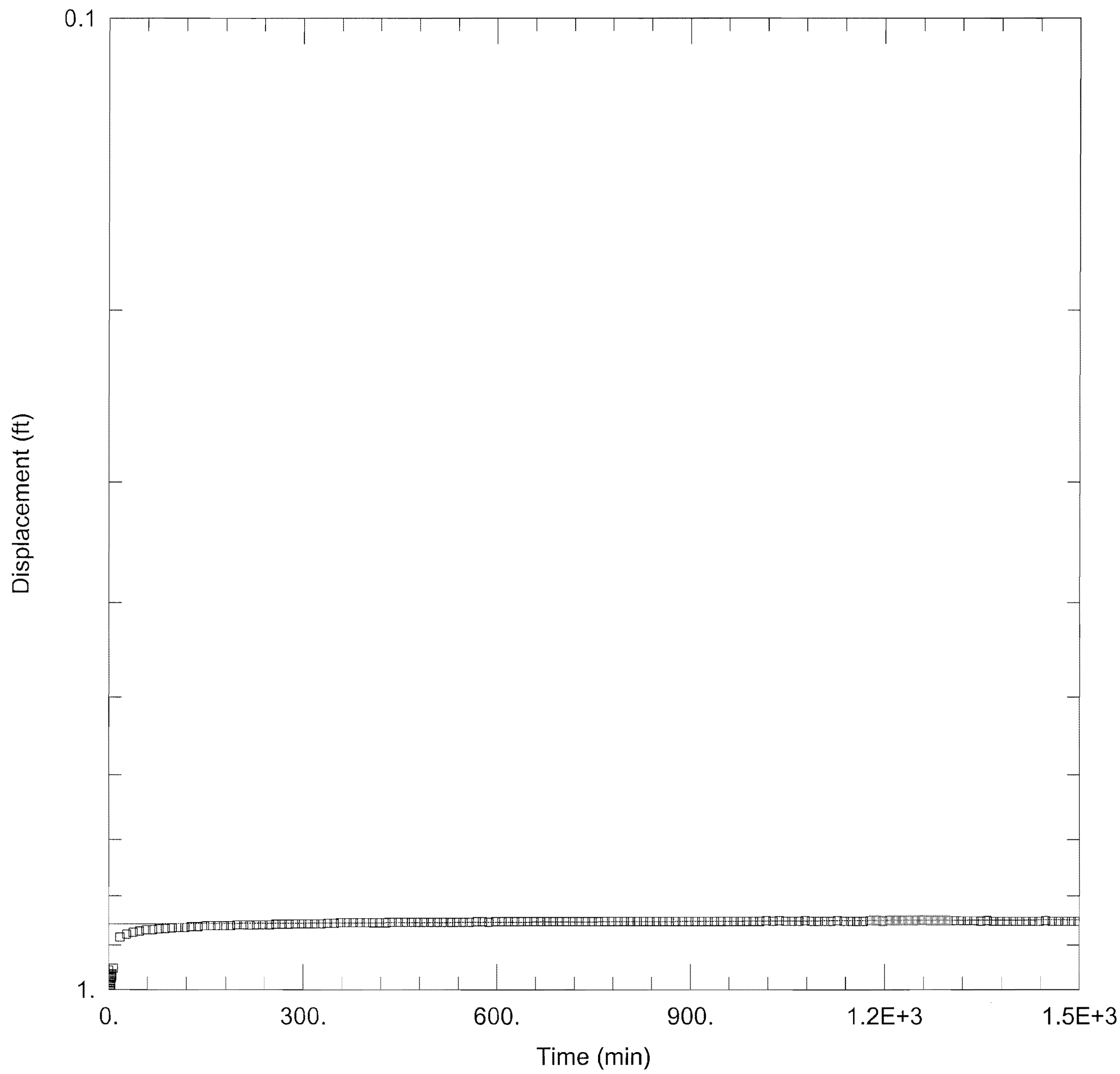
Casing Radius: 0.167 ft

Wellbore Radius: 0.51 ft

Gravel Pack Porosity: 0.44

Well 16-2657 Rising Head Test 1

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

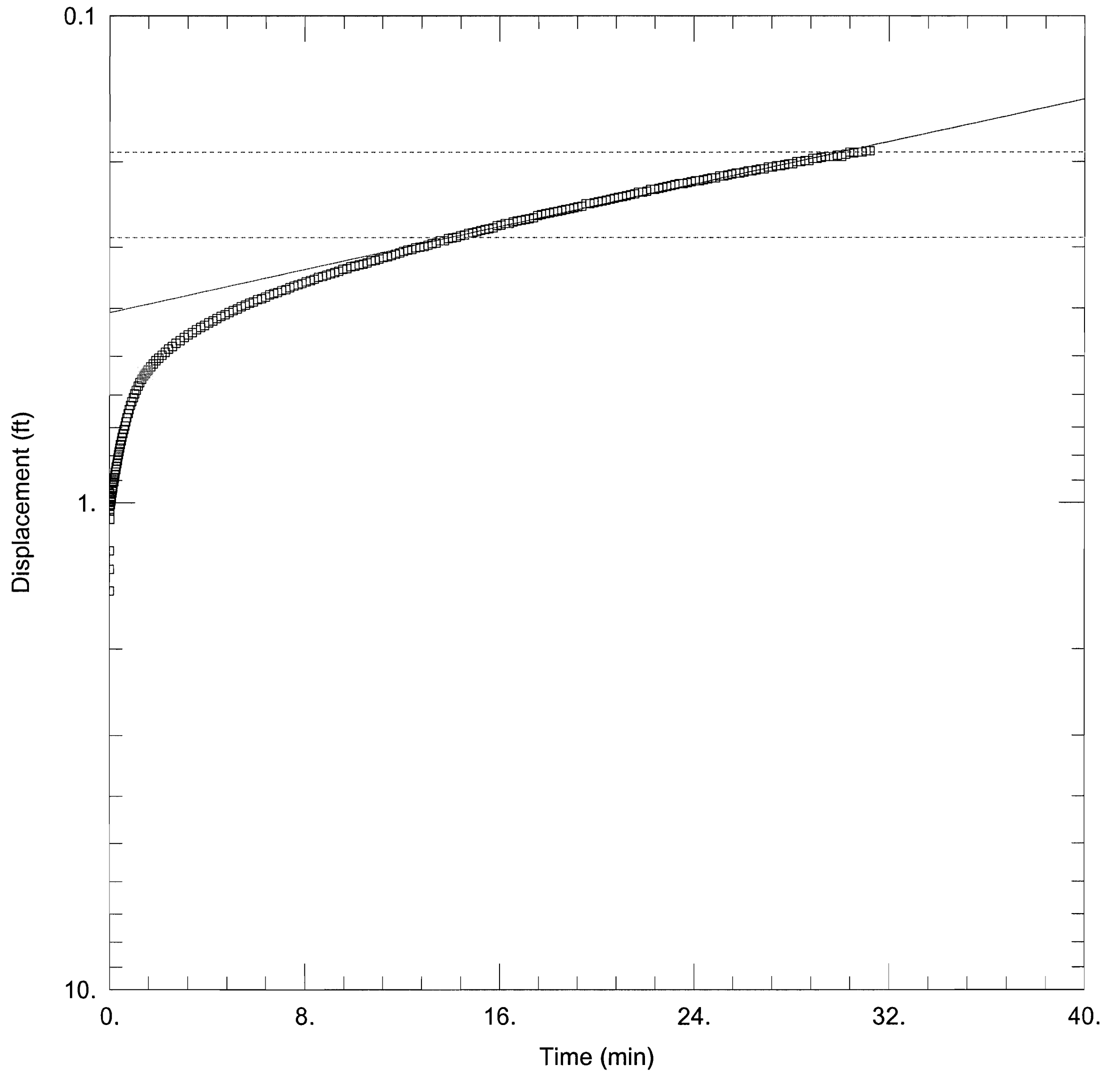
K = 6.467E-8 cm/sec y0 = 0.8555 ft

WELL DATA (CDV-16-2657)

Initial Displacement: 0.955 ft
Static Water Column Height: 3.619 ft
Total Well Penetration Depth: 3.619 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2658 Rising Head Test 1

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

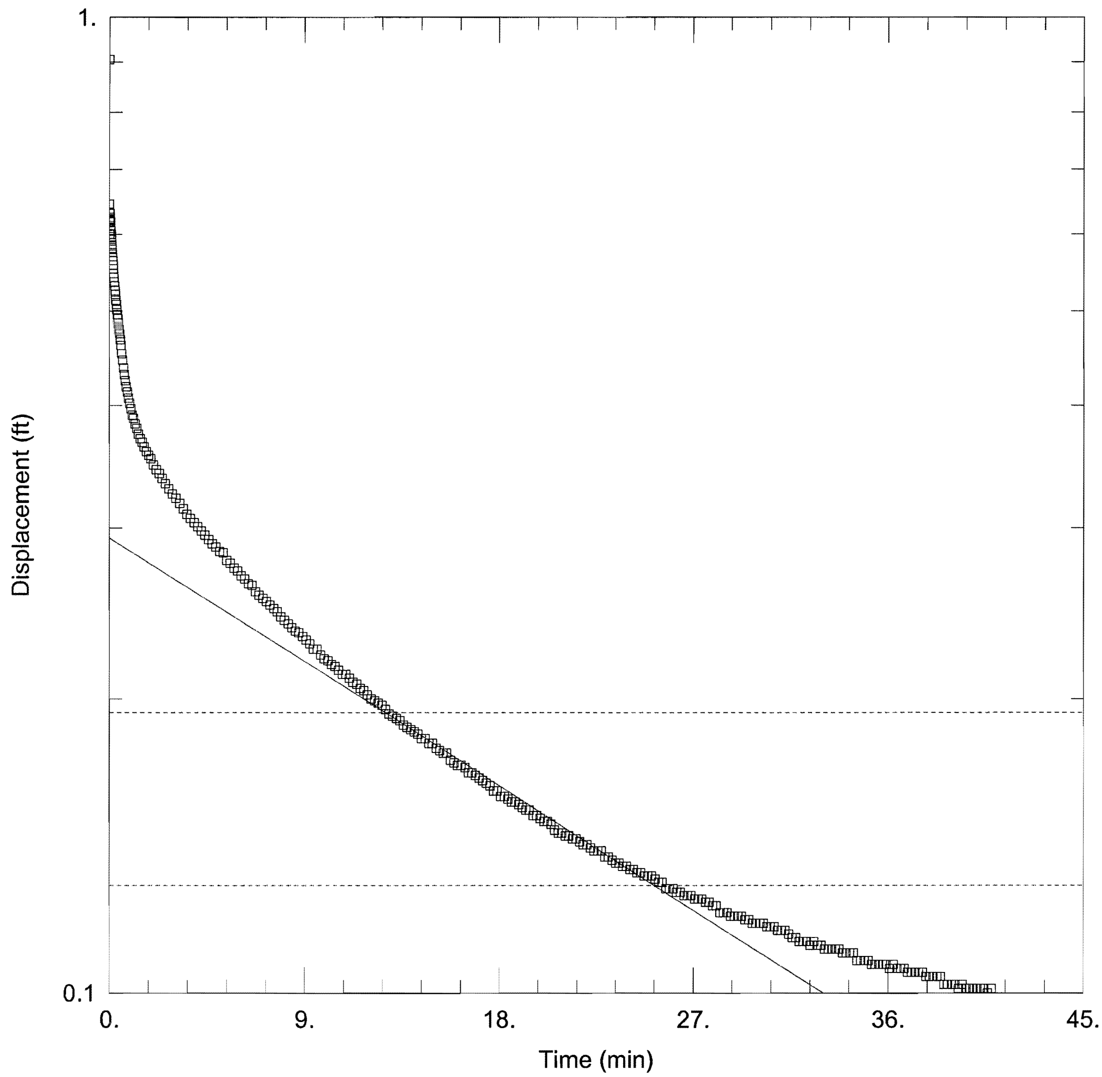
K = 0.0002523 cm/sec y0 = 0.408 ft

WELL DATA (CDV-16-2658)

Initial Displacement: 0.955 ft
Static Water Column Height: 4.021 ft
Total Well Penetration Depth: 4.021 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2658 Falling Head Test 2

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

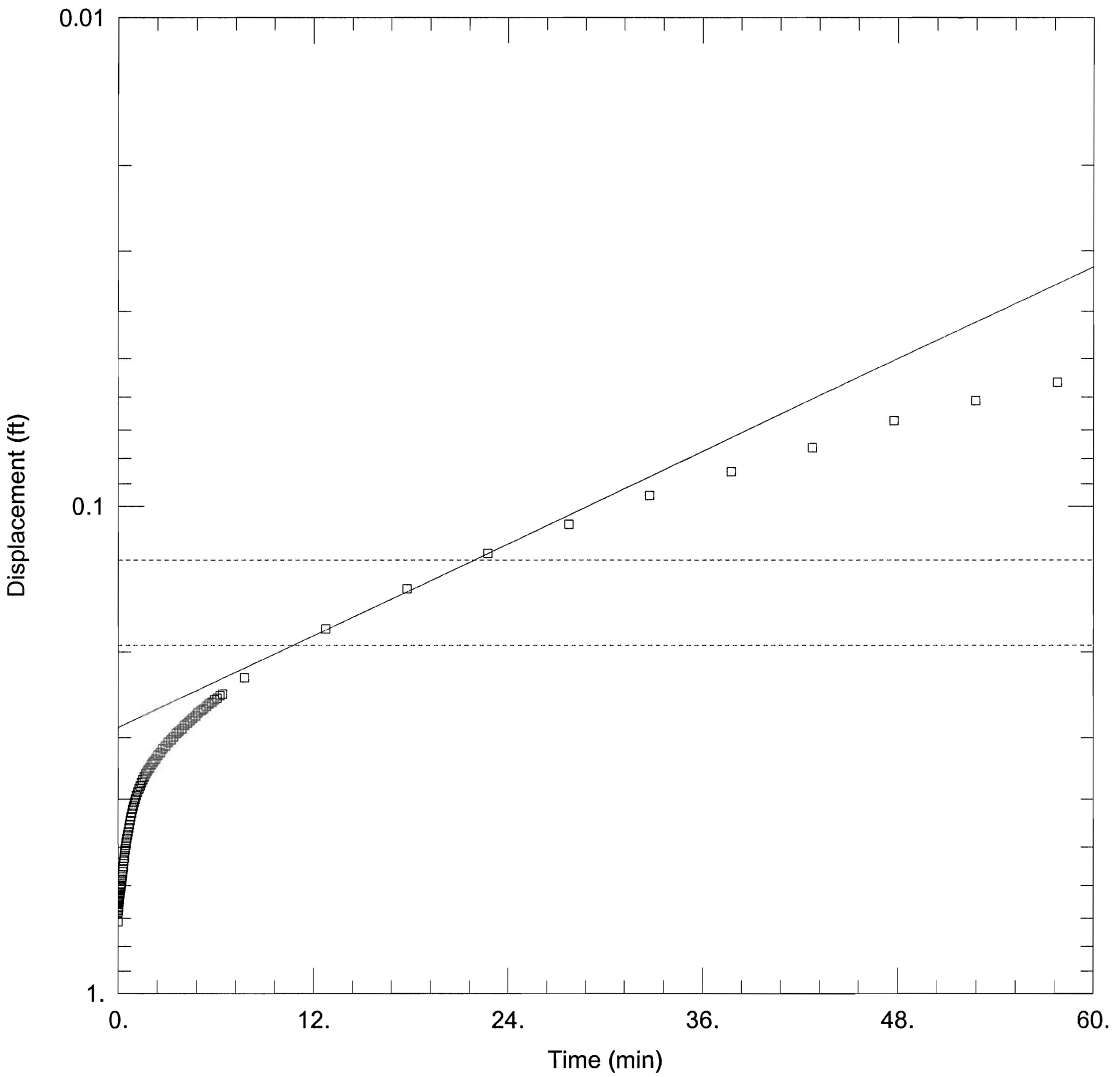
Aquifer Model: Unconfined
Solution Method: Bouwer-Rice
K = 0.0003041 cm/secy0 = 0.2932 ft

WELL DATA (CDV-16-2658)

Initial Displacement: 0.645 ft
Static Water Column Height: 3.852 ft
Total Well Penetration Depth: 3.852 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2658 Rising Head Test 2

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

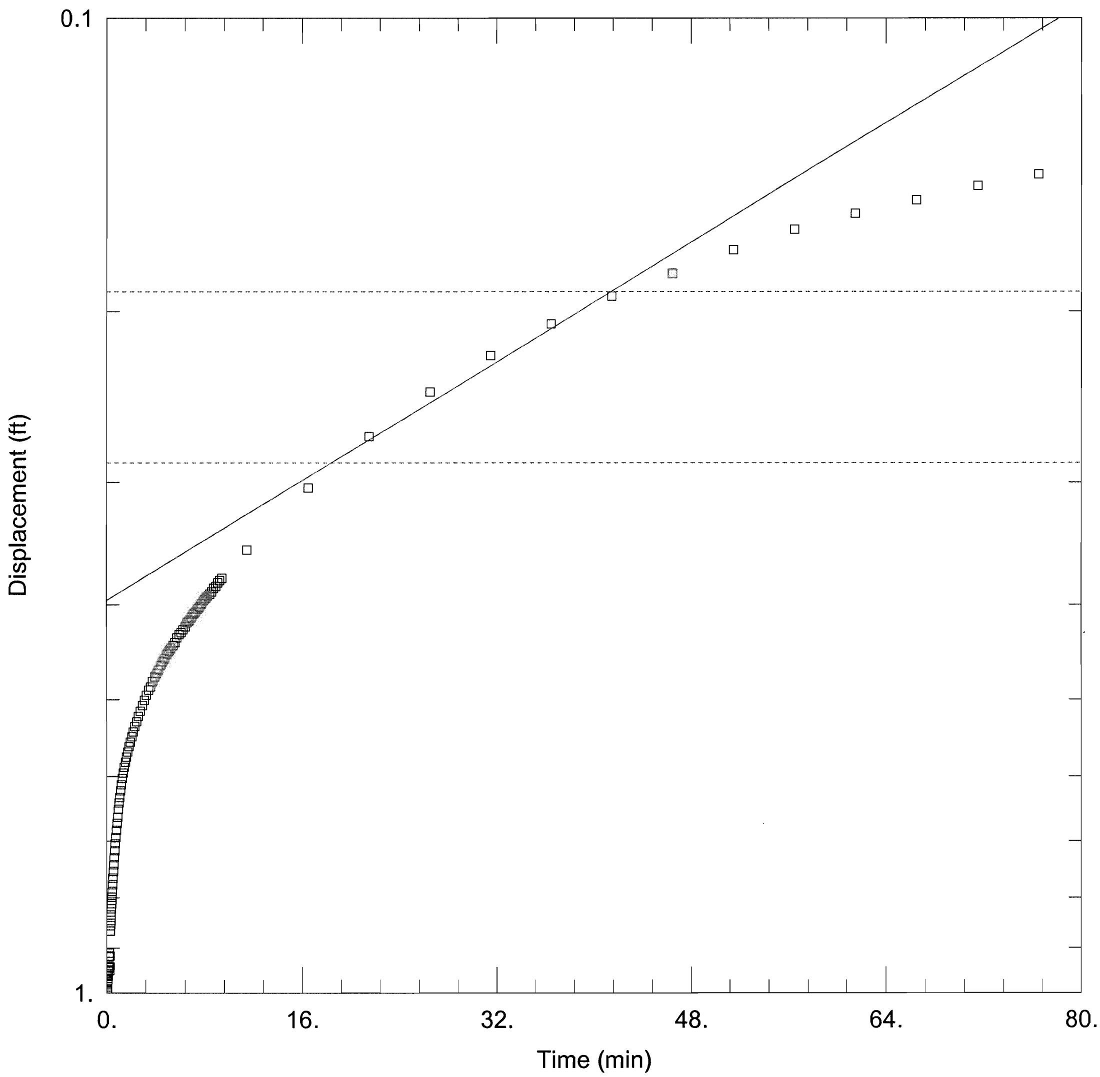
K = 0.0003544 cm/secy0 = 0.2861 ft

WELL DATA (CDV-16-2658)

Initial Displacement: 0.645 ft
Static Water Column Height: 3.952 ft
Total Well Penetration Depth: 3.952 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2658 Rising Head Test 3

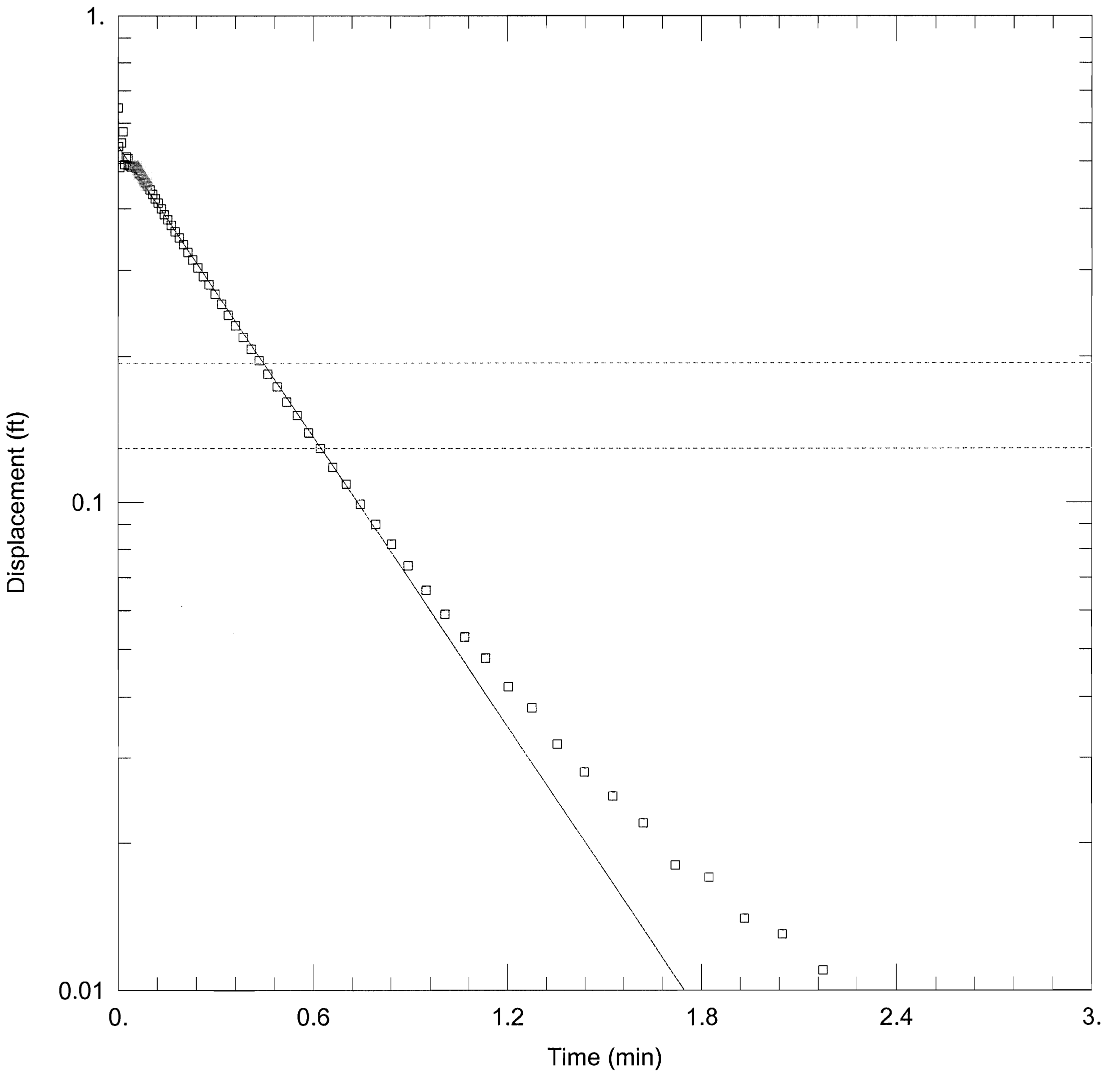
Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION	WELL DATA (CDV-16-2658)
Aquifer Model: Unconfined	Initial Displacement: 0.955 ft
Solution Method: Bouwer-Rice	Static Water Column Height: 4.056 ft
K = 0.0001762 cm/secy0 = 0.3961 ft	Total Well Penetration Depth: 4.056 ft
	Screen Length: 5. ft
	Casing Radius: 0.167 ft
	Wellbore Radius: 0.51 ft
	Gravel Pack Porosity: 0.44

Well 16-2659 Falling Head Test 1

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

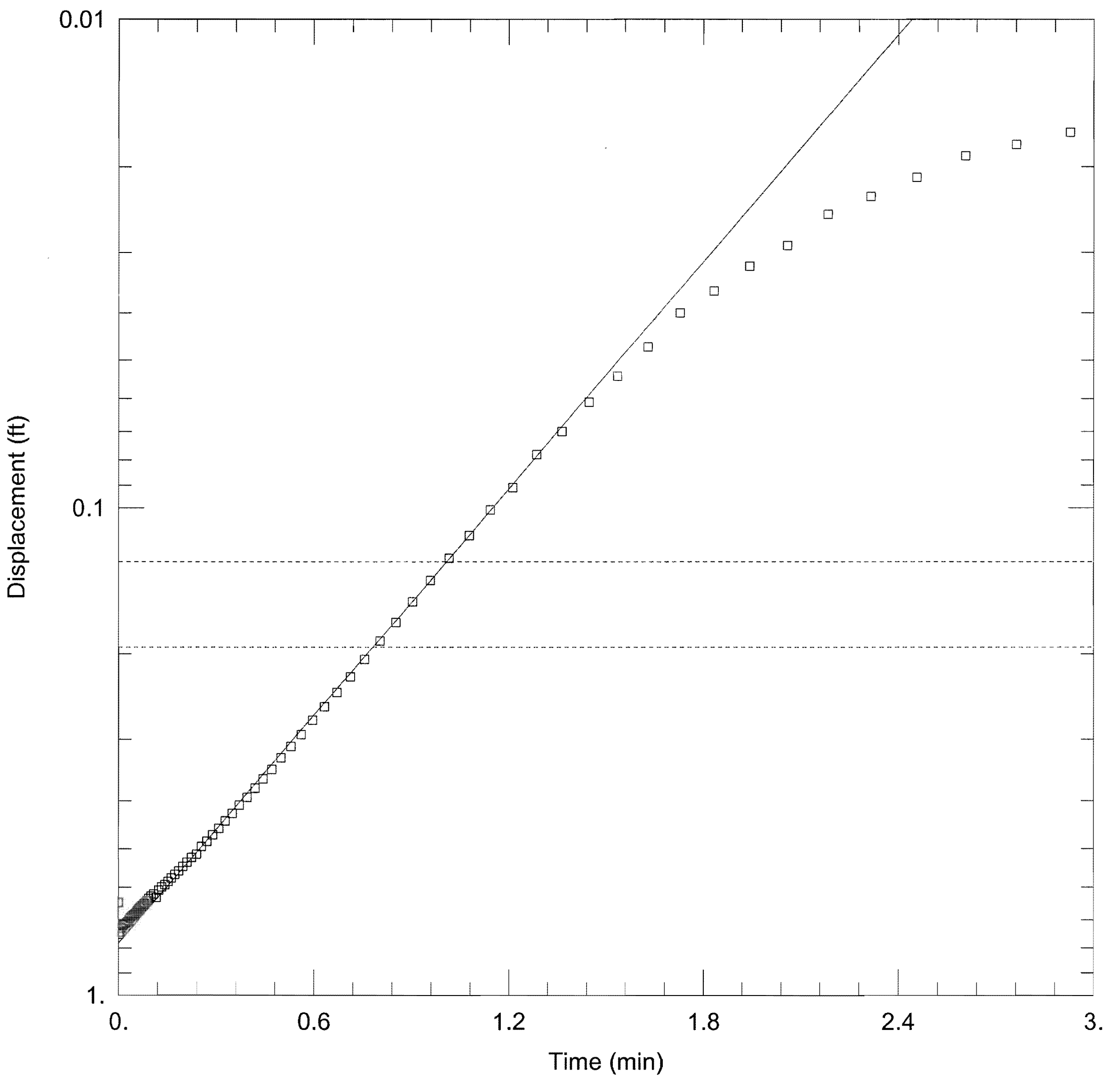
K = 0.01945 cm/sec y0 = 0.538 ft

WELL DATA (CDV-16-2659)

Initial Displacement: 0.645 ft
Static Water Column Height: 2.806 ft
Total Well Penetration Depth: 2.806 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2659 Rising Head Test 1

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

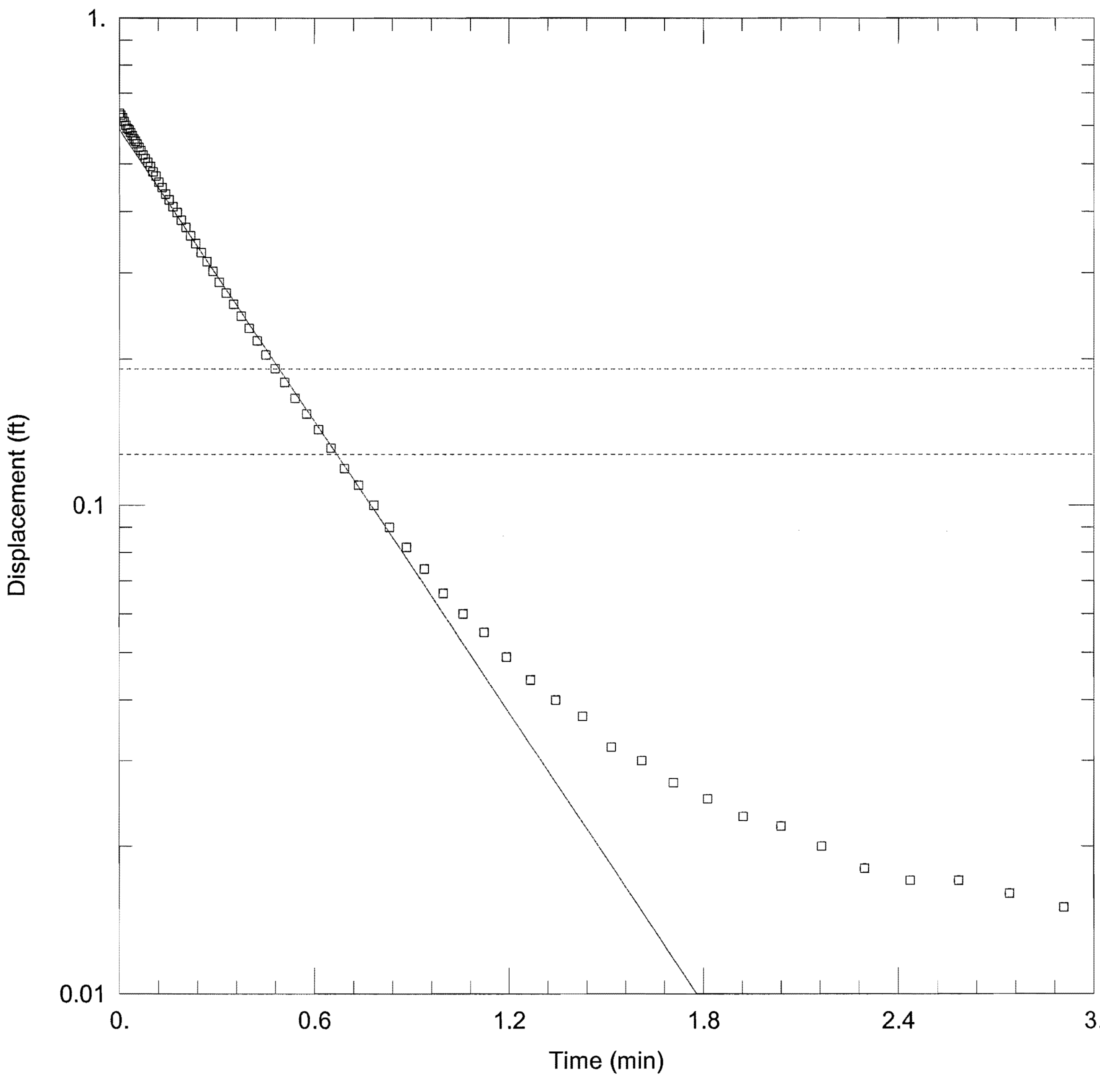
K = 0.01524 cm/sec   y0 = 0.782 ft

WELL DATA (CDV-16-2659)

Initial Displacement: 0.645 ft
Static Water Column Height: 2.811 ft
Total Well Penetration Depth: 2.811 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2659 Falling Head Test 2

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

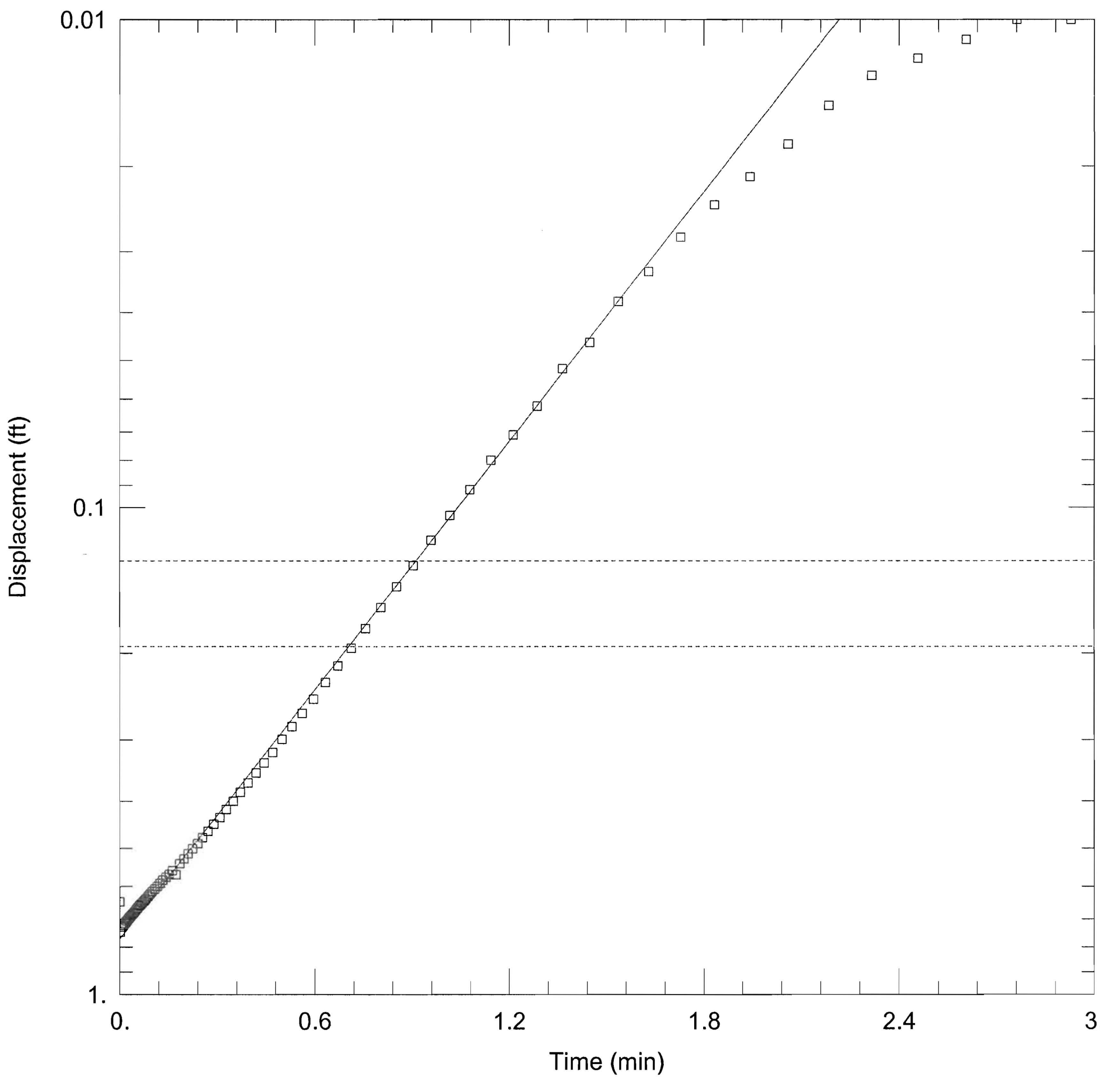
K = 0.0195 cm/sec   y0 = 0.5898 ft

WELL DATA (CDV-16-2659)

Initial Displacement: 0.636 ft
Static Water Column Height: 2.794 ft
Total Well Penetration Depth: 2.794 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2659 Rising Head Test 2

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.01798 cm/sec   y0 = 0.7703 ft

WELL DATA (CDV-16-2659)

Initial Displacement: 0.645 ft

Static Water Column Height: 2.805 ft

Total Well Penetration Depth: 2.805 ft

Screen Length: 5. ft

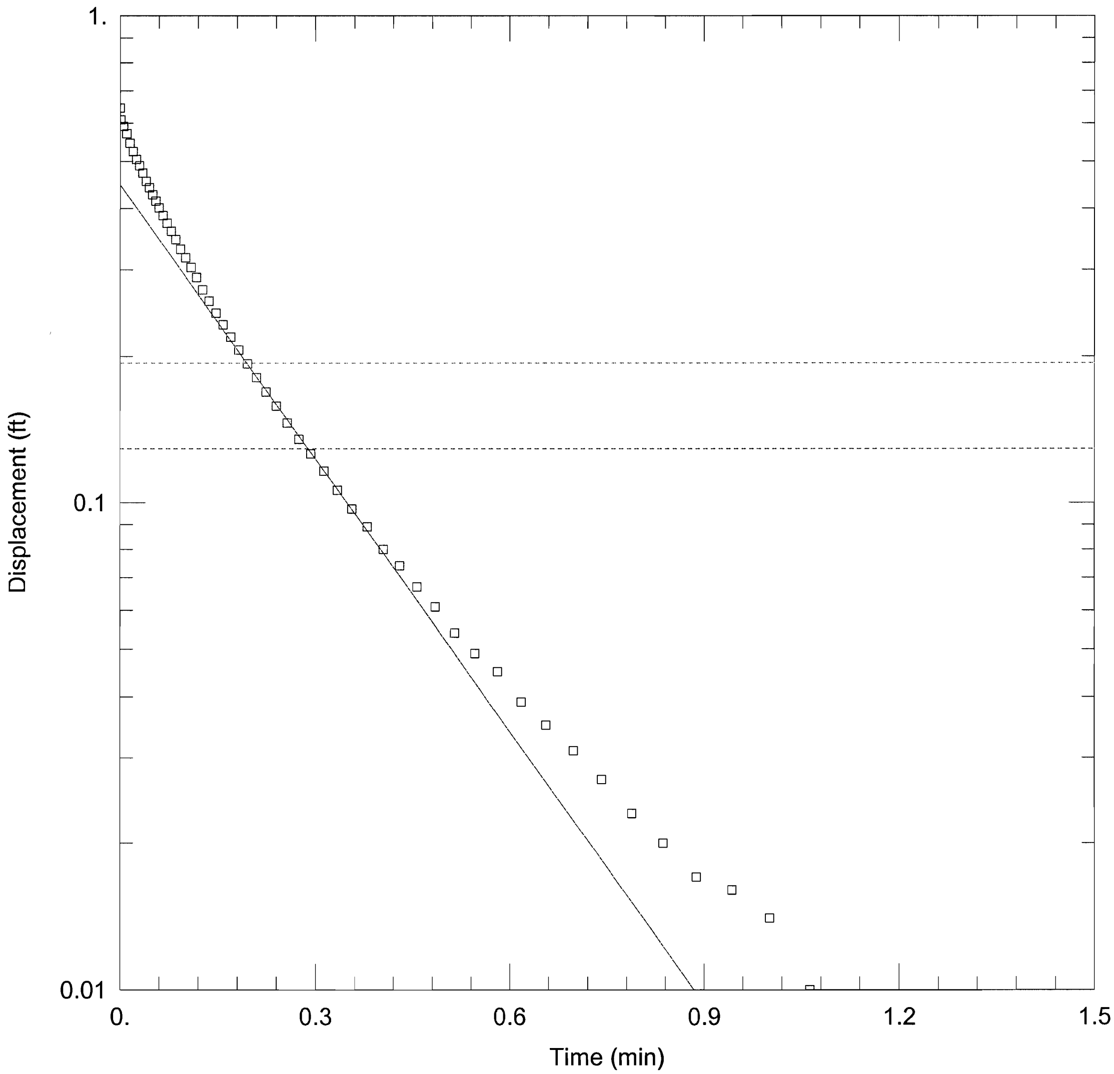
Casing Radius: 0.167 ft

Wellbore Radius: 0.51 ft

Gravel Pack Porosity: 0.44

Well 16-2660 Falling Head Test 1

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

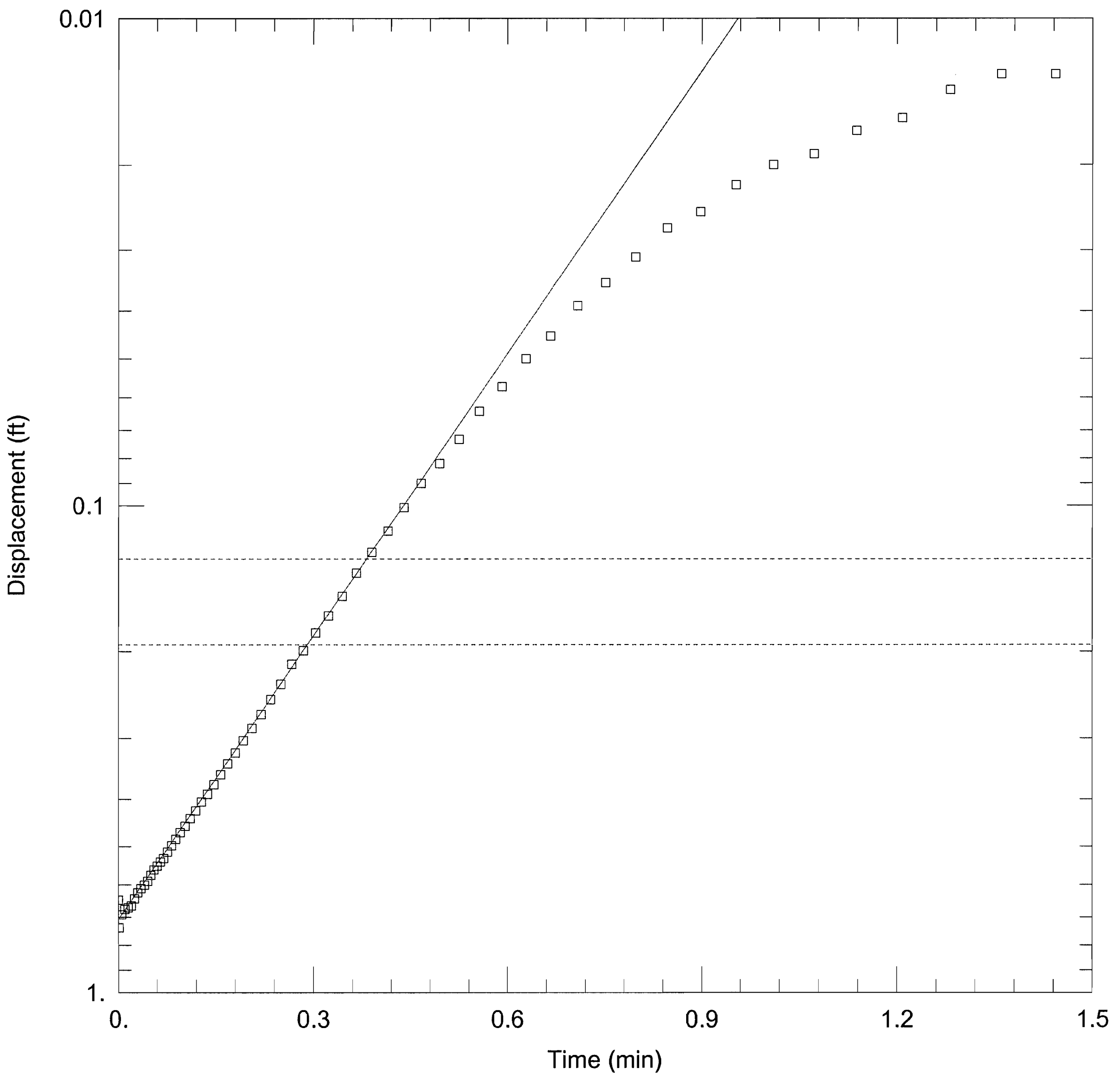
K = 0.03681 cm/sec   y0 = 0.4478 ft

WELL DATA (CDV-16-2660)

Initial Displacement: 0.645 ft
Static Water Column Height: 2.83 ft
Total Well Penetration Depth: 2.83 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2660 Rising Head Test 1

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

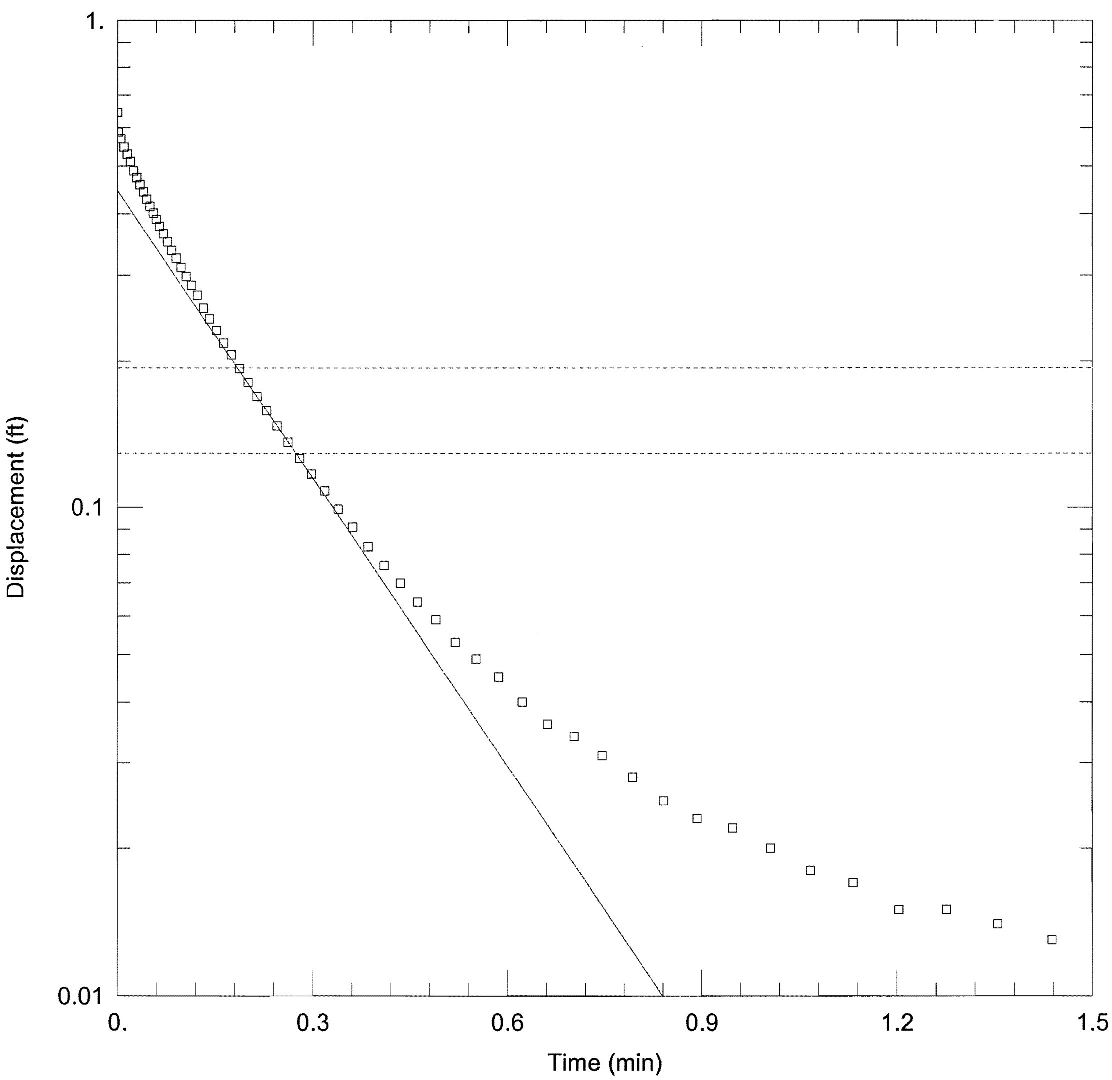
K = 0.03809 cm/sec   y0 = 0.7079 ft

WELL DATA (CDV-16-2660)

Initial Displacement: 0.645 ft
Static Water Column Height: 2.82 ft
Total Well Penetration Depth: 2.82 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2660 Falling Head Test 2

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

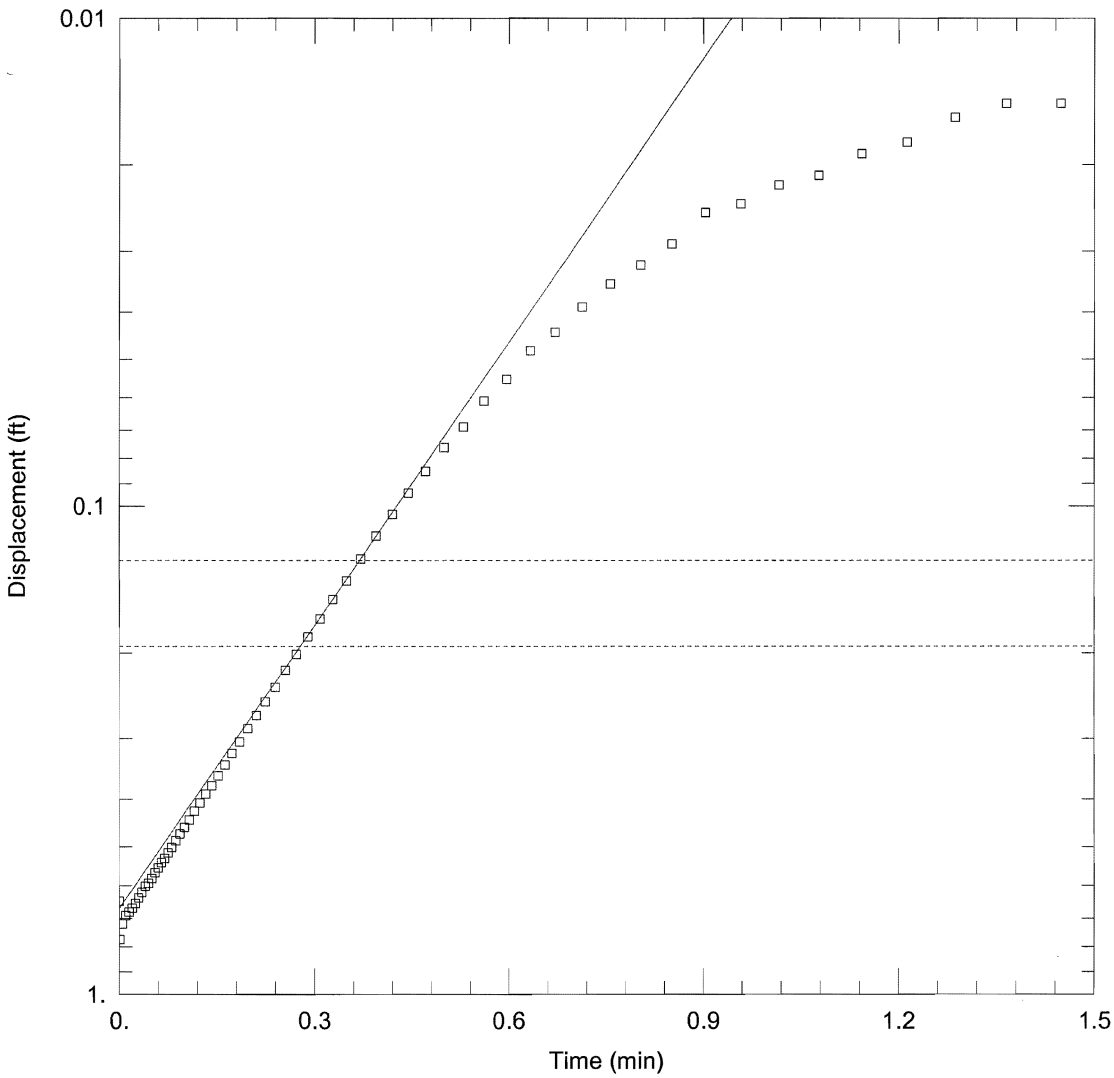
K = 0.03868 cm/sec y0 = 0.4466 ft

WELL DATA (CDV-16-2660)

Initial Displacement: 0.645 ft
Static Water Column Height: 2.82 ft
Total Well Penetration Depth: 2.82 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-2660 Rising Head Test 2

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Canon de Valle



SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.03809 cm/sec   y0 = 0.6695 ft

WELL DATA (CDV-16-2660)

Initial Displacement: 0.645 ft

Static Water Column Height: 2.82 ft

Total Well Penetration Depth: 2.82 ft

Screen Length: 5. ft

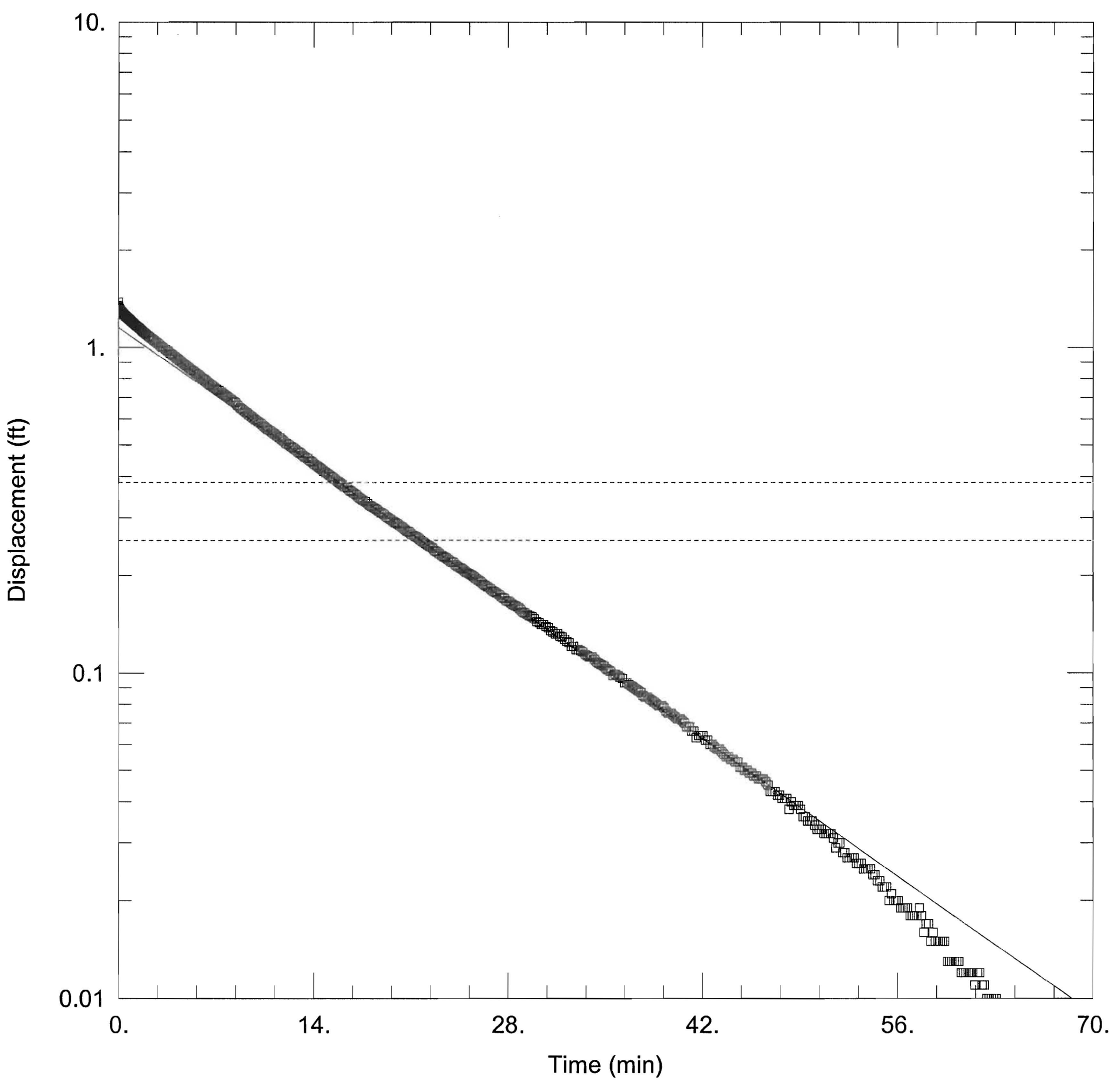
Casing Radius: 0.167 ft

Wellbore Radius: 0.51 ft

Gravel Pack Porosity: 0.44

Well 16-6294 Falling Head Test 1

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

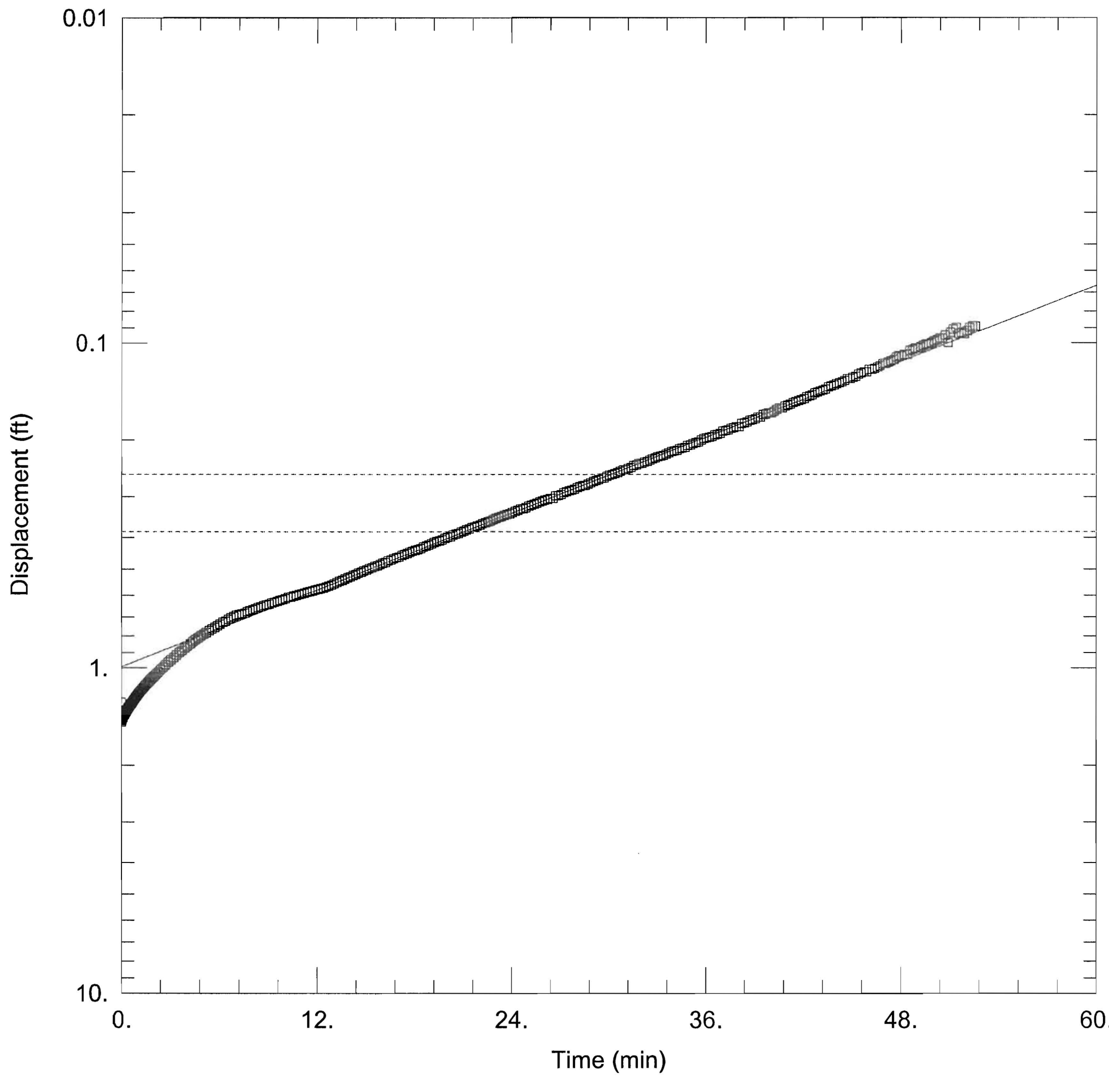
K = 0.0007717 cm/secy0 = 1.152 ft

WELL DATA (16-6294)

Initial Displacement: 1.28 ft
Static Water Column Height: 5.47 ft
Total Well Penetration Depth: 5.47 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-6294 Rising Head Test 1

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.0001075 cm/sec y0 = 0.9933 ft

WELL DATA (16-6294)

Initial Displacement: 1.28 ft

Static Water Column Height: 5.47 ft

Total Well Penetration Depth: 5.47 ft

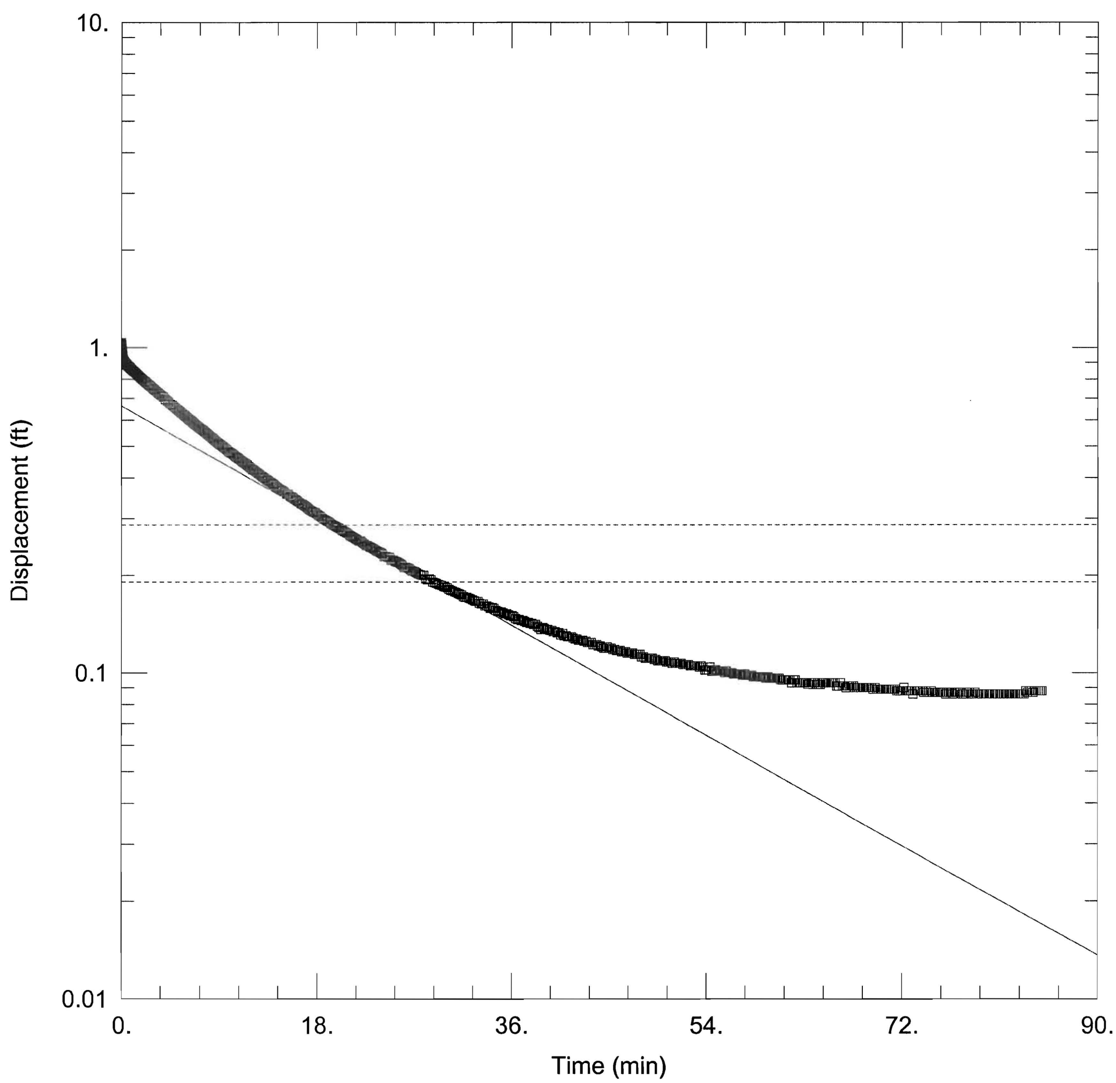
Screen Length: 5. ft

Casing Radius: 0.167 ft

Wellbore Radius: 0.51 ft

Well 16-6294 Falling Head Test 2

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

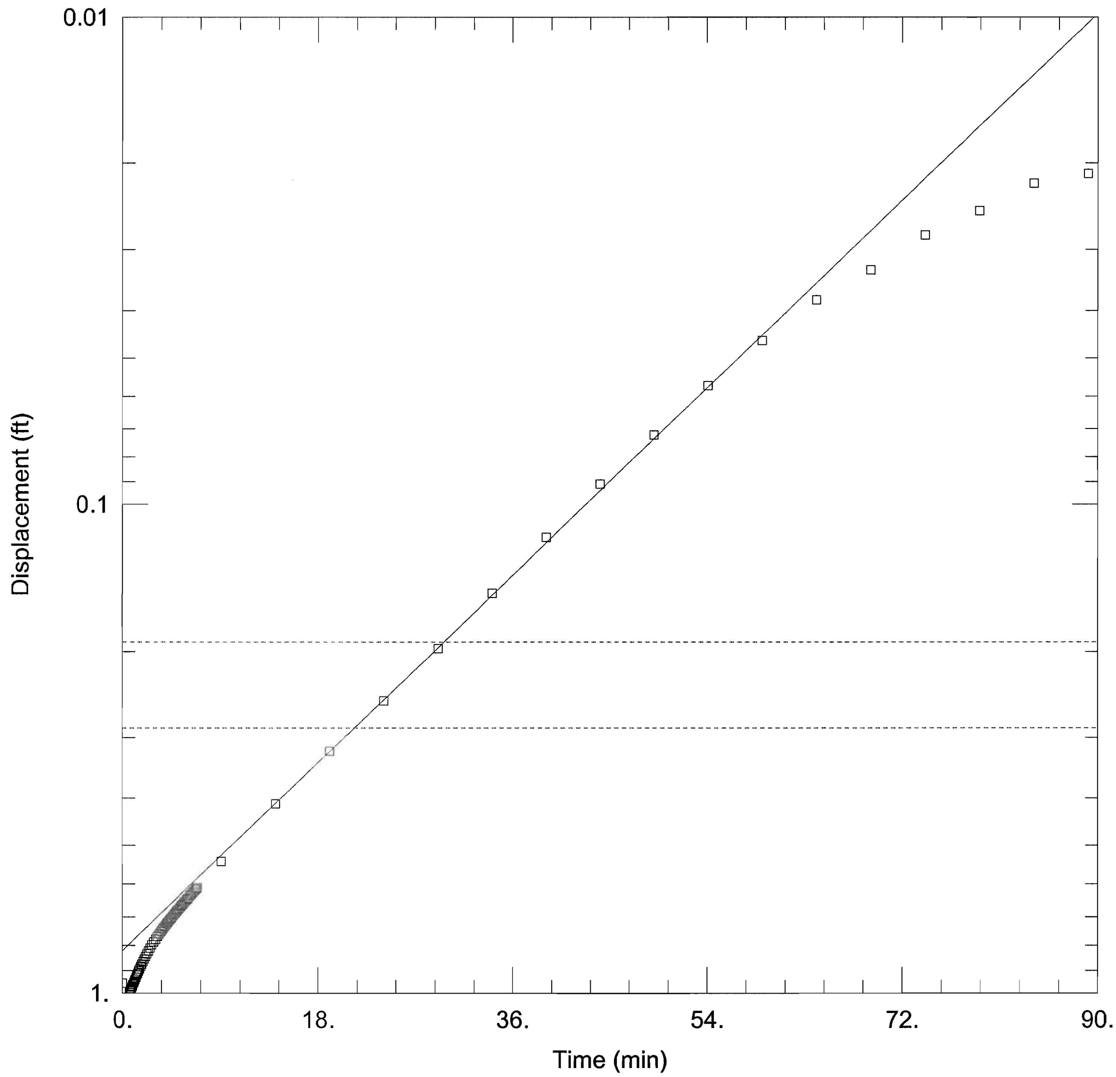
K = 0.0004674 cm/sec y0 = 0.6637 ft

WELL DATA (16-6294)

Initial Displacement: 0.955 ft
Static Water Column Height: 5.39 ft
Total Well Penetration Depth: 5.39 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-6294 Rising Head Test 2

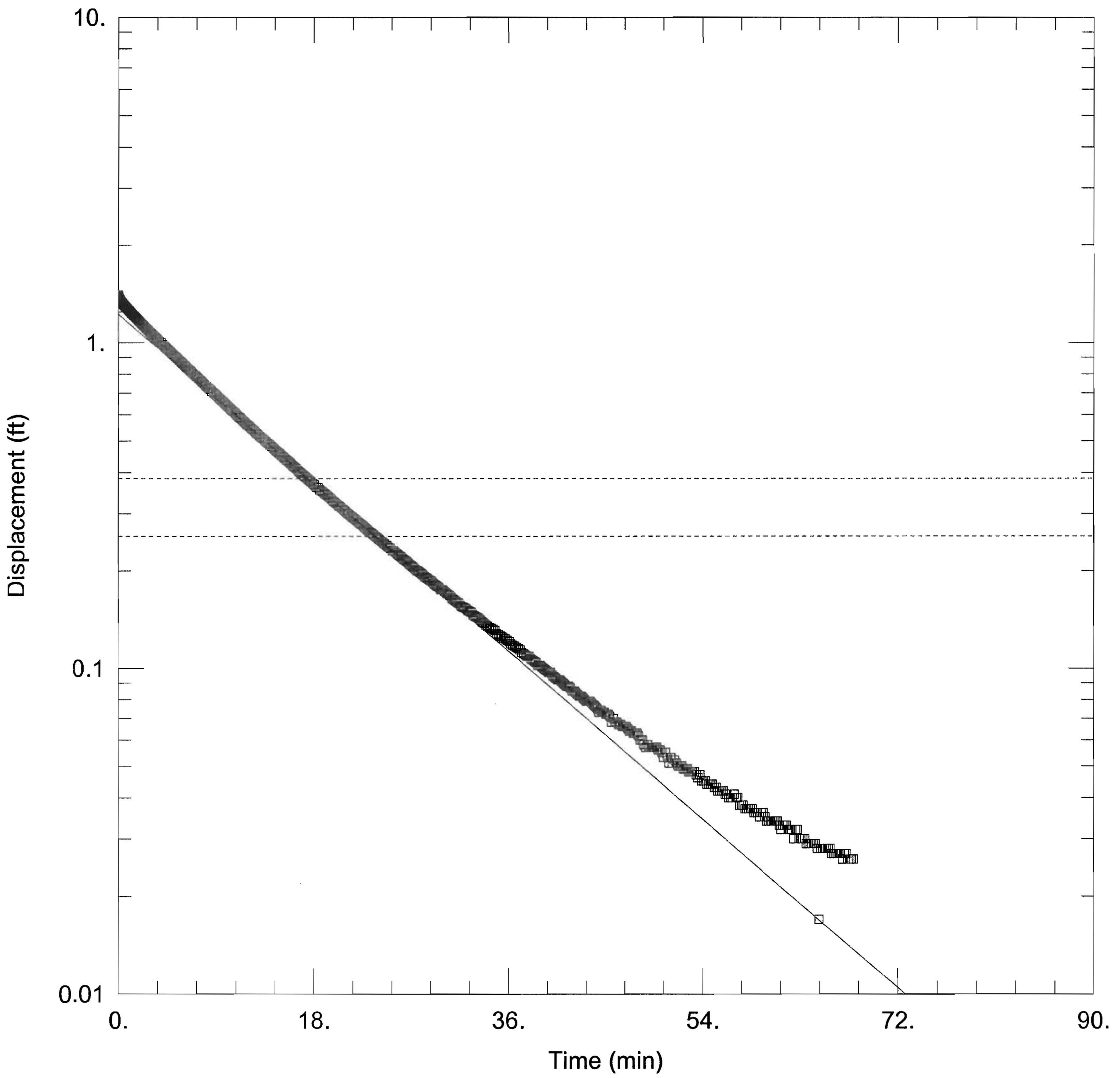
Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION	WELL DATA (16-6294)
Aquifer Model: Unconfined	Initial Displacement: 0.955 ft
Solution Method: Bouwer-Rice	Static Water Column Height: 5.49 ft
K = 0.0001175 cm/secy0 = 0.8203 ft	Total Well Penetration Depth: 5.49 ft
	Screen Length: 5. ft
	Casing Radius: 0.167 ft
	Wellbore Radius: 0.51 ft

Well 16-6294 Falling Head Test 3

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

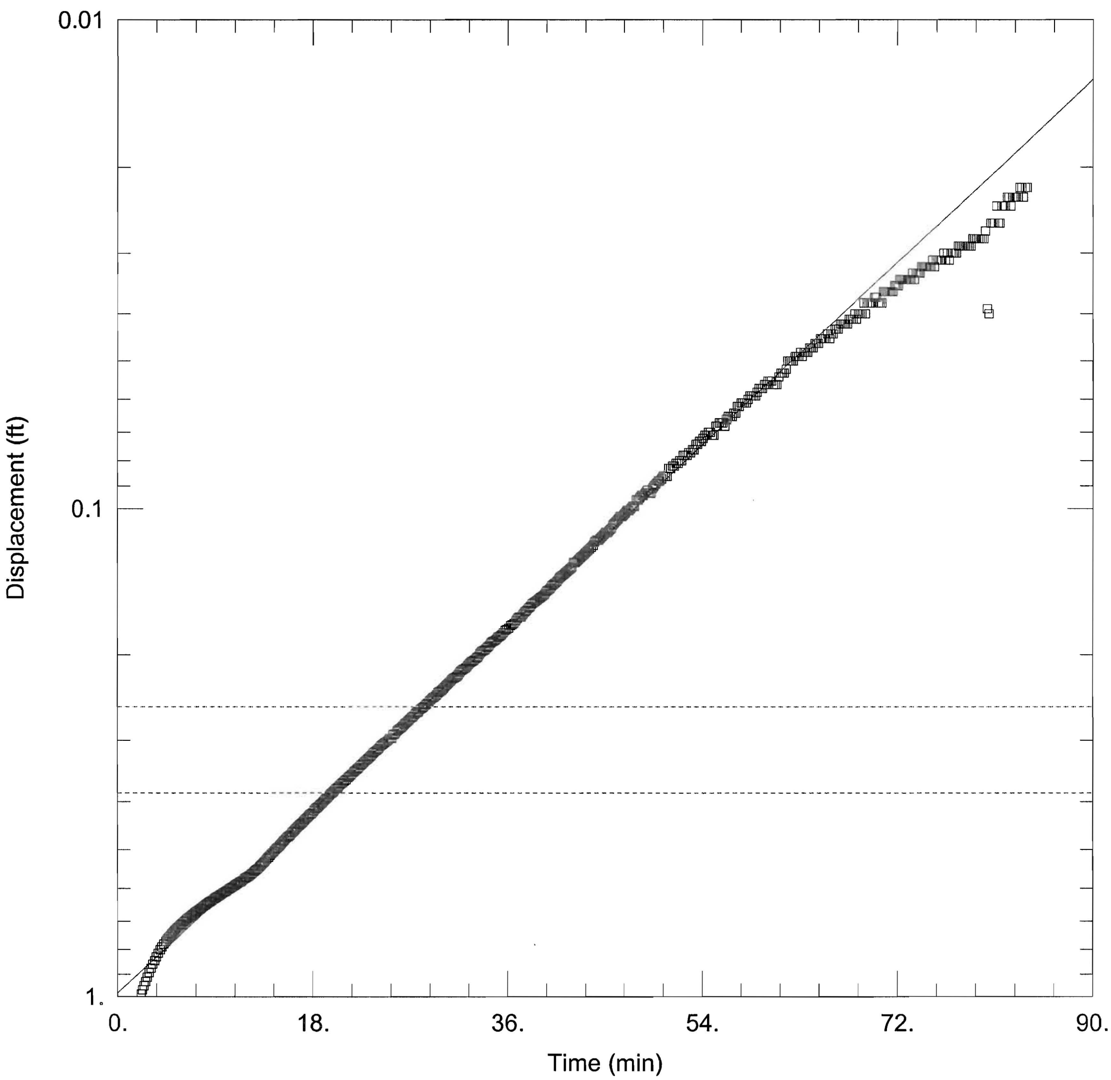
K = 0.0007339 cm/secy0 = 1.222 ft

WELL DATA (16-6294)

Initial Displacement: 1.28 ft
Static Water Column Height: 5.42 ft
Total Well Penetration Depth: 5.42 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

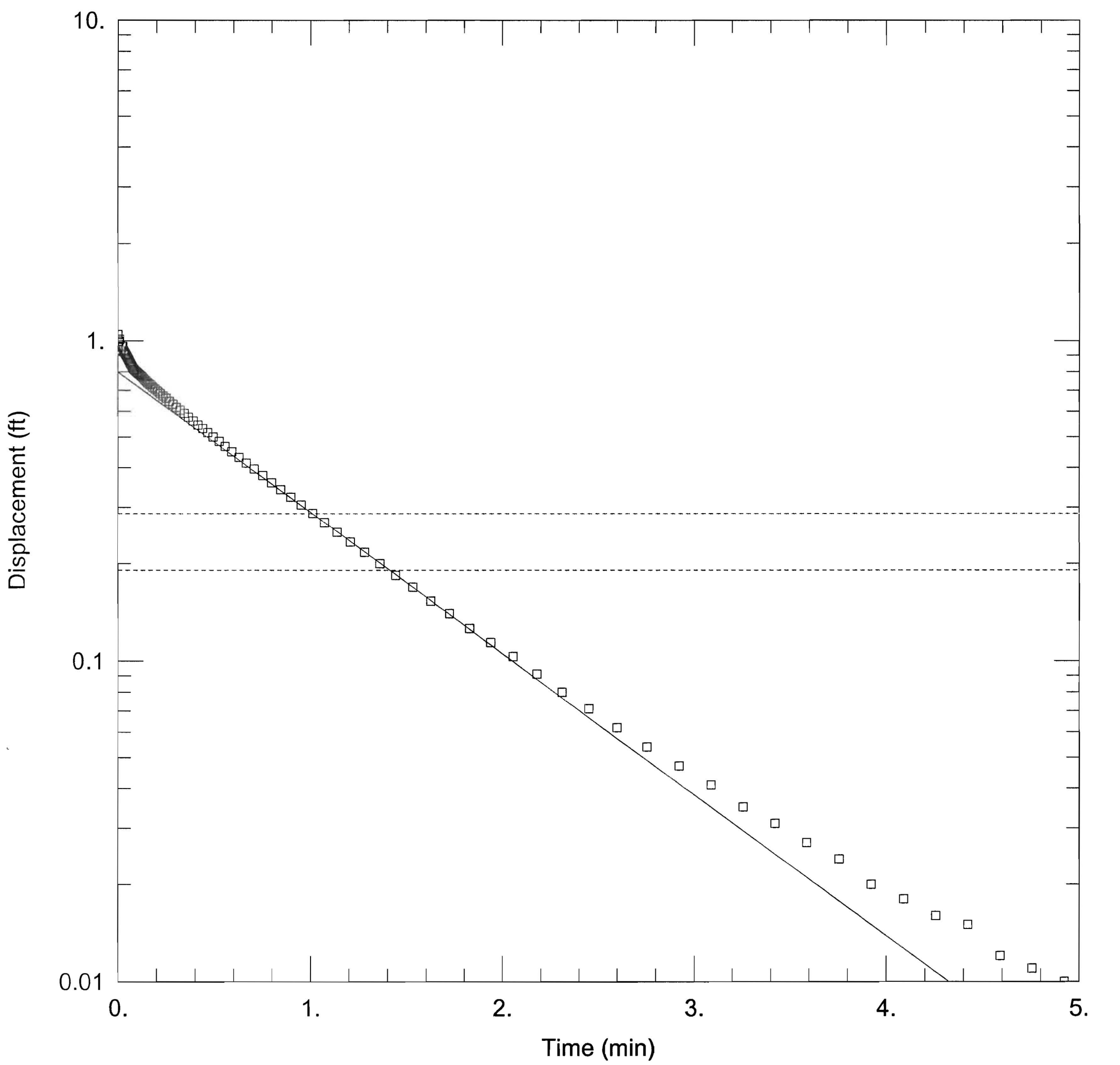
Well 16-6294 Rising Head Test 3

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION	WELL DATA (16-6294)
Aquifer Model: Unconfined	Initial Displacement: 1.28 ft
Solution Method: Bouwer-Rice	Static Water Column Height: 5.44 ft
K = 0.0001141 cm/secy0 = 0.9849 ft	Total Well Penetration Depth: 5.44 ft
	Screen Length: 5. ft
	Casing Radius: 0.167 ft
	Wellbore Radius: 0.51 ft

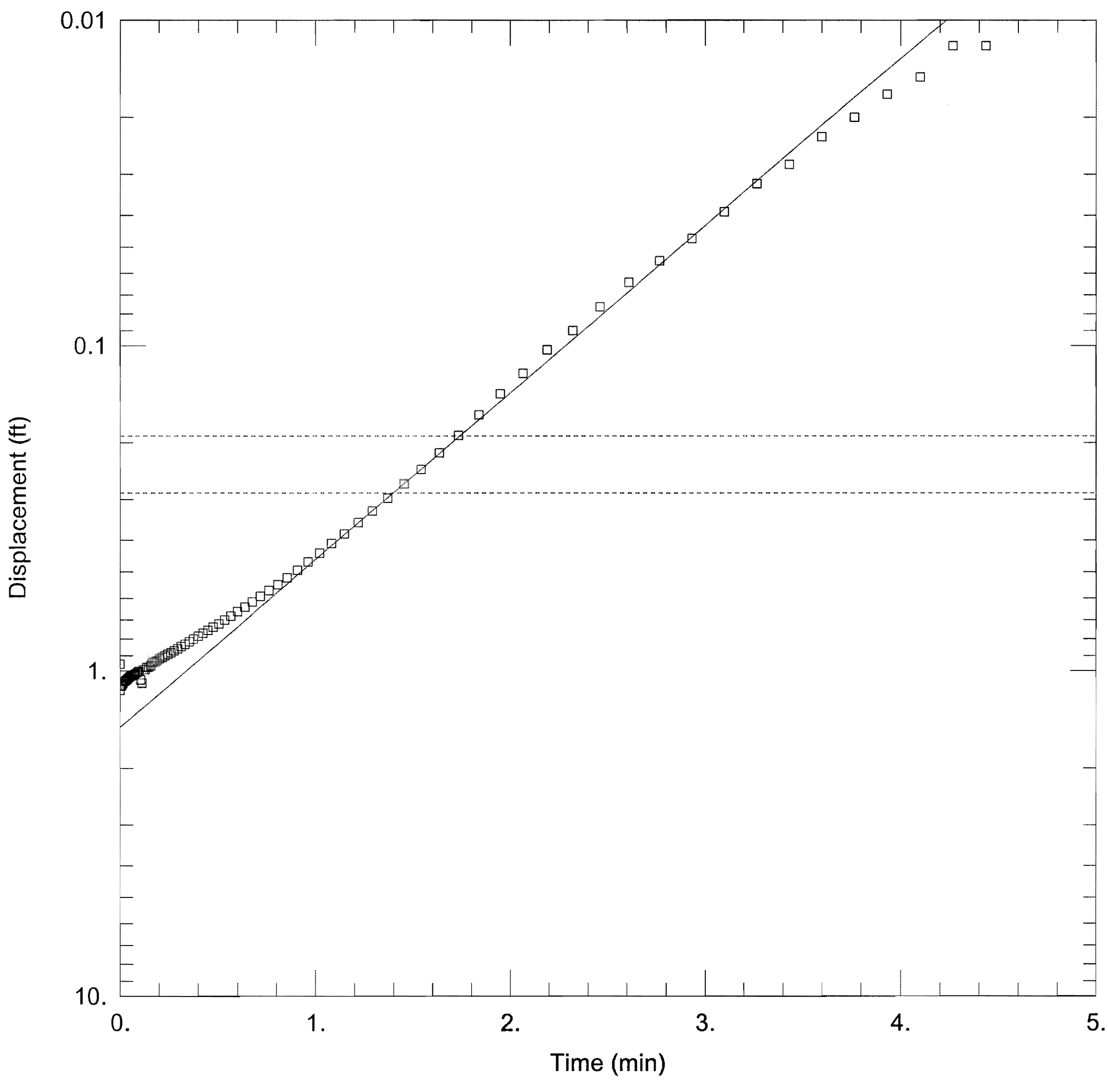
Well 16-6295 Falling Head Test 3	
Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION	WELL DATA (16-6295)
Aquifer Model: Unconfined Solution Method: Bouwer-Rice K = 0.0104 cm/sec y0 = 0.799 ft	Initial Displacement: 0.955 ft Static Water Column Height: 4.33 ft Total Well Penetration Depth: 4.33 ft Screen Length: 5. ft Casing Radius: 0.167 ft Wellbore Radius: 0.51 ft Gravel Pack Porosity: 0.44

Well 16-6295 Rising Head Test 3

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

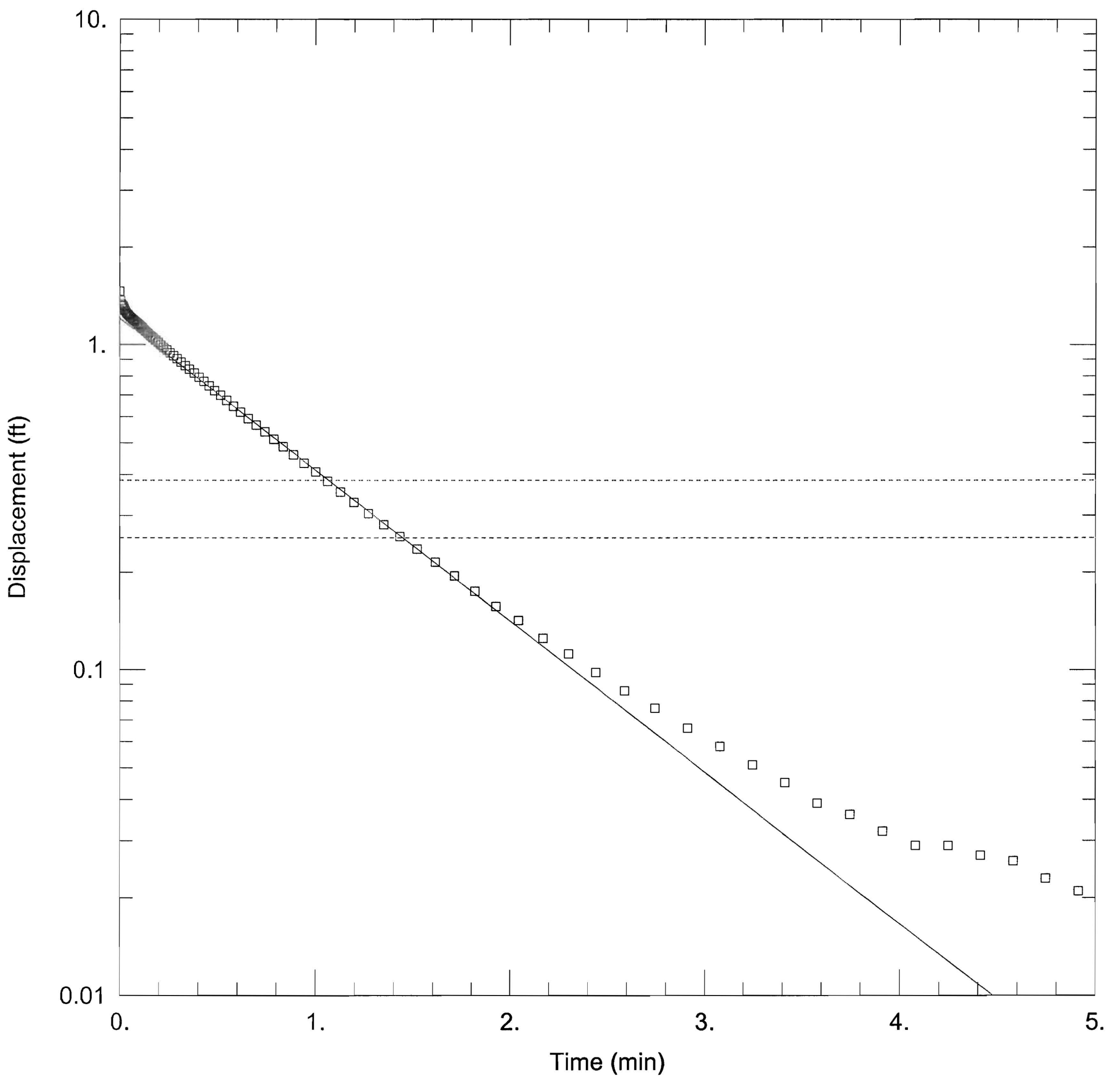
K = 0.01214 cm/sec   y0 = 1.497 ft

WELL DATA (16-6295)

Initial Displacement: 0.955 ft
Static Water Column Height: 4.331 ft
Total Well Penetration Depth: 4.331 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-6295 Falling Head Test 4

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.011 cm/sec y0 = 1.206 ft

WELL DATA (16-6295)

Initial Displacement: 1.28 ft

Static Water Column Height: 4.35 ft

Total Well Penetration Depth: 4.35 ft

Screen Length: 5. ft

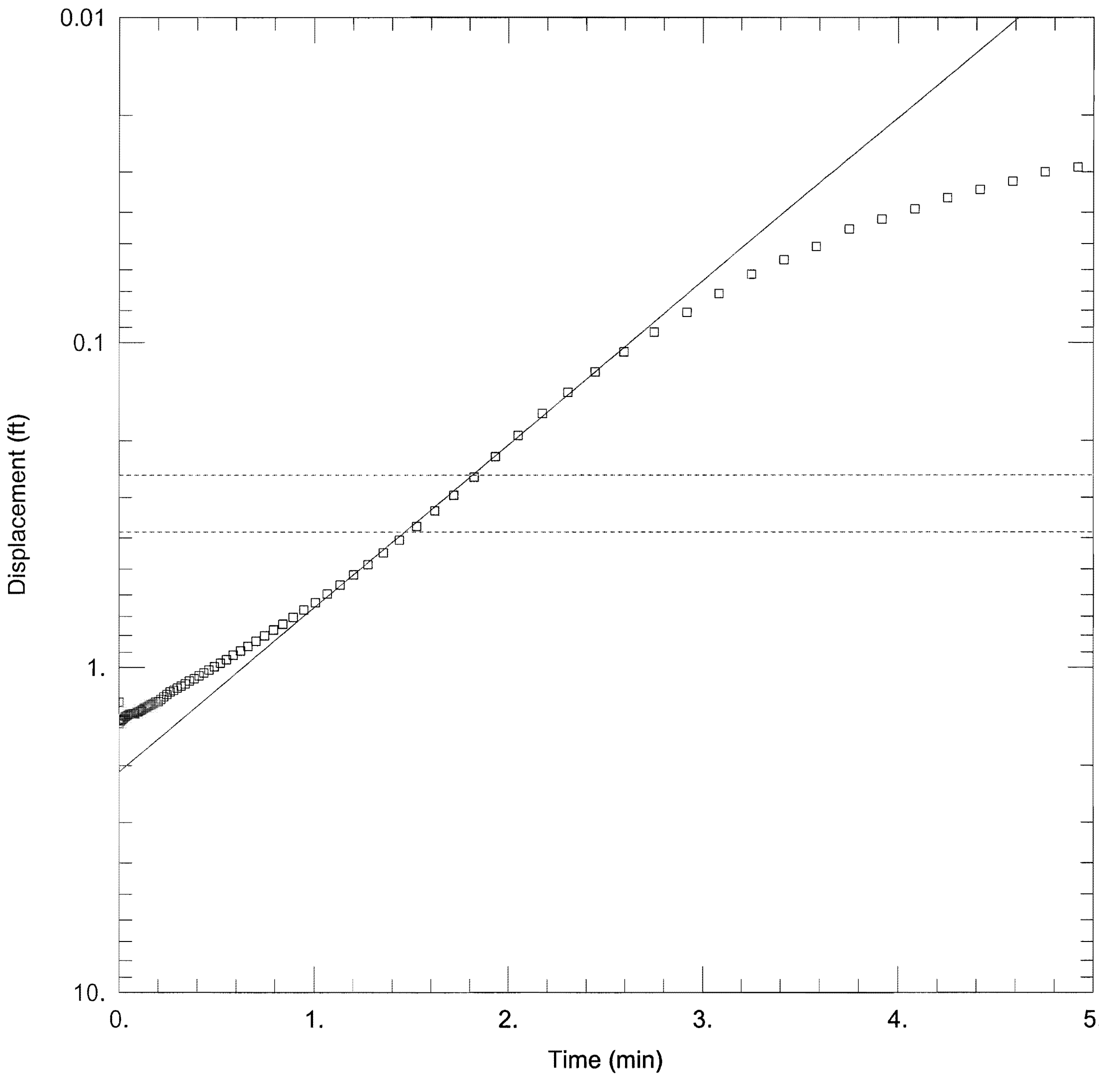
Casing Radius: 0.167 ft

Wellbore Radius: 0.51 ft

Gravel Pack Porosity: 0.44

Well 16-6295 Rising Head Test 4

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

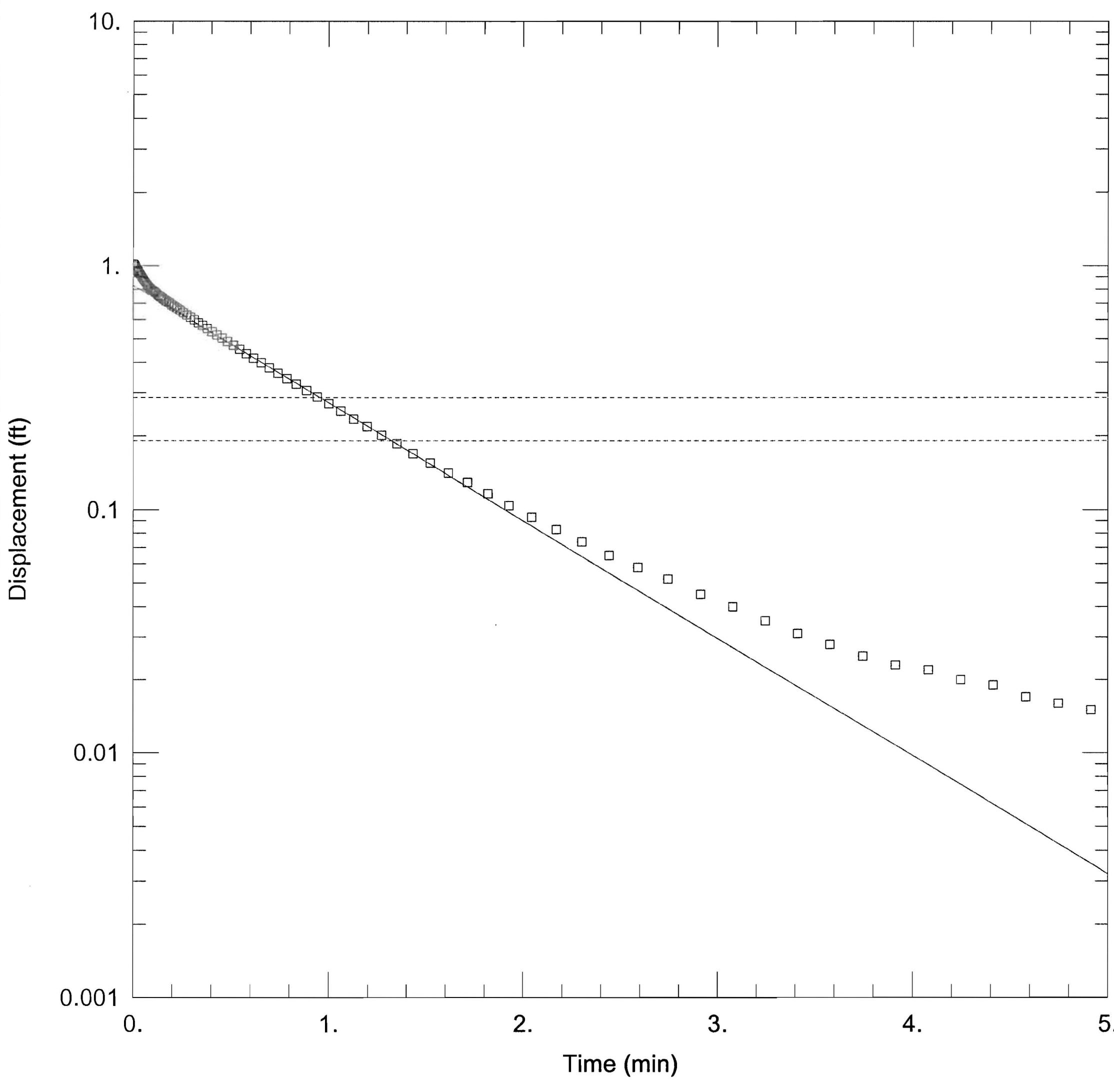
K = 0.01191 cm/sec y0 = 2.095 ft

WELL DATA (16-6295)

Initial Displacement: 1.28 ft
Static Water Column Height: 4.36 ft
Total Well Penetration Depth: 4.36 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-6295 Falling Head Test 5

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION

Aquifer Model: Unconfined
Solution Method: Bouwer-Rice

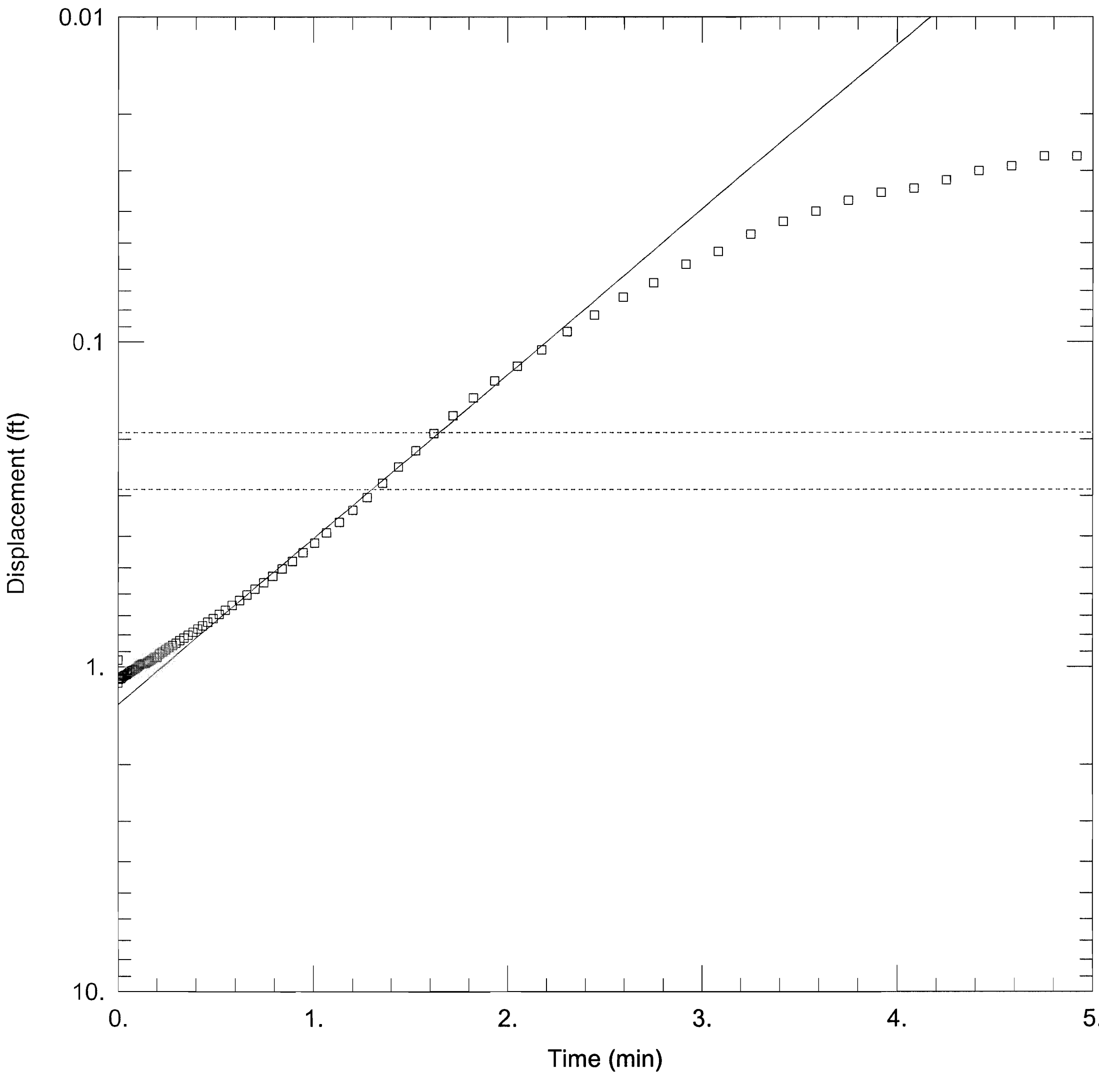
K = 0.01141 cm/sec   y0 = 0.8302 ft

WELL DATA (16-6295)

Initial Displacement: 0.955 ft
Static Water Column Height: 4.35 ft
Total Well Penetration Depth: 4.35 ft
Screen Length: 5. ft
Casing Radius: 0.167 ft
Wellbore Radius: 0.51 ft
Gravel Pack Porosity: 0.44

Well 16-6295 Rising Head Test 5

Prepared By: DBS&A	Prepared For: LANL
Project: TA-16 Alluvial Well Slug Tests	Location: Martin Spring Canyon



SOLUTION

Aquifer Model: Unconfined

Solution Method: Bouwer-Rice

K = 0.01203 cm/sec   y0 = 1.31 ft

WELL DATA (16-6295)

Initial Displacement: 0.955 ft

Static Water Column Height: 4.37 ft

Total Well Penetration Depth: 4.37 ft

Screen Length: 5. ft

Casing Radius: 0.167 ft

Wellbore Radius: 0.51 ft

Gravel Pack Porosity: 0.44

Appendix B-3

Groundwater Model of the
Cañon de Valle Pilot Permeable Reactive Barrier

B3-1.0 INTRODUCTION

A groundwater model was developed and a series of numerical groundwater flow simulations were conducted in support of the design of the pilot permeable reactive barrier (PRB) proposed for installation in Cañon de Valle, located at Los Alamos National Laboratory (LANL or the Laboratory) in Los Alamos, New Mexico. The model was used to evaluate the impact of a proposed funnel and gate PRB design on groundwater flow and hydraulic head in the vicinity of the PRB. In the funnel and gate design, a set of groundwater barrier walls (funnel) direct groundwater into a reactive cell (gate). The model also evaluated the impact of the angle of the barrier wall on groundwater flow. This appendix describes the design of the groundwater flow model and the methods used to evaluate the impact of the proposed PRB design on local groundwater flow and summarizes the results of the PRB design evaluation.

B3-2.0 MODEL DESIGN

The following sections describe the primary design elements of the groundwater flow model for the Cañon de Valle proposed PRB. The elements consist of the model code selected, assumptions made during model design, the model grid and layering, boundary conditions used in the model, and the properties assigned to the aquifer and the reactive media in the PRB simulation.

The Cañon de Valle PRB groundwater flow model was constructed with Groundwater Vistas Graphical User Interface. Groundwater Vistas fully supports the model code MODFLOW (McDonald and Harbaugh 1988, 056041), which was used to develop the groundwater flow model.

B3-2.1 Model Code

The groundwater model was developed using the model code MODFLOW (McDonald and Harbaugh 1988, 056041), a three-dimensional, finite-difference, groundwater flow model developed by the U.S. Geological Survey. MODFLOW was selected for use in this project because the code is nonproprietary, well documented, and has been verified for a range of field problems (EPA 1993, 095777). Numerous models based on this code have been published in peer-reviewed technical journals.

B3-2.2 Assumptions of Model Design

For the purpose of investigating the influence of the PRB on groundwater flow and hydraulic head in the vicinity of the PRB, the following assumptions were made to simplify the design of the model:

- No significant source of groundwater recharge to the alluvial aquifer exists in Cañon de Valle.
- Infiltration of precipitation and/or surface runoff into the alluvial aquifer is negligible.
- Downward groundwater flow between the alluvium and underlying Bandelier Tuff can be ignored.
- Aquifer property data and water levels measured at the monitoring well 16-02658 are representative of the entire model domain.

B3-2.3 Model Grid

The model grid constructed model domain is a 5-layer, 40-row by 60-column, uniformly spaced, finite-difference grid. Each cell in the model domain is 1 ft^2 in area, and the model is oriented with the long axis in the east-west direction (Figure B3-1). The model grid is not anchored to site coordinates.

B3-2.4 Model Grid Layers

Groundwater flow in the Cañon de Valle alluvial aquifer is simulated in the model with five layers. Each layer has a thickness of 1 ft. The top elevation of the model grid was measured at monitoring well 16-02658 and is assumed to be constant throughout the grid. The bottom elevation of the grid was obtained from a geologic log of the well boring for monitoring well 16-02658 (LANL 1998, 059891).

The top elevation of the grid was determined to be 7373 ft above mean sea level (amsl). The bottom of the alluvial aquifer is 5 ft below ground surface at monitoring well 16-02658, so the bottom elevation of the model grid was determined by subtracting 5 ft from the top elevation. A bottom elevation of 7368 ft amsl was used throughout the model grid.

The model domain was divided into five layers of equal thickness to ensure the numerical stability of the model and does not imply vertical variation in the alluvial aquifer. It is assumed that the alluvial aquifer at Cañon de Valle is homogeneous and isotropic; therefore, each of the five layers will have identical aquifer properties.

B3-2.5 Flow Conditions

Flow conditions in the Cañon de Valle PRB groundwater flow model are simulated as unconfined in a homogeneous and isotropic aquifer. The transmissivity of model grid varies during the model simulation period and is calculated from the saturated thickness and the hydraulic conductivity specified (McDonald and Harbaugh 1988, 056041).

B3-2.6 Boundary Conditions

The following boundary conditions were used in the Cañon de Valle PRB groundwater flow model:

- Upper boundary of the model grid–free-surface boundary
- East and west boundaries–constant-head boundaries
- North and south boundaries–no-flow boundaries

The upper boundary of the model grid is a free-surface boundary to simulate the water table within the alluvial aquifer. The free-surface elevation varies during the simulation period and is calculated during solution of the model (McDonald and Harbaugh 1988, 056041).

The lower boundary of the model grid is a no-flow boundary because it is assumed that the downward movement of water from the alluvial aquifer into the tuff is negligible (section 2.2).

The east and west grid boundaries are constant-head boundaries (Figure B3-1). The constant-head boundary values simulated the observed horizontal gradients in the area of the proposed PRB. The head values were computed from observed saturated thicknesses in the location of the proposed PRB and an assumed constant gradient. A single value of head is used for each boundary during the steady-state models. During the transient model runs, the western head boundary changes at a prescribed rate over the course of 48 hr.

The north and south grid boundaries are no-flow boundaries because the grid is oriented parallel to the primary direction of groundwater flow.

Monitoring well data collected from well 16-02658 indicate that the average saturated thickness between 1998 and 2002 in the vicinity of the proposed PRB is 2.27 ft (see Attachment B3-1 for calculations).

During the same period, the minimum and maximum saturated thicknesses were observed to be 0.5 and 2.95 ft, respectively. Constant-head boundary values were calculated using saturated thicknesses of 1.0, 2.0, and 3.0 ft.

Alluvial groundwater gradients were monitored between 16-02658 and 16-02659 during the course of 4 yr (1998–2002). Little variation was observed in the gradient during this period; therefore, it is assumed that the alluvial aquifer gradient is constant at a value of 0.044 (see Attachment B3-1 for calculations). This gradient value was used to determine constant-head values for the model.

B3-3.0 AQUIFER PROPERTIES

B3-3.1 Recharge

No recharge was simulated in the model. The infiltration of precipitation and surface runoff is assumed to be negligible in the area of the proposed PRB.

B3-3.2 Hydraulic Conductivity

The alluvium is represented as a single zone of hydraulic conductivity. Three different values for the aquifer hydraulic conductivity were evaluated during the Cañon de Valle PRB groundwater flow model simulation (Table B3-1). The values used are estimated conductivities determined by slug test results conducted in three different alluvial monitoring wells located in Cañon de Valle: 16-02658, 16-02659, and 16-02660 (see Attachment B3-1 for calculations).

B3-4.0 MODEL CALIBRATION

Model calibration was not performed because no observation wells are available; only well 16-02658 is located in the vicinity of the pilot PRB.

B3-5.0 EVALUATION OF PROPOSED PRB DESIGN

The groundwater model, described in the previous sections, was used to evaluate the impact of the proposed PRB on groundwater flow in the alluvial aquifer. Included in this evaluation was the determination of the relative levels of impact for two different treatment materials: raw zeolite and zero-valent iron (ZVI).

B3-5.1 Simulation of the PRB

To capture more accurately the behavior of groundwater in, and through, the proposed PRB, 2 additional rows and 16 additional columns were added to the grid. This resultant model grid consisted of 42 rows and 86 columns, with row and column spacing of 6 in. through the proposed PRB (Figure B3-1).

The reactive media in the PRB was represented as a single zone with a uniform effective hydraulic conductivity. Three hydraulic conductivities were tested for each of the treatment materials considered for use in the PRB. A literature review of flow parameters for the ZVI indicated that the hydraulic conductivity of the material can range from 100 to 1000 ft/d. It is assumed that the PRB material will consist of 50%–70% sand and 30%–50% treatment material and that the two materials are evenly distributed throughout the PRB. The three hydraulic conductivity values used for the ZVI-sand PRB mixture were 30.85 ft/d, 130.85 ft/d, and 255.85 ft/d. These values were calculated by taking a weighted average of the ZVI hydraulic conductivity with the hydraulic conductivity of clean sand, which was assumed to be 11.7 ft/d (Carsel and Parish 1988, 070224).

The range of hydraulic conductivity values observed during the literature review is 0.5 to 300 ft/d. The three hydraulic conductivity values used for the zeolite-sand PRB mixture were 5.98 ft/d, 18.35 ft/d, and 80.85 ft/d. These values were calculated by the same methods as the ZVI-sand hydraulic conductivity calculation.

The barrier walls were simulated as slurry walls filled with bentonite clay and as a single, uniform zone of hydraulic conductivity with a value of 2.8×10^{-6} ft/d (EPA 1997, 095776). The hydraulic conductivity used for the barrier walls represents the hydraulic conductivity of a saturated bentonite wall. Two wall angles (90 and 45 degrees, relative to the box edge) were simulated to evaluate the impact of wall angle on the groundwater flow regime.

To evaluate the impact of the barrier wall angle on groundwater flow in the alluvial aquifer, two different model domains were developed (Figures B3-1 and B3-2). For a given wall angle (90 or 45 degrees), the hydraulic conductivity of the aquifer was held constant at 50 ft/d and the PRB material hydraulic conductivity was kept at 500 ft/d. These two values were chosen for a general case with a difference of one order of magnitude in the conductivity between the aquifer and treatment materials. The three saturated thicknesses (1.0, 2.0, and 3.0 ft) were simulated for each wall angle.

Steady-state flow conditions were used to simulate the operation of the PRB under typical groundwater flow conditions in the alluvium during most of the year. Additionally, transient flow conditions were simulated to observe the response of the system to surges in the groundwater because of heavy rain and runoff. A saturated thickness of either 2.0 or 3.0 ft was used for the steady-state and transient groundwater flow simulations.

Model calibration targets were input into layers 4 and 5, across the length of the model domain. The targets were used to determine the computed head values for a given simulation at the layer elevation. These targets were not used for model calibration (see section 4.0).

Transient flow conditions were also simulated to evaluate the impact of the PRB on groundwater flow through the alluvial aquifer. The values of both the aquifer and PRB hydraulic conductivity were selected based on results from the steady-state flow simulations.

Five artificial monitoring wells were added to the model domain for simulations of transient flow conditions. Each monitoring well was screened over the thickness of the model domain, with a top screen elevation of 7373 ft and a bottom screen elevation of 7368 ft. The artificial monitoring wells were used to ensure uniformity when examining head values computed by the model in each of the simulations. Figure B3-3 illustrates the location of the five monitoring wells as well as the transient-head and constant-head boundaries.

Water-level transducer data collected between September 2005 and September 2006 at well 16-02658 were used to determine the rate of head change that should be applied for the transient flow condition models. The average rate of change in water level during this period was determined to be 0.187 ft/d. This average value was selected for the model input calculations. A pulse of groundwater flow was simulated by raising the upstream head (h_1) at a rate of 0.187 ft/d over a period of one day, followed by a decrease in head over one day at the same rate.

Transient flow models were run with an initial saturated thickness of 2.0 ft as well as 3.0 ft. A saturated thickness of 3.0 ft was selected for use in the transient model because this is approximately equal to the maximum, observed saturated thickness at well 16-02658 and, therefore, represents highly saturated conditions in the alluvial aquifer before the pulse of groundwater flow.

The influence of a perennial stream was also evaluated under transient flow conditions for an aquifer conductivity of 50 ft/d. The stream was simulated as a line of recharge on the southern half of the model domain (Figure B3-4). The rate of recharge was determined from precipitation data for 122 d between June and October 2006 in Cañon de Valle. It was assumed that 10% of the precipitation received in the canyon would infiltrate the ground as recharge. The average precipitation during this period was 0.091 inches. The rate of recharge used in the transient flow condition model was therefore 6.24×10^{-4} ft/d.

B3-5.2 Impact of the PRB on Groundwater Head and Flow in the Alluvial Aquifer

The steady-state head solution for the alluvial aquifer in layers 4 and 5 after the proposed PRB was installed is shown in Figures B3-5, B3-6, and B3-7 for the two different wall angles and three saturated thicknesses evaluated. These results show a negligible difference between the head solutions observed for the 90-degree wall angle relative to the 45-degree wall angle. It was therefore concluded that the wall angle has minimal impact on hydraulic heads and groundwater flow in the alluvial aquifer; all following model grid designs focus on the 90-degree wall angle, because of its relative simplicity and ease of installation.

The perturbation in groundwater heads caused by the PRB was investigated by comparing the model results for various PRB reactive cell and alluvial conductivities with the natural gradient. These results, shown in Figures B3-8, B3-9, and B3-10, generally indicate the presence of a slight groundwater depression at the entrance to the PRB. The perturbation from the natural gradient is most pronounced when the contrast between the reactive cell and alluvial conductivities is highest (Figure B3-10). For the most realistic alluvial conductivity (determined from slug testing at well 16-02658) and the mid-range value of reactive cell conductivity (K_{PRB}=80.85 ft/d), the groundwater depression is approximately 7370.16 ft. The hydraulic depression observed at the PRB entrance is shown in Figure B3-11.

There is a notable difference in the value of hydraulic head at the PRB exit for the various PRB reactive cell and alluvial conductivities (Figures B3-8, B3-9, and B3-10). For greater contrasts between the reactive cell and alluvial conductivities, there is a drop in the water level at the PRB exit. As the two material conductivities approach the same order of magnitude, the water level evens out at the PRB exit. For an alluvial conductivity of 1 ft/d, the most realistic case, and a mid-range value of reactive cell conductivity (K_{PRB}=80.85 ft/d), the hydraulic head at the PRB exit is 7370.04 ft. The dropping off of head at the PRB exit can be observed in Figure B3-11.

For an aquifer hydraulic conductivity of 1 ft/d, no significant difference between the steady-state head solutions for the six PRB reactive cell material hydraulic conductivities (Figure B3-8). It is therefore reasonable to conclude from these steady-state model results that the proposed PRB will have a negligible impact on hydraulic heads and groundwater flow.

Observable differences in computed head relative to the natural gradient across the model domain were observed for the 50-ft/d and 100-ft/d aquifer hydraulic conductivity values for all six PRB treatment material hydraulic conductivities (Figure B3-9 and B3-10). With these materials, the contrast was highest between the alluvial conductivity and reactive cell conductivity.

It was determined that the transient model simulations should focus on scenarios with an aquifer hydraulic conductivity of 50 ft/d and a PRB treatment material hydraulic conductivity of 5.98 ft/d because this combination resulted in the greatest contrast in computed head across the model domain. Additional transient model simulations were also conducted with the more realistic aquifer conductivity (determined from slug testing at well 16-2658) and a reactive cell conductivity of 5.98 ft/d.

Figure B3-12 illustrates the movement of the groundwater pulse over time at monitoring wells 3 and 4 for an initial saturated thickness of 2.0 ft and an aquifer conductivity of 50 ft/d. The results for an initial saturated thickness of 3.0 ft and aquifer conductivity of 50 ft/d are shown in Figure B3-13 for monitoring wells 3 and 4. There is an observable difference in the water level at monitoring well 3 relative to the water level at monitoring well 4. The water level before the proposed PRB stays at approximately the same level in both scenarios (saturated thicknesses of 2.0 and 3.0 ft). In the case of an initial saturated thickness of 2.0 ft, the water level remains well below the ground surface and there is a noticeable difference in groundwater levels before and after the proposed PRB. For an initial saturated thickness of 3.0 ft, the water level is within 0.6 ft of the ground surface, increasing the risk of flooding in the canyon upstream of the PRB.

For an initial saturated thickness of 2.0 ft and a more realistic aquifer conductivity of 1 ft/d, there is a difference of only 0.14 ft between the hydraulic heads in monitoring wells 3 and 4 at the end of the 2-day period (Figure B3-14). When the initial saturated thickness is 3.0 ft and the aquifer conductivity is 1 ft/d, there is much greater difference in the hydraulic heads between monitoring wells 3 and 4; the difference in the two heads is 2.07 ft. Figure B3-15 illustrates the hydraulic head over time at monitoring wells 3 and 4 for the 3.0-ft saturated thickness.

The effect of the simulated stream on groundwater flow through the alluvial aquifer is negligible. Figures B3-16 and B3-17 illustrate that there is no observable difference in the water level for conditions without recharge and conditions with recharge from the stream.

In summary, groundwater modeling of the pilot PRB yielded several important findings:

- The configuration of the funnel walls, either linear or angled, is not important hydraulically.
- Because of the contrast between the alluvial- and reactive-cell hydraulic conductivities, deviations from the natural groundwater gradient in the form of a slight depression occur at the entrance of the PRB, with the magnitude of the deviation proportional to the contrast in conductivities.
- Under a transient boundary condition head change of 0.187 ft/d associated with storm surges, a potential for flooding exists when the aquifer is highly saturated before the storm event. To offset this potential effect, the width of the PRB reaction cell should be increased to 6 ft.

B3-6.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and Environmental Remediation and Surveillance Program identification (ER ID) number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Program–Environment and Remediation Support Services (EP-ERSS) Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the EP-ERSS Program master reference set.

Copies of the master reference set are maintained at the New Mexico Environment Department Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; U.S. Environmental Protection Agency, Region 6; and the EP-ERSS Program. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every *document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.*

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EPA (U.S. Environmental Protection Agency), February 1993. "A Manual of Instructional Problems for the U.S.G.S. Modflow Model," EPA/600/R-93/010, Robert S. Kerr Environmental Research Laboratory, Office of Research and Development, Ada, Oklahoma. (EPA 1993, 095777)

EPA (U.S. Environmental Protection Agency), July 1997. "Geosynthetic Clay Liners Used in Municipal Solid Waste Landfills," EPA530-F-97-002, Office of Solid Waste and Emergency Response, Washington, D.C. (EPA 1997, 095776)

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McDonald, M.G., and A.W. Harbaugh, 1988. "A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model," Book 6, Chapter A1 abstract only, in Techniques of Water-Resources Investigations of the United States Geological Survey, Washington, D.C. (McDonald and Harbaugh 1988, 056041)

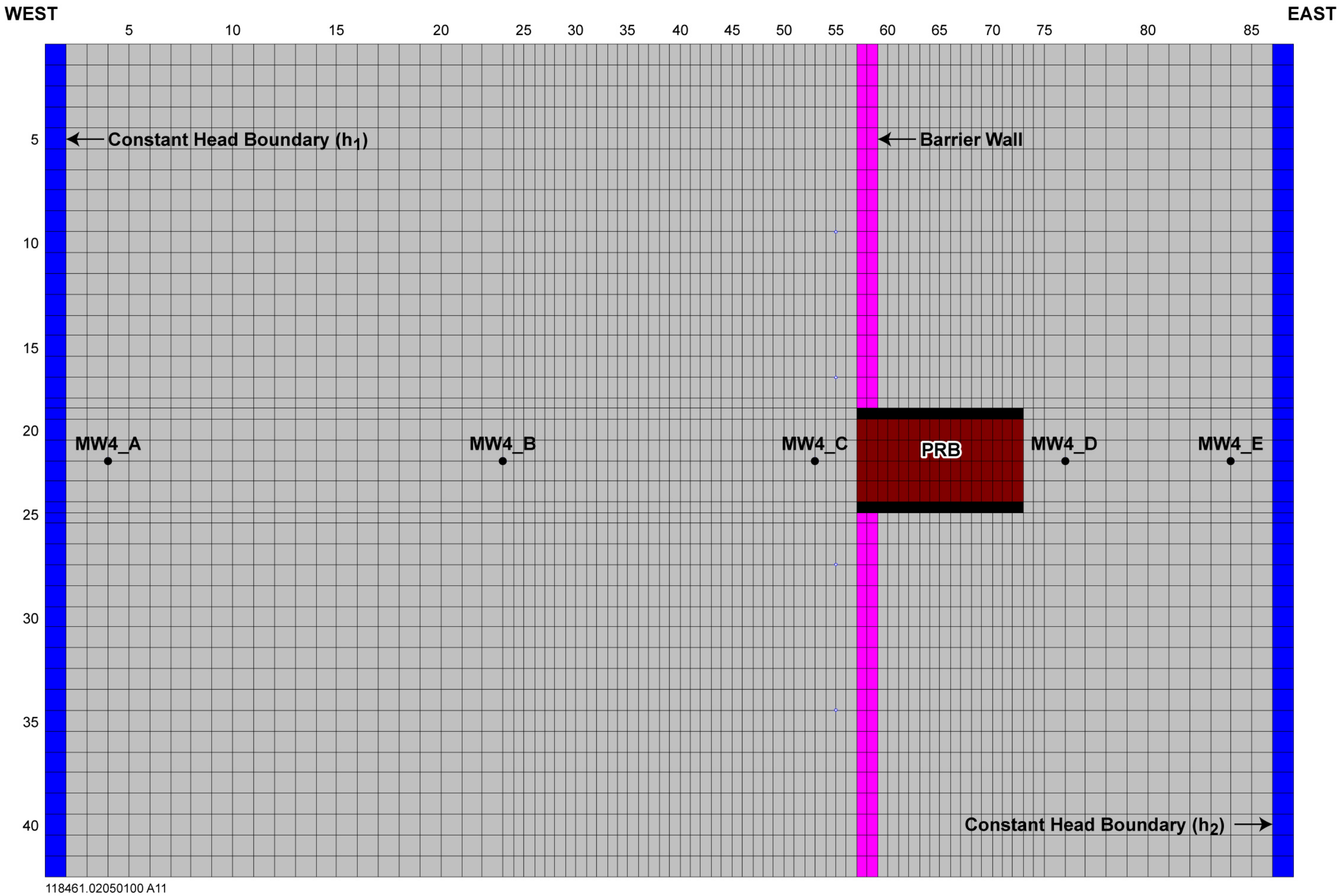


Figure B3-1 **Barrier wall angle of 90°, steady-state model domain, Cañon de Valle PRB**

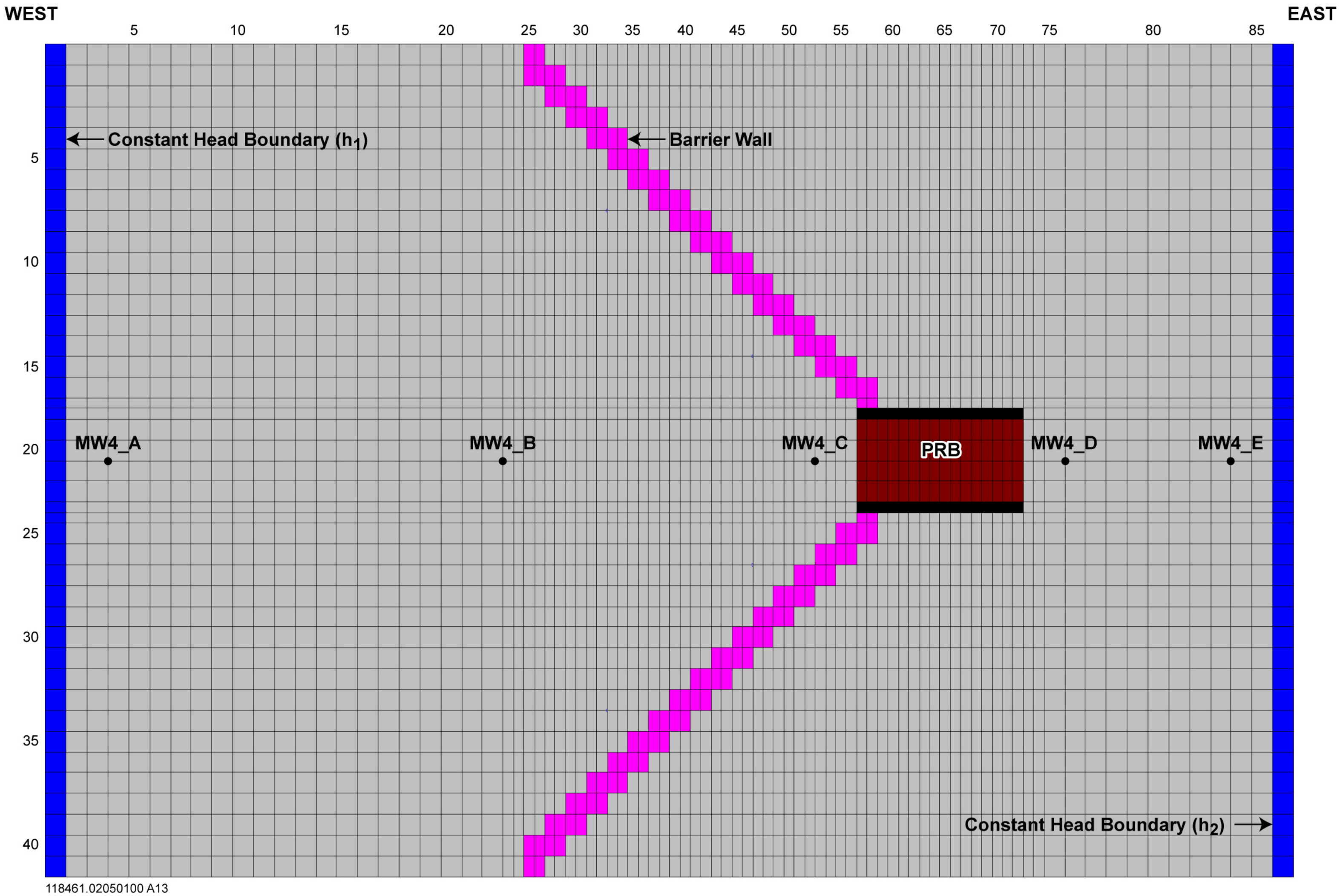


Figure B3-2 Barrier wall angle of 45°, steady-state model domain, Cañon de Valle PRB

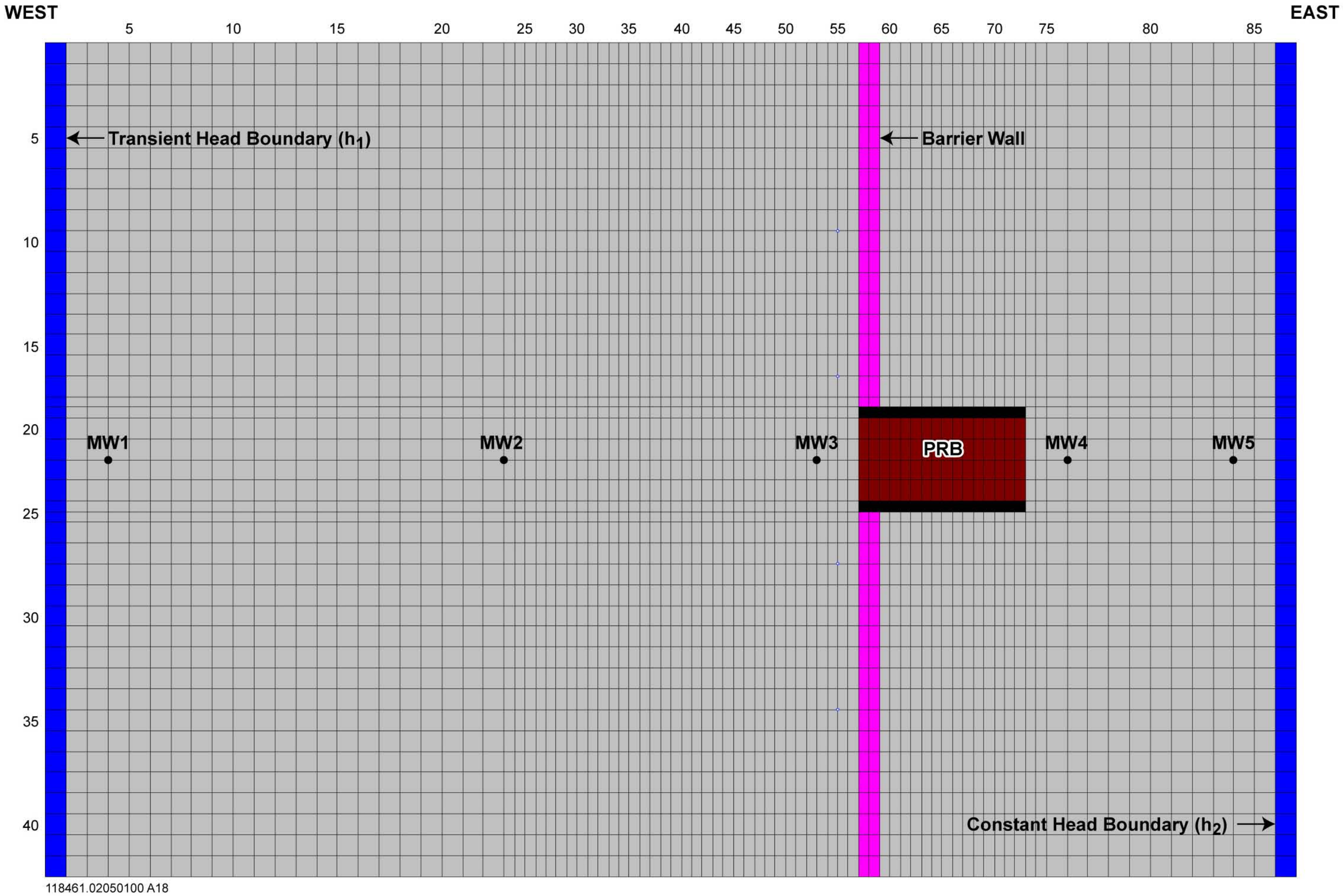


Figure B3-3 Transient model domain, Cañon de Valle Pilot PRB

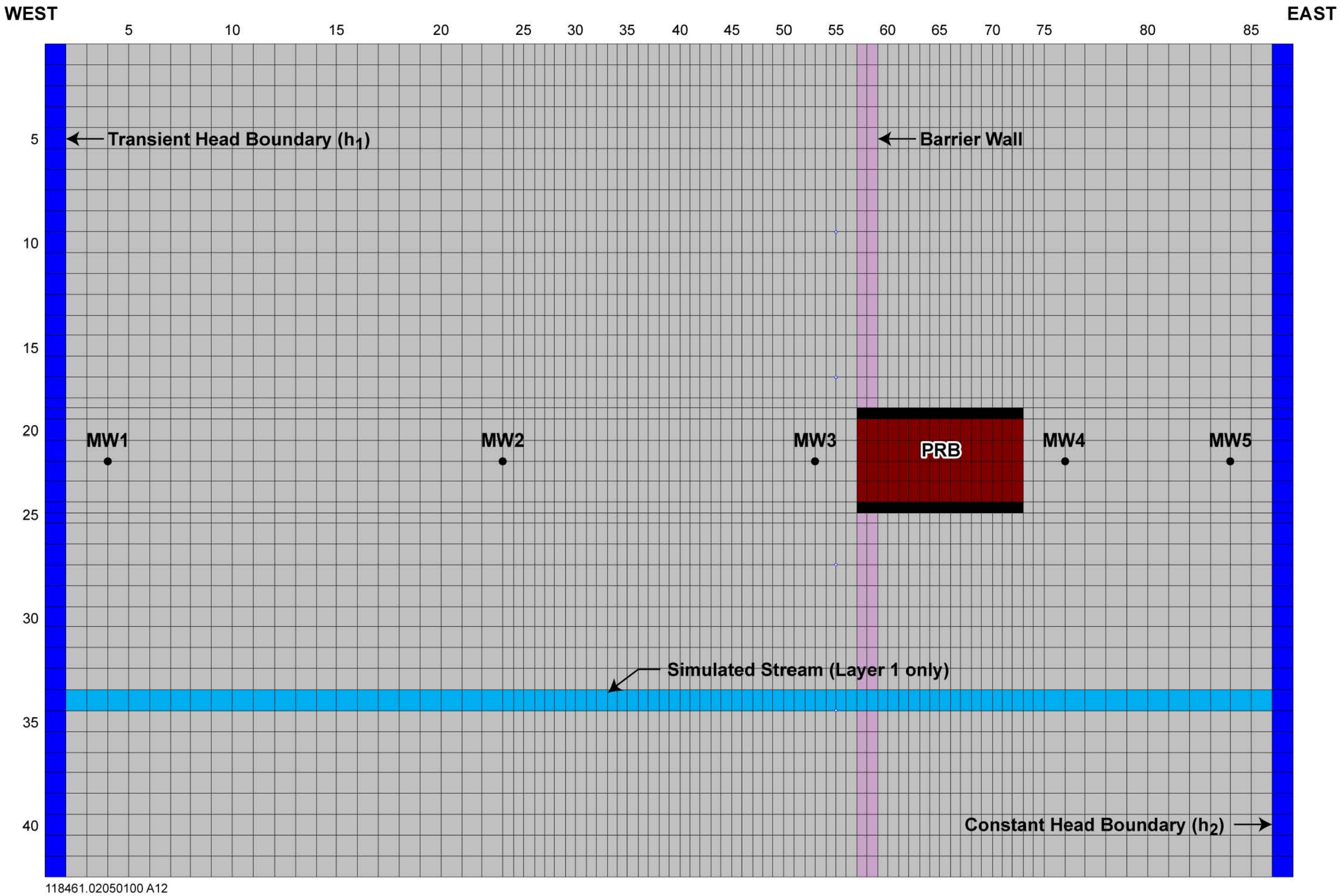


Figure B3-4 Model domain with simulated stream, Cañon de Valle Pilot PRB

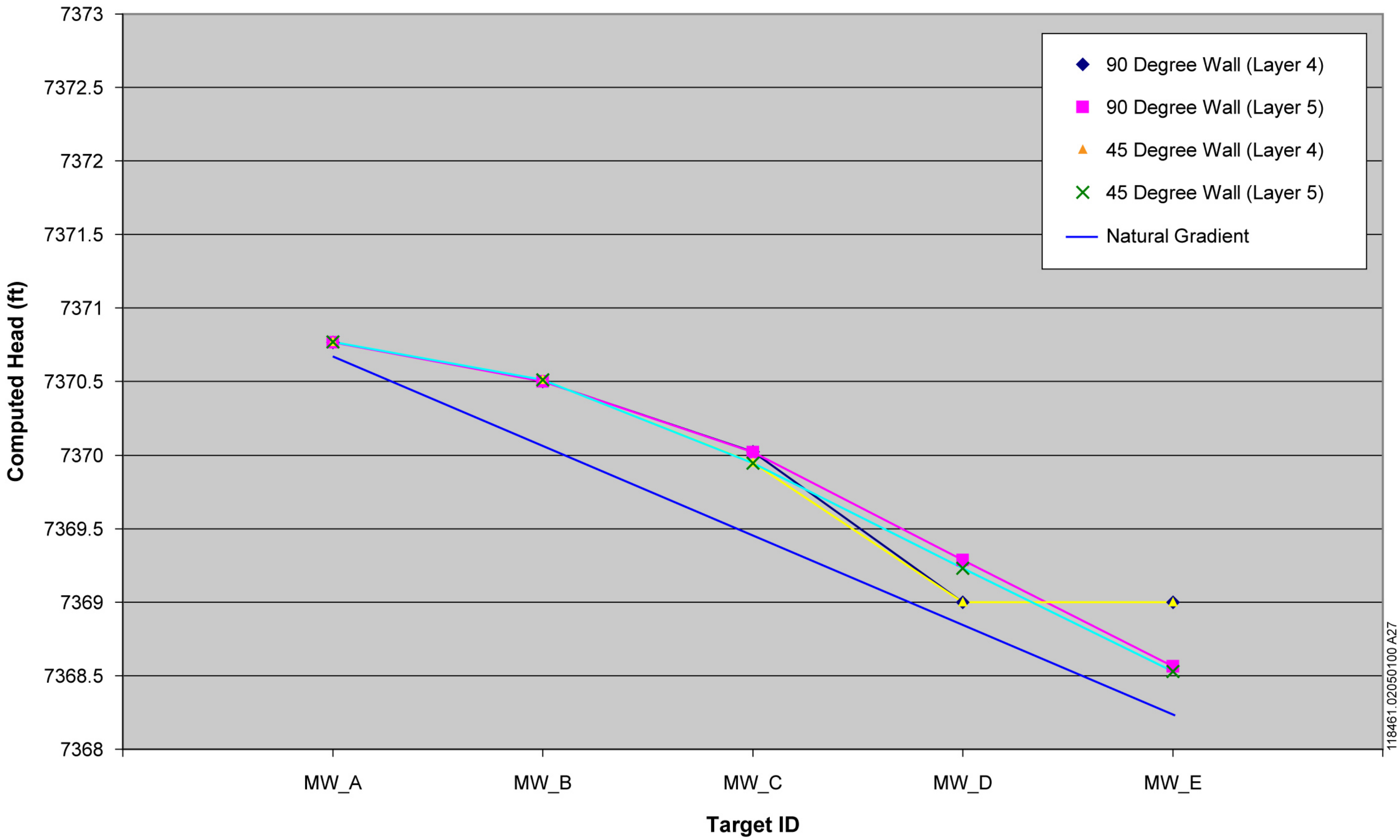


Figure B3-5 Steady-state model target results (layers 4 and 5), 1.0-ft saturated thickness, Cañon de Valle Pilot

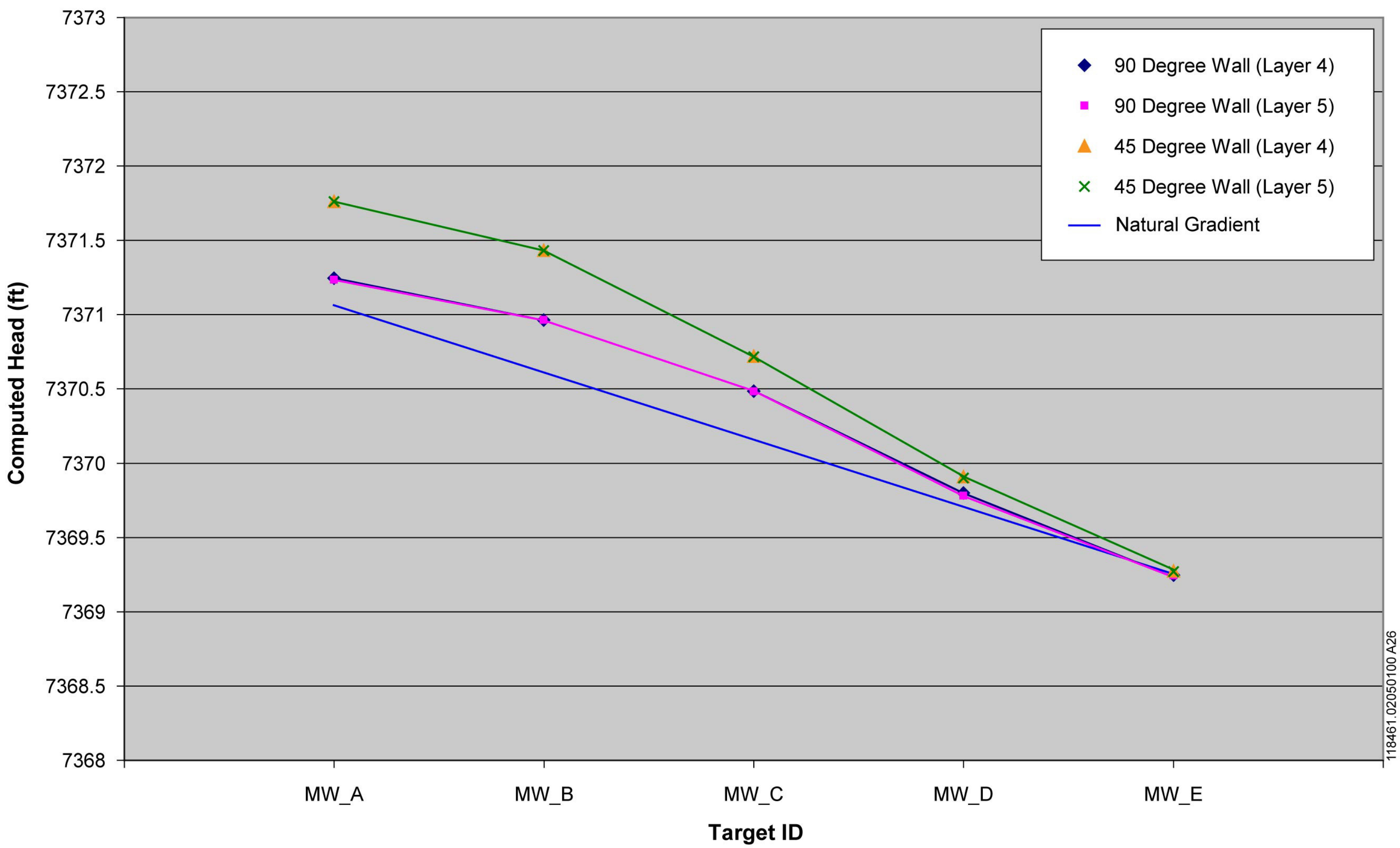


Figure B3-6 Steady-state model target results (layers 4 and 5), 2.0-ft saturated thickness, Cañon de Valle Pilot PRB

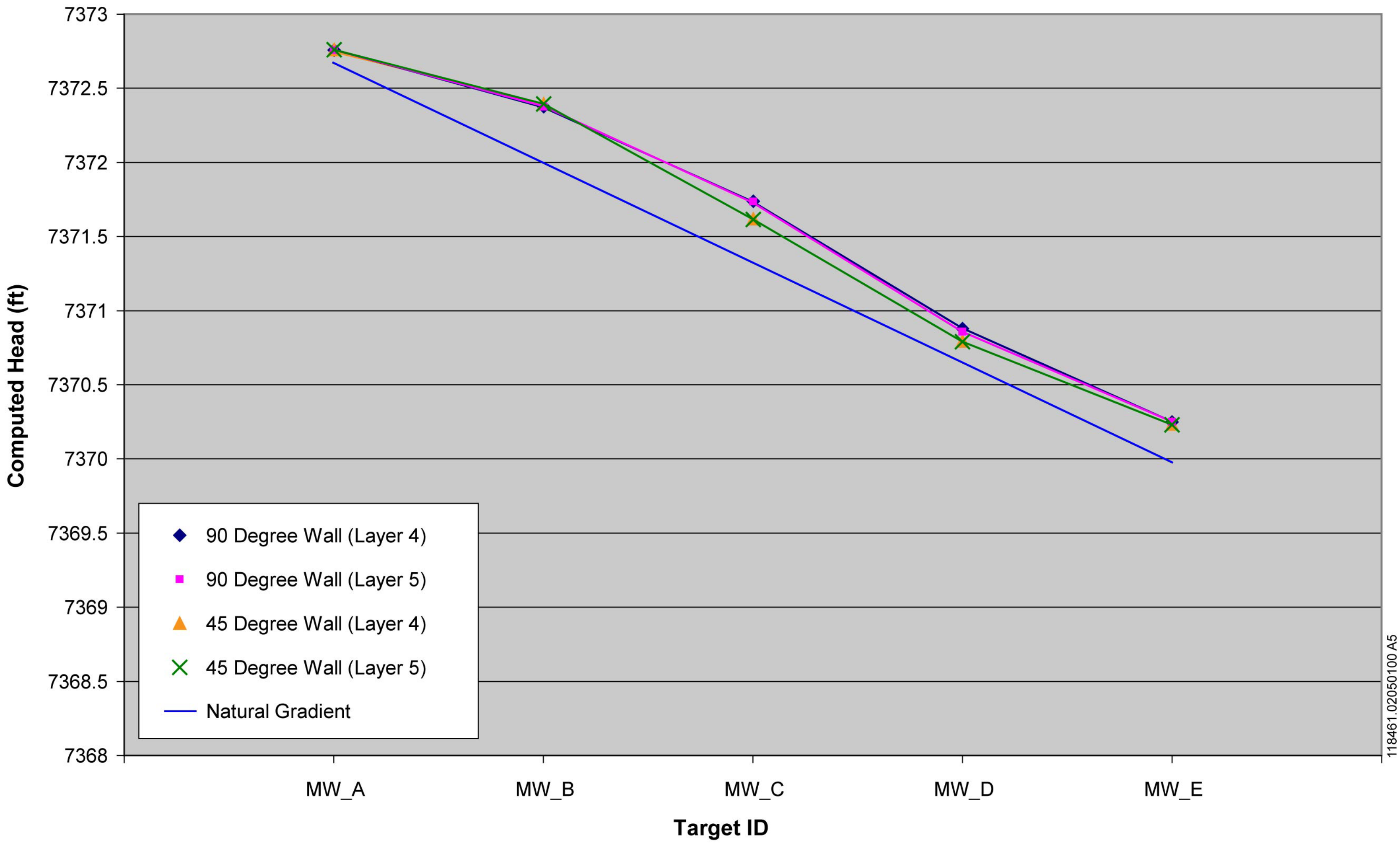


Figure B3-7 Steady-state model target results (layers 4 and 5), 3.0-ft saturated thickness, Cañon de Valle Pilot PRB

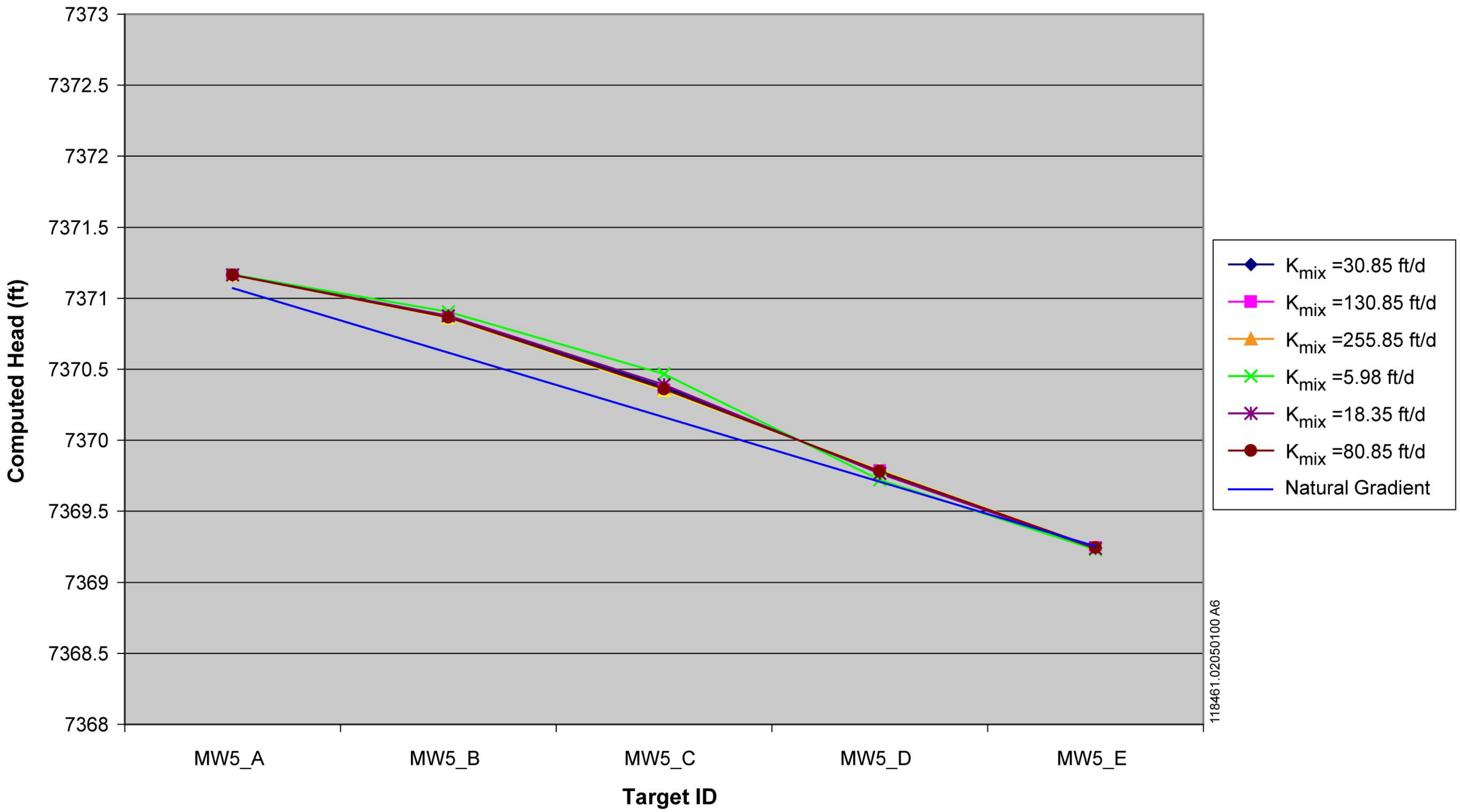


Figure B3-8 Steady-state model results (layer 5), $K_{aquifer}$ = 1.0 ft/d, Cañon de Valle Pilot PRB

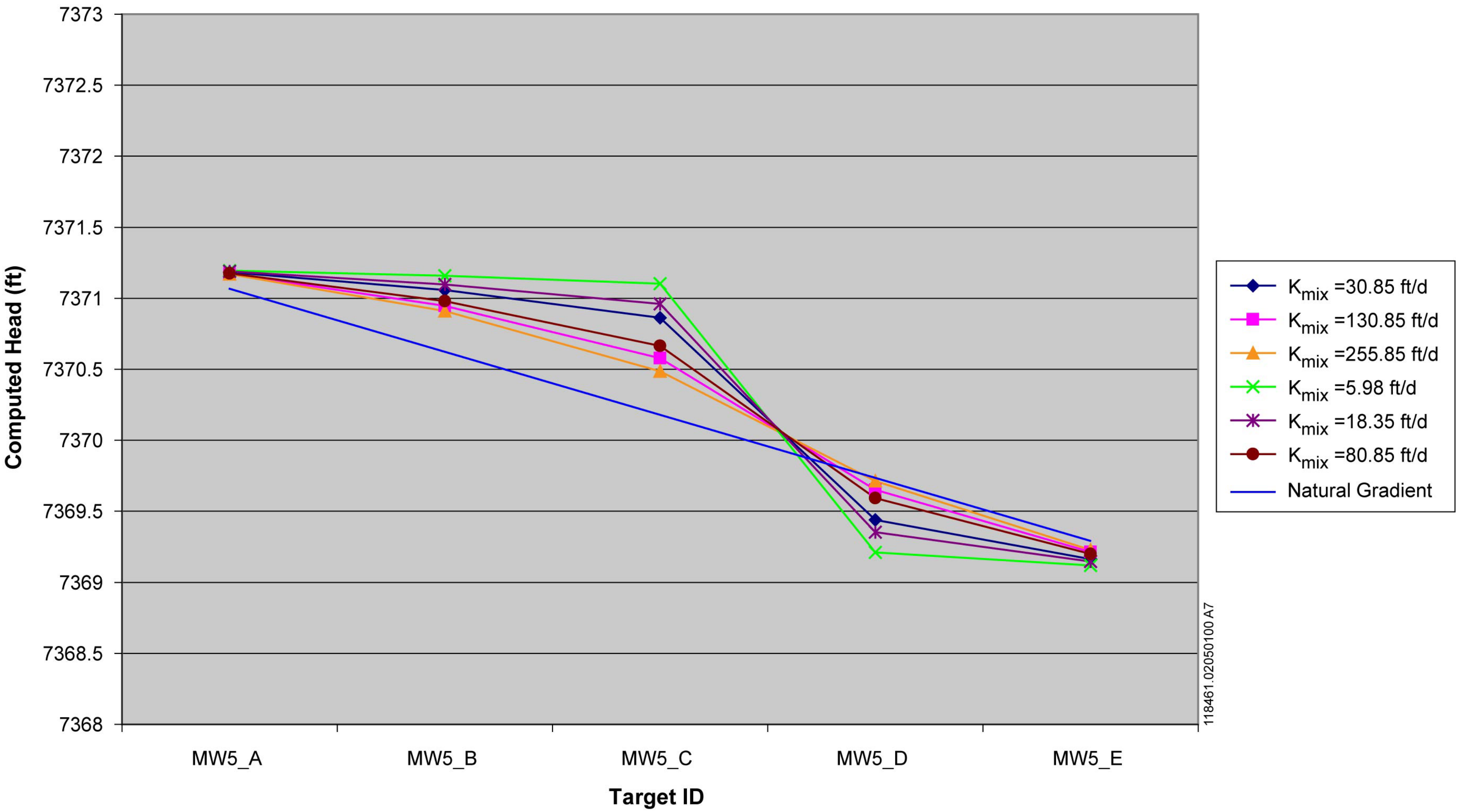


Figure B3-9 Steady-state model results (layer 5), $K_{aquifer}$ = 50.0 ft/d, Cañon de Valle Pilot PRB

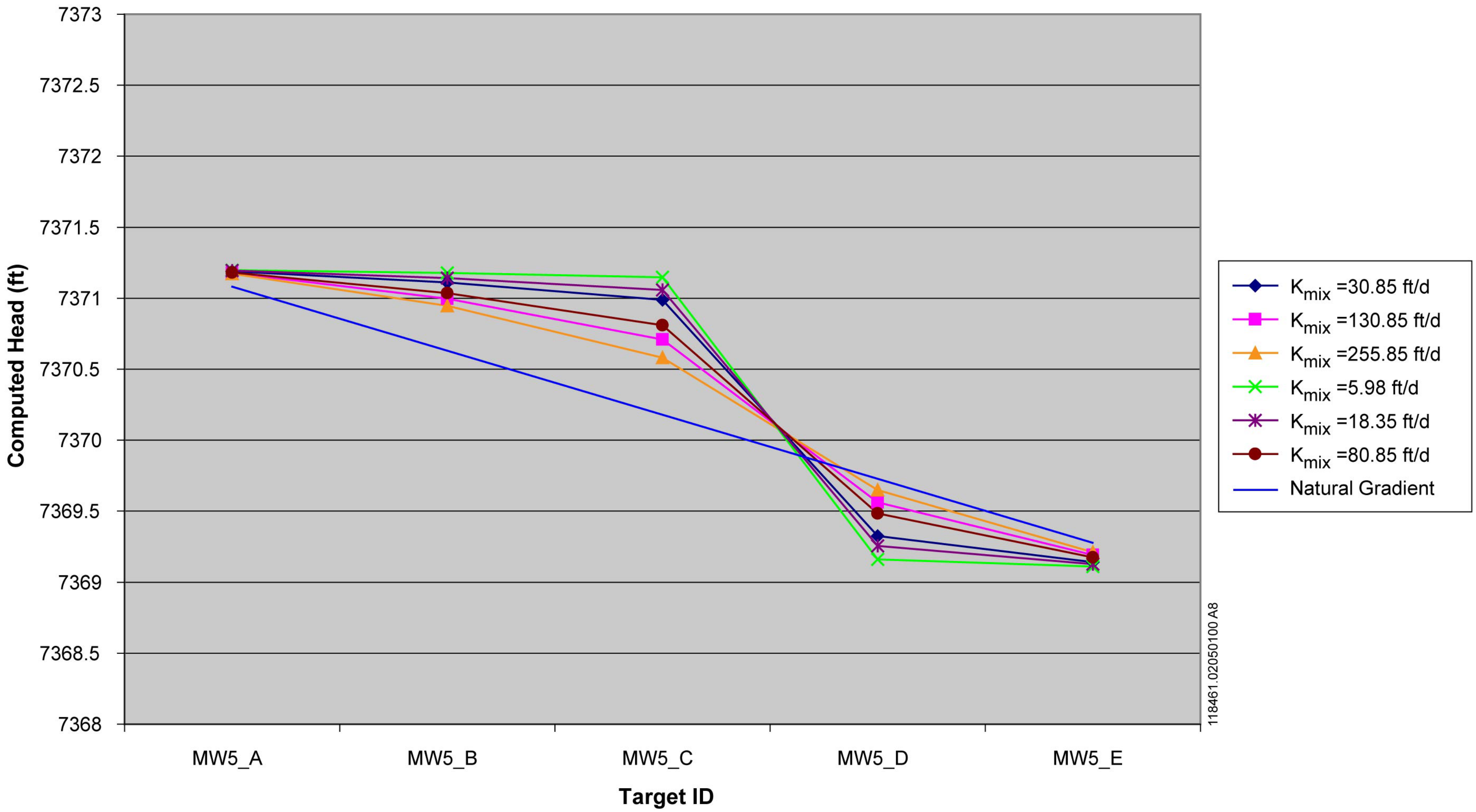


Figure B3-10 Steady-state model results (layer 5), $K_{aquifer}$ = 100.0 ft/d, Cañon de Valle Pilot PRB

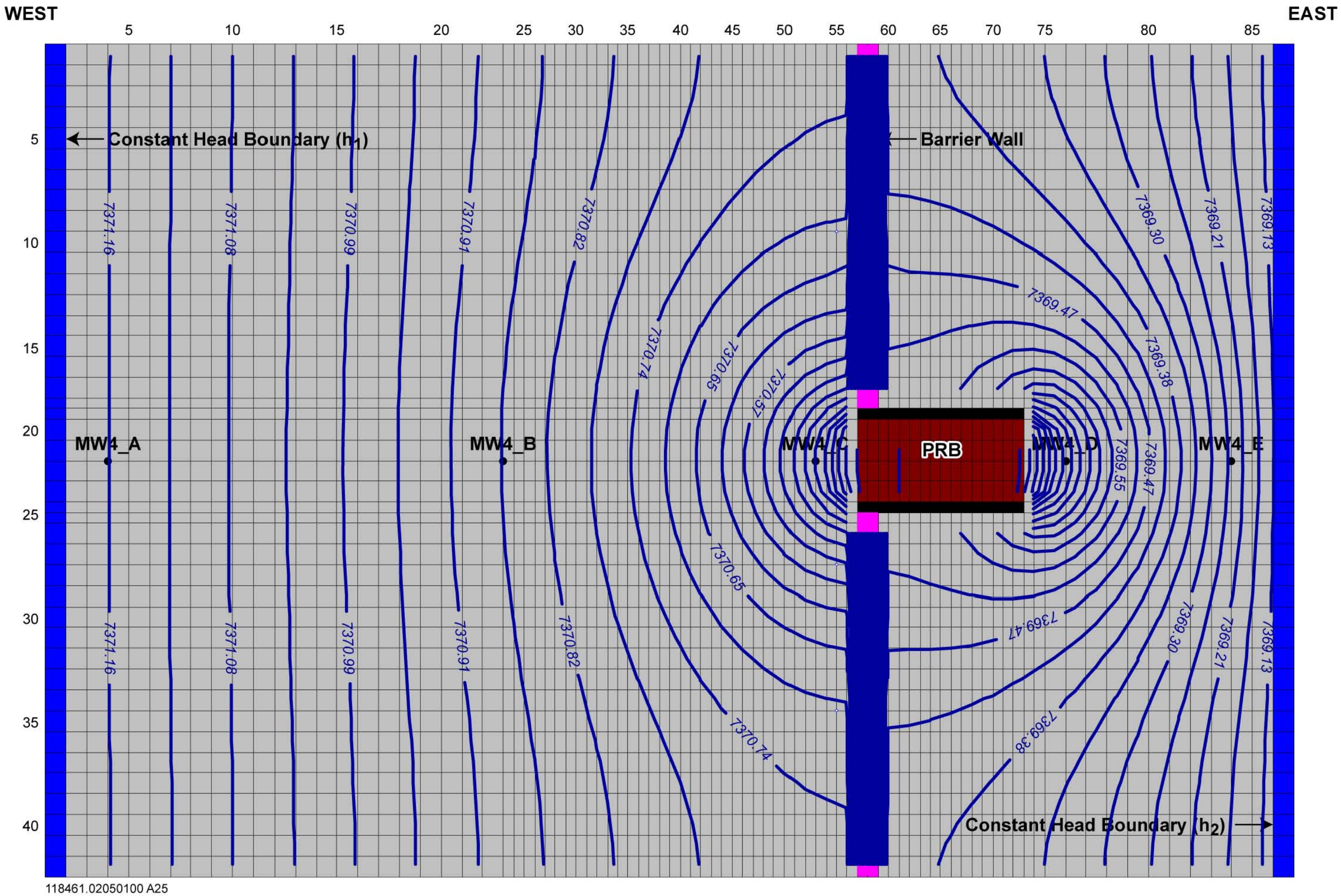


Figure B3-11 Head contour results for steady state, Cañon de Valle Pilot PRB

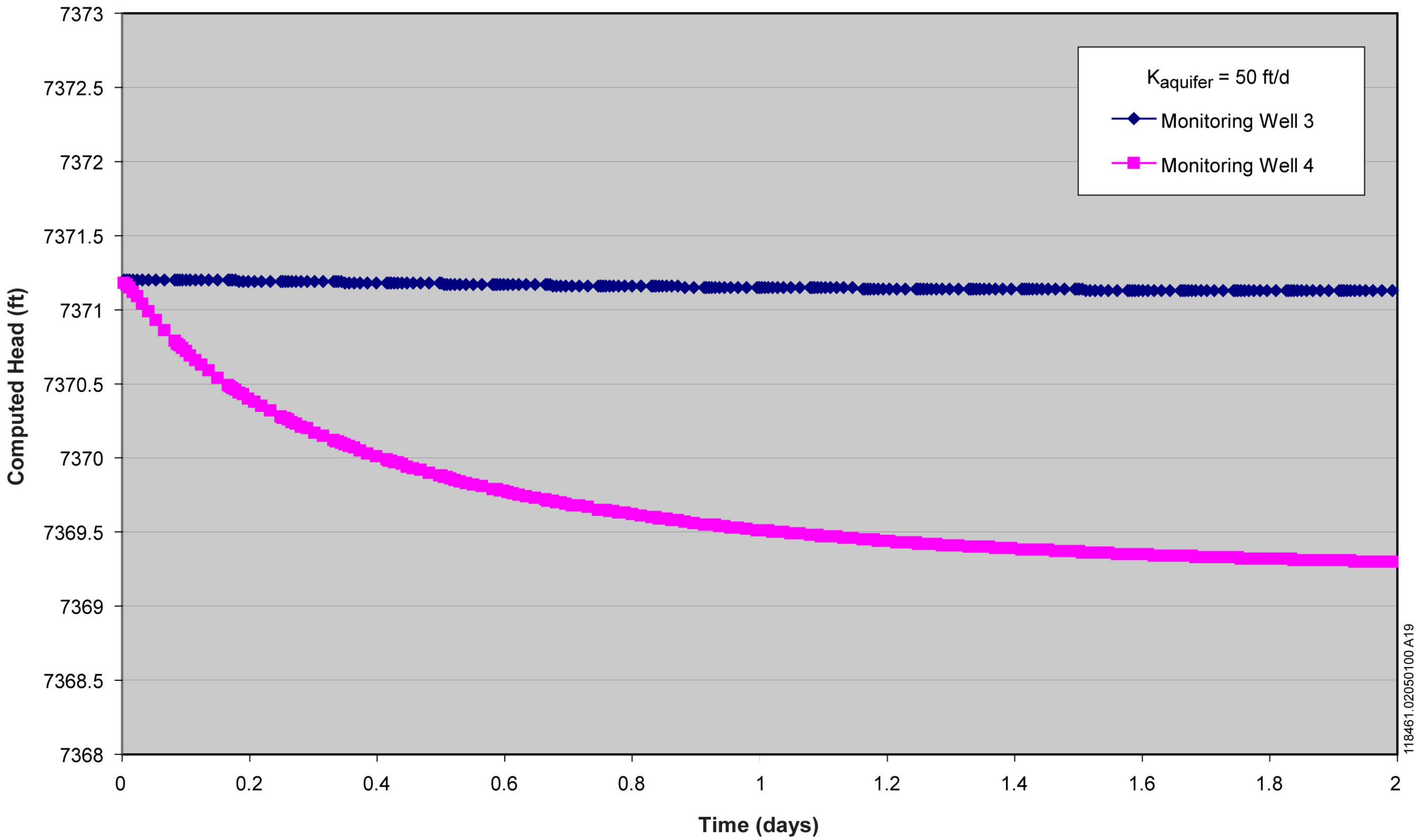


Figure B3-12 Transient model results (layer 5), 2.0-ft saturated thickness, Cañon de Valle Pilot PRB

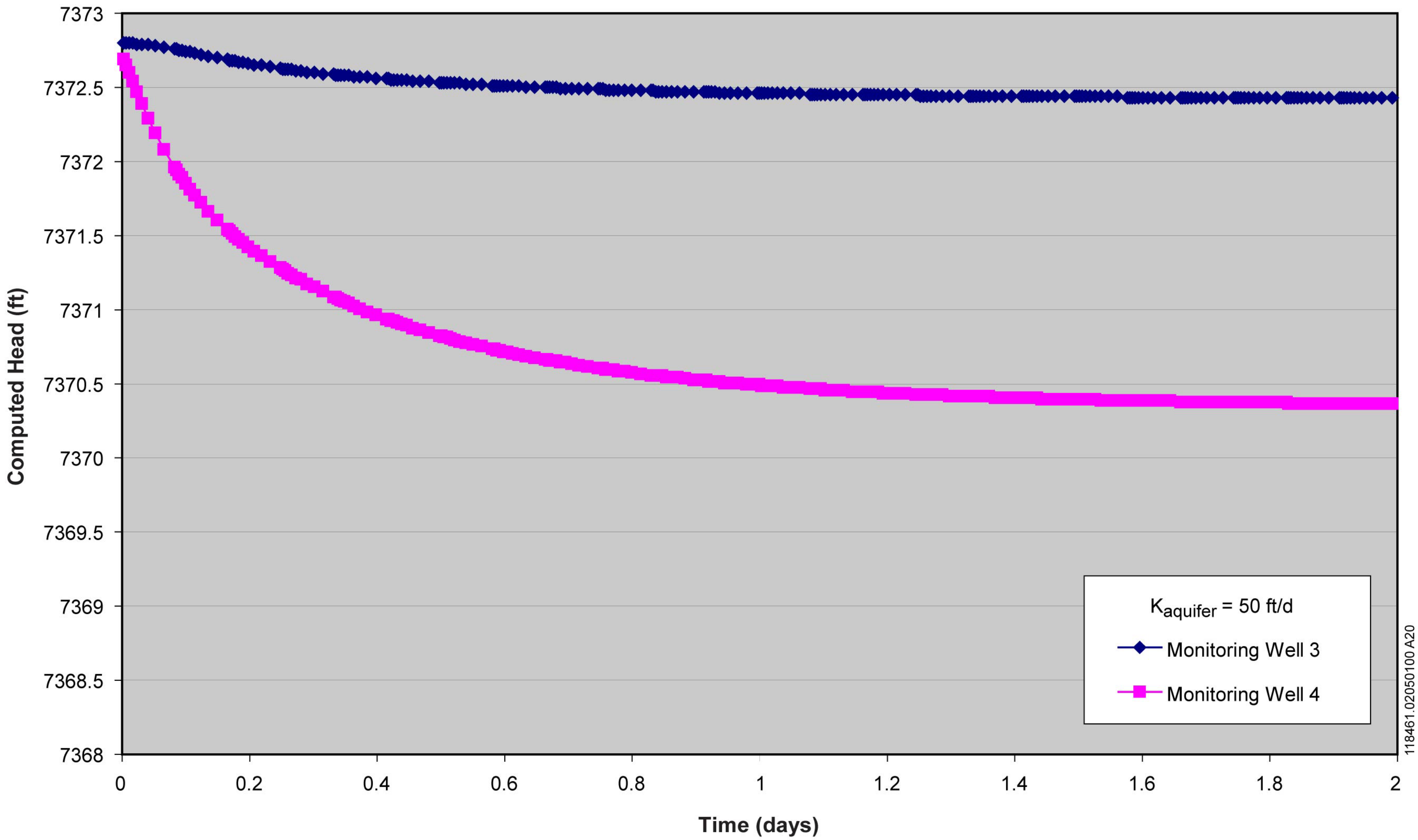


Figure B3-13 Transient model results (layer 5), 3.0-ft saturated thickness, Cañon de Valle Pilot PRB

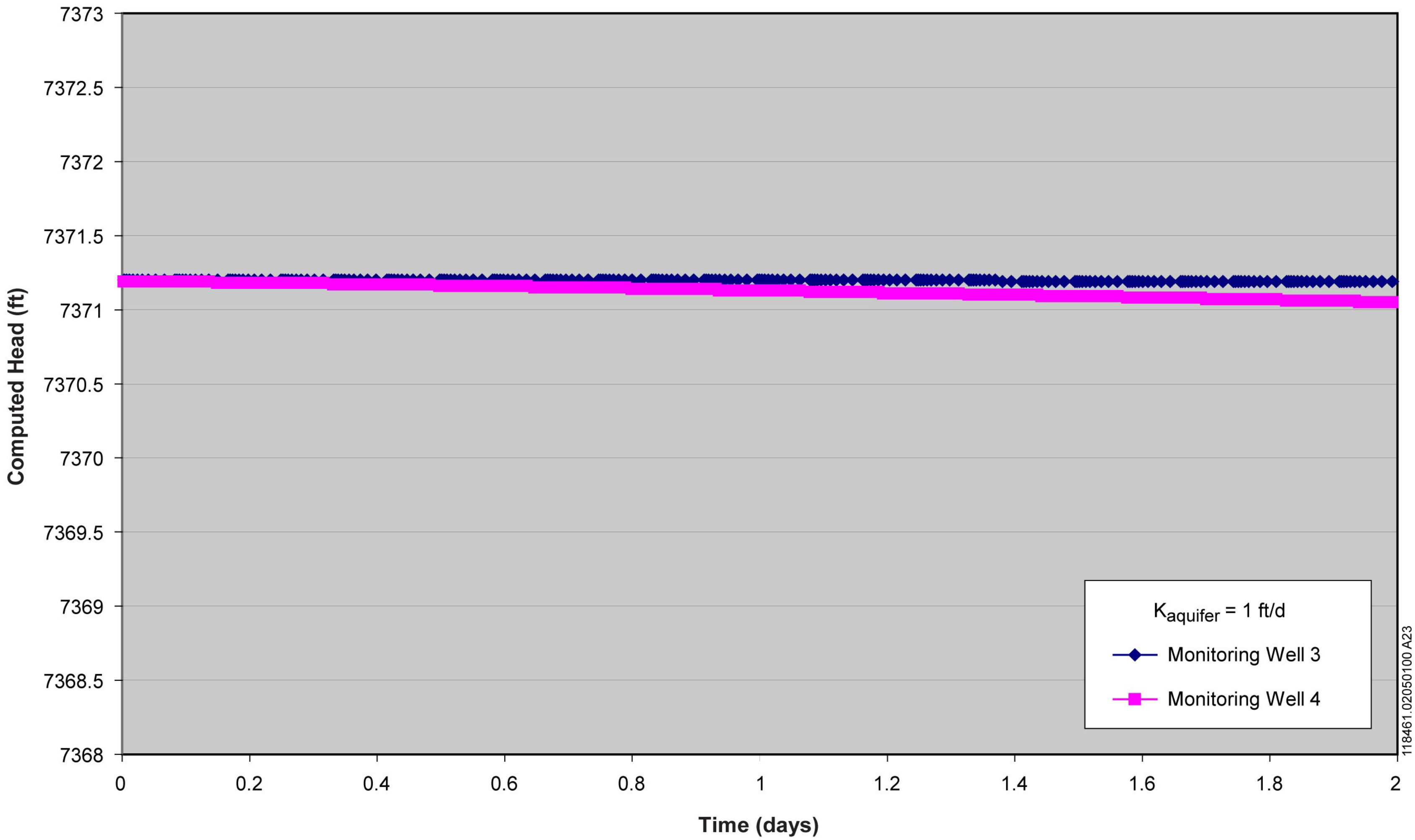


Figure B3-14 Transient model results (layer 5), 2.0-ft saturated thickness, Cañon de Valle Pilot PRB

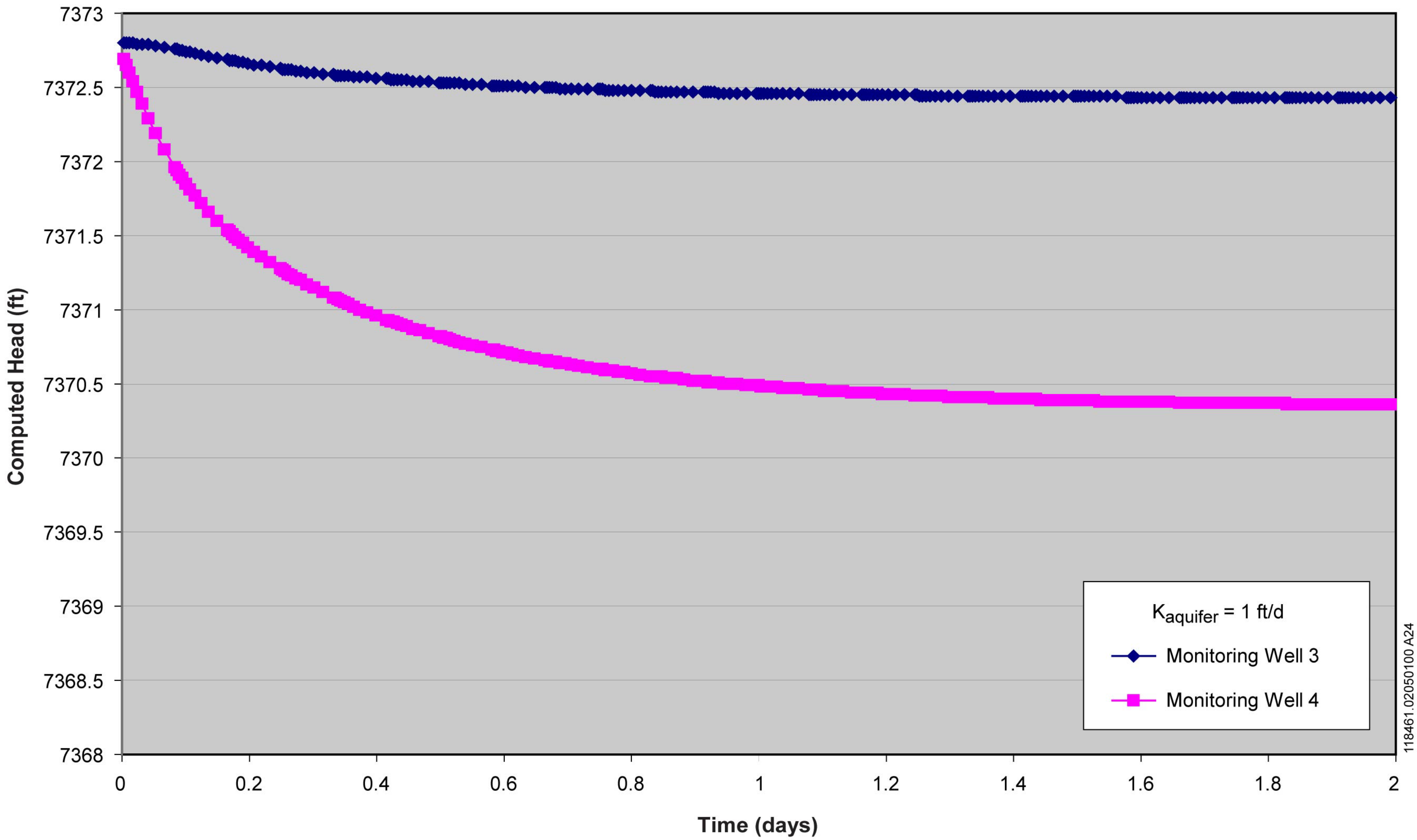


Figure B3-15 Transient model results (layer 5), 3.0-ft saturated thickness, Cañon de Valle Pilot PRB

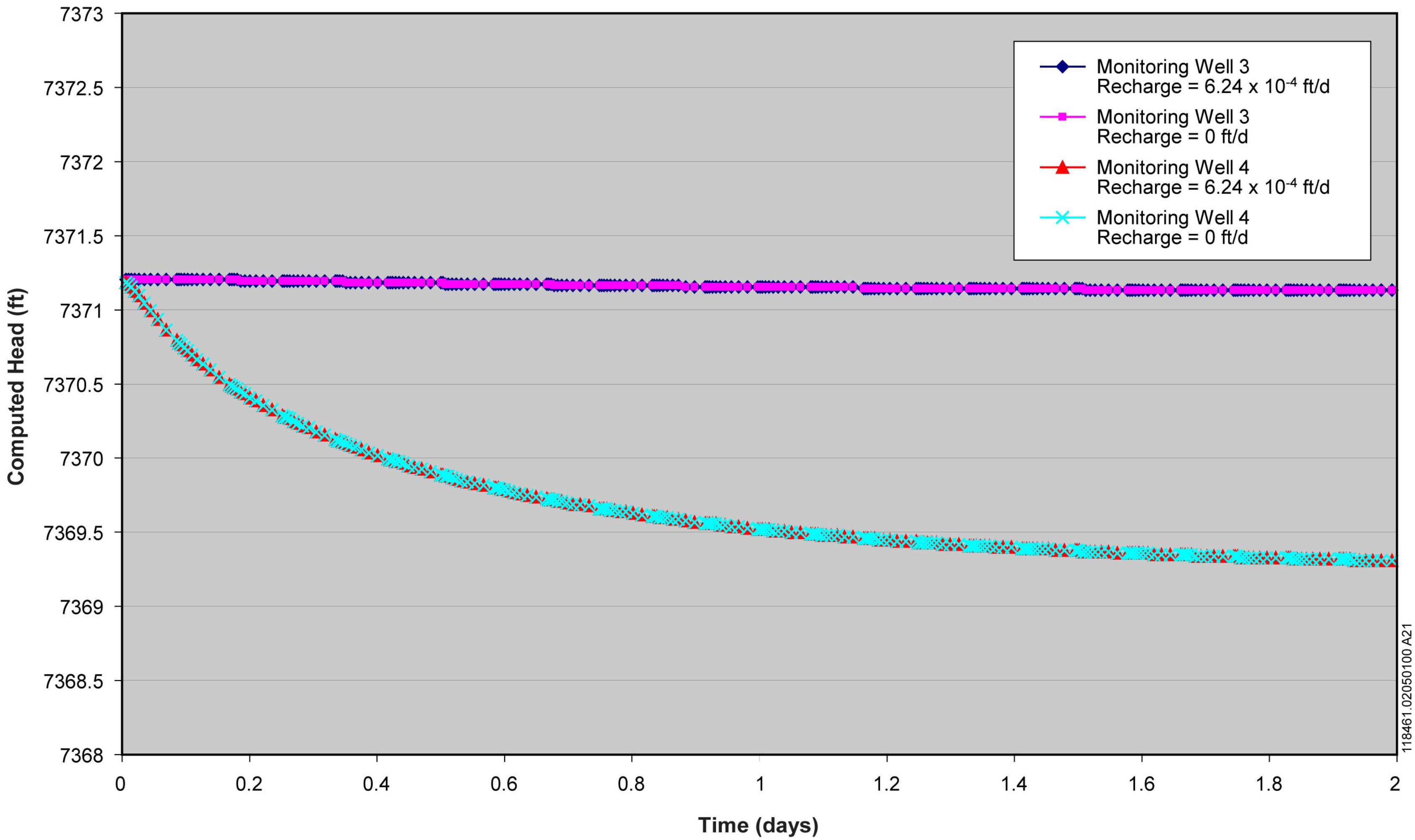


Figure B3-16 Transient results with recharge (layer 5), 2.0-ft saturated thickness, Cañon de Valle Pilot PRB

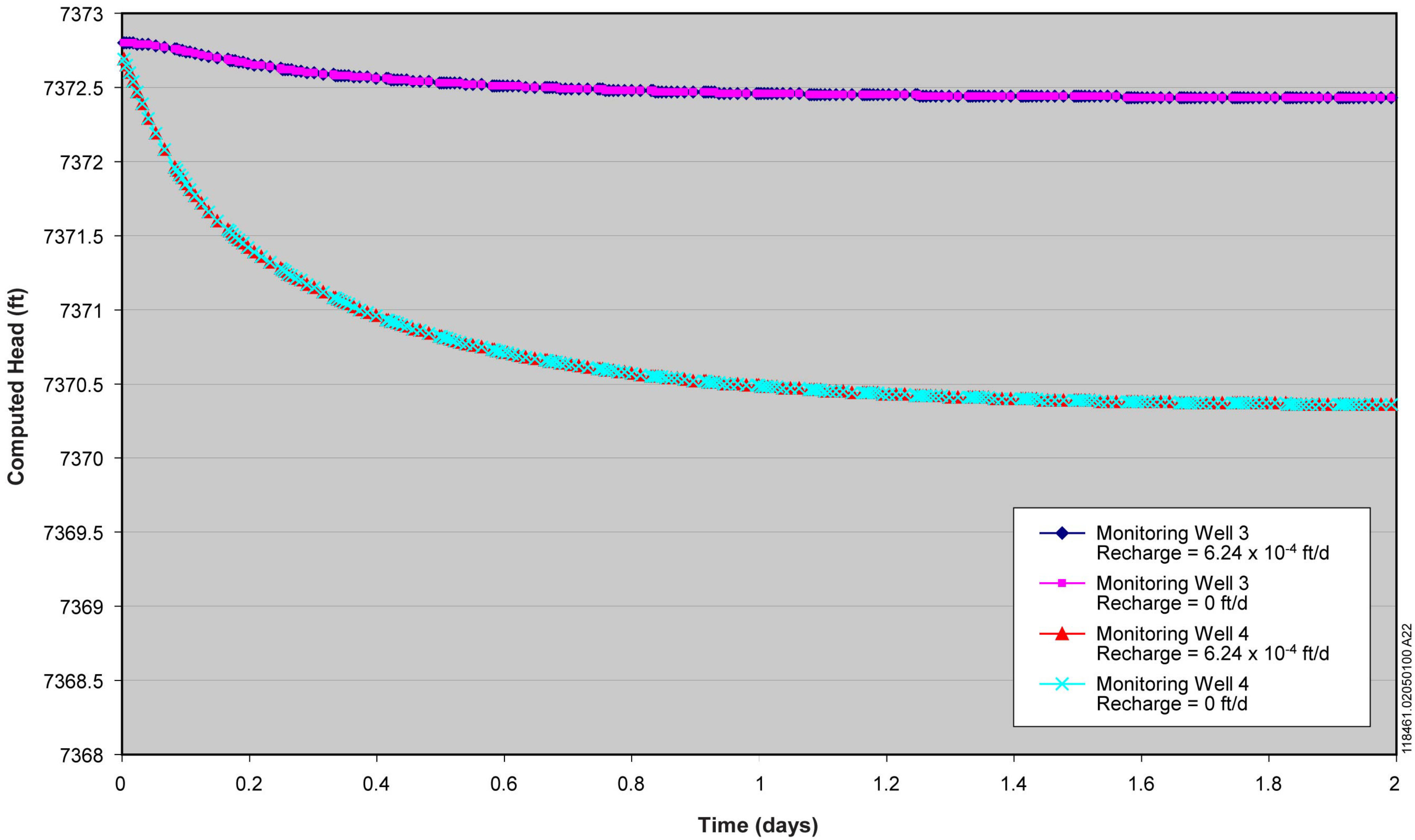


Figure B3-17 Transient results with recharge (layer 5), 3.0-ft initial saturated thickness, Cañon de Valle Pilot PRB

Table B3-1
Material Hydraulic Conductivity Values
Cañon de Valle Pilot Permeable Reactive Barrier
Los Alamos National Laboratory, Los Alamos, New Mexico

	Aquifer Conductivity (ft/d)	ZVI and Sand (50:50 mix) Conductivity (ft/d)	Zeolite and Sand (50:50 mix) Conductivity (ft/d)
K_1*	1	50	100
K_2	30.85	130.85	255.85
K_3	5.98	18.35	80.85

*K = Hydraulic conductivity.

Attachment B3-1

Calculations

Shaw Shaw Environmental & Infrastructure, Inc.

FINAL

By JMPietz	Date 12/20/06	Subject Calculation of Water Level Trends in Cañon de Valle Alluvial Well 16-2658	Sheet No. 1 of 2
Chkd. By DWK	Date 01/11/07		Proj.No. 118461.020301

Purpose

The purpose of this calculation brief is to calculate several water level trends from existing data, including thickness of alluvial water above the tuff interface and depth to water.

Abstract

The purpose of this calculation brief is to calculate several water level trends from existing data, including thickness of alluvial water above the tuff interface and depth to water. Maximum thickness of the water above the tuff interface was 2.95 feet. Minimum depth to water from the ground surface was 2.45 feet.

Background

Cañon de Valle (CdV) alluvial well 16-2658 is in the immediate vicinity of the pilot permeable reactive barrier (PRB) to be installed in CdV. To properly size the PRB, the historical trends in alluvial water thickness are required for this well.

Assumptions

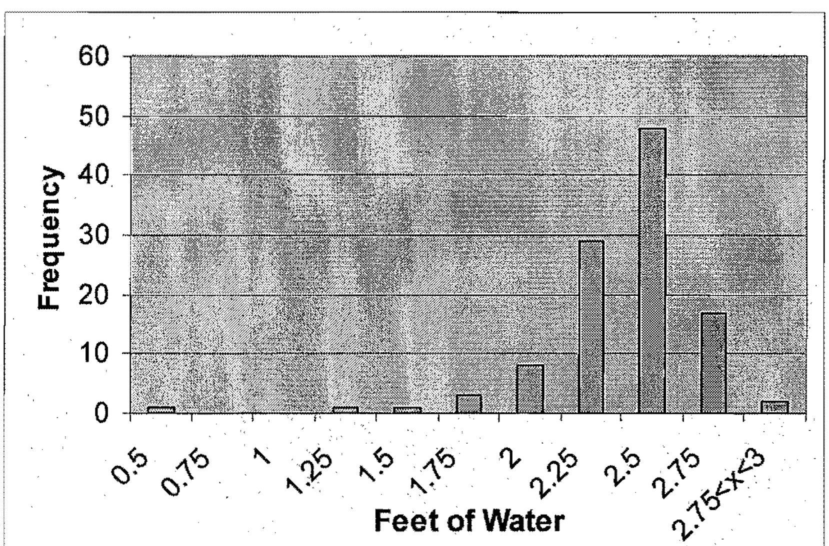
1. Water level data (Reference 1) from 1998-2002 are representative of future water levels at this location.
2. Because of the absence of ground surface survey data, the boring log for 16-2658 in Reference 2 is accurate.
3. Top of casing data for 16-2658 is accurate as presented in Reference 3.

Methodology

Calculate statistics on the thickness of water in well 16-2658 using a spreadsheet. Several dates may have two measurements, but these measurement do not differ significantly (within 0.01 feet), and so one is deleted.

Results

Figure 1 Histogram of Water Thickness Above Tuff Interface, Well 16-2658



Shaw
Shaw Environmental & Infrastructure, Inc.

FINAL

By JMPietz Date 12/20/06 Subject Calculation of Water Level Trends in Cañon de Valle Alluvial Well 16-2658 Sheet No. 2 of 2
Chkd. By DWR Date 01/11/07 Proj.No.118461.020301

Table 1 Summary of Water Level Statistics, Well 16-2658

	Water Thickness Above Tuff Interface, ft	Depth to Water from Surface, ft
Average	2.27	3.13
min	0.50	2.45
max	2.95	4.90
stdev	0.33	0.33
median	2.33	3.07

References

1. Manual Alluvial Well Data.xls Excel Database, 1998-2002
2. RFI Report for Potential Release Site 16-021(c) LA-UR-98-4101 September 1998
3. Kevin Reid to John Pietz, Personal Communication November 9, 2006

Shaw
Shaw Environmental & Infrastructure, Inc.

FINAL

By JMPietz	Date 12/26/06	Subject Calculation of Average Groundwater Gradient in Alluvial Well 16-2657, 16-2658, and 16-2659	Sheet No. 1 of 1
Chkd. By DMR	Date 01/16/06		Proj.No. 118461.020301

Purpose

The purpose of this calculation brief is to calculate the average hydraulic gradients in the vicinity of the pilot permeable reactive barrier (PRB) to be installed in Cañon de Valle.

Abstract

The purpose of this calculation brief is to calculate the average hydraulic gradient in the vicinity of the pilot PRB in Cañon de Valle using wells 16-2657, 16-2658, and 16-2659. For the 16-2657/16-2658 well pair, the average gradient was 0.046. For the 16-2658/16-2659 well pair, the average gradient was 0.044.

Background

Cañon de Valle (CdV) alluvial wells 16-2657, 16-2658, 16-2659 are in the vicinity of the pilot PRB to be installed in CdV. To properly model groundwater flow in the PRB, the historical groundwater gradients are required for this region of CdVl.

Assumptions

1. Water level data (Reference 1) from 1998-2002 are representative of future gradients for the PRB location.

Methodology

Calculate statistics on the gradient between 16-2657 and 16-2658, and 16-2658 and 26-2659. Use the map from Reference 2 for distances between these well pairs. Use top of casing data from reference 3. Delete duplicate dates from the water level data. Number of points in the calculation may be limited by the available dates.

Results

Table 1 Summary of Alluvial Groundwater Gradients, 1998-2002

	2657-2658	2658-2659
Average	0.046	0.044
Min	0.044	0.043
Max	0.048	0.045

References

1. Manual Alluvial Well Data.xls Excel Database, 1998-2002
2. Map "Select TA-16 Location IDs", May 7, 2003
3. Kevin Reid to John Pietz, Personal Communication November 9, 2006

Attachments: CdV Alluvial Well Gradient Spreadsheet.xls

Shaw Environmental & Infrastructure, Inc.

FINAL

By JMPietz Date 12/27/06 Subject Calculation of Average Groundwater Flowrate Near Alluvial Well 16-2658 Sheet No. 1 of 2

Chkd. By JMK Date 03/12/07 Proj.No. 118461.020301

Purpose

The purpose of this calculation brief is to calculate the average alluvial groundwater flowrate in the vicinity of the pilot permeable reactive barrier (PRB) to be installed in Cañon de Valle.

Abstract

The purpose of this calculation brief is to calculate the average alluvial groundwater flowrate in the vicinity of the pilot PRB in Cañon de Valle using wells 16-2657, 16-2658, and 16-2659. The average groundwater gradient and saturated thickness in this area were previously calculated (references 1 and 2). The results show the average groundwater flowrate is approximately 24 gallons per day and the maximum is approximately 31 gallons per day.

Background

Cañon de Valle (CdV) alluvial well 16-2658 is in the vicinity of the pilot PRB to be installed in CdV. To properly model groundwater flow in the PRB, the historical alluvial groundwater flowrate in this area should be estimated.

Assumptions

1. Water level data (Reference 1) CdV alluvial well 16-2658 from 1998-2002 are representative of the saturated thickness near the pilot PRB.
2. Hydraulic gradients from nearby wells (Reference 2) from 1998-2002 are representative of the local groundwater gradient near the pilot PRB.
3. The alluvial aquifer width is approximately 40 feet wide (40 feet will be used), based on seismic refraction data (Reference 5) and the approximate width of the channel which contains the stream.
4. Hydraulic conductivity in the vicinity of the pilot PRB (well 16-2658) is 2.72E-04 cm/sec (from Reference 4).

Methodology

Use Darcy's Law to calculate the groundwater flowrate for the minimum, maximum and average saturated thicknesses (from Reference 1). Darcy's Law is

By Darcy's Law [Reference 3, page 28], the flowrate is:

$$Q = -KiA$$

where

Q = flowrate, ft^3/sec

K =hydraulic conductivity, ft/s

i =hydraulic gradient, ft/ft

A =cross sectional area, ft^2

K=2.72E-04 cm/sec (Reference 4) or 2.72E-06 m/sec. Convert to ft/sec: 2.72E-06 m/sec * 3.28 = 8.92E-6 ft/sec (see page 29, reference 3).

For i, take average of gradients from well pairs 2657-2658 and 2658-2659: 0.046+0.044/2=0.045 from reference 2.

From assumption 3, the width of the alluvium at alluvial well 2658 (MW-2658 in Reference 5) is approximately 40 feet. For A, use 40 feet with the following aquifer thicknesses (reference 1): 2.27 feet (average), 0.5 feet (minimum), and 2.95 feet (maximum)

Results

Table 1 Summary of Groundwater Flowrates, 1998-2002

Aquifer Width (ft)	Aquifer Thickness (ft)	Gradient	Conductivity (ft/sec)	Flowrate (ft3/s)	Flowrate (ft3/day)	Flowrate (gal/day)	Flowrate (gal/min)
40	2.27	0.045	8.92E-06	3.64E-05	3.149	23.555	0.016
40	0.5	0.045	8.92E-06	8.03E-06	0.694	5.188	0.004
40	2.95	0.045	8.92E-06	4.74E-05	4.092	30.611	0.021

References

1. Calculation of Water Level Trends in Cañon de Valle Alluvial Well 16-2658, calculation brief. 12/20/06, Project # 118461.020301, Shaw Environmental, Inc
2. Calculation of Average Groundwater Gradient in Alluvial Well 16-2657, 16-2658, and 16-2659, , calculation brief. 12/26/06, Project # 118461.020301, Shaw Environmental, Inc
3. Groundwater, Freeze, R.A. and J.A. Cherry, 1979, Prentice Hall
4. Personal Communication, Don Hickmott to John Pietz, Transmittal of Preliminary Slug Test Results, December 22, 2006
5. Report on Geophysical Surveying at Cañon de Valle TA-16 Los Alamos National Laboratory, Project 2001-048, by HydroGeophysics, Inc, 2302 N. Forbes Blvd. Tucson, AZ 85745 for IT Corporation PO#179131 2001

Attachments:

Pilot PRB Groundwater Flowrate.xls

Appendix C

Consolidated Unit 16-021(c)-99
Technical Area 16-260 Surge Bed Investigations

C-1.0 INTRODUCTION

This field summary report documents the March 2007 drilling investigation conducted at the Technical Area 16 (TA-16) 260 Outfall area. The principal goal of the investigation was to document the lateral extent of high explosives (HE) contamination previously identified in a surge bed at borehole (BH) 16-02700. The following regulatory documents directed this work:

1. “Notice of Approval, Proposal to Drill Boreholes to Support the Corrective Measures Study and Remedy Selection at Solid Waste Management Unit (SWMU) 16-021(c) Los Alamos National Laboratory, EPA ID #NM0890010515 HWB-LANL-03-021” (NMED 2006, 093551)
2. “Response to Informal Requests for Supplemental Information on the TA-16-260 Outfall [Consolidated Unit 16-021(c)-99] Corrective Measure Study, issued by LANL to the NMED, May 2006” (LANL 2006, 092554)
3. “Investigation Work Plan for Consolidated Solid Waste Management Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line) at Technical Area 16” (LANL 2005, 089331)
4. “Response to the Notice of Disapproval for the Investigation Work Plan for Consolidated SWMUs 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line) at Technical Area 16, Los Alamos National Laboratory, EPA-ID #NM0890010515 HWB-LANL-05-004, Rev. 1, issued by LANL to the NMED, August 2005” (LANL 2005, 089653)
5. “RE: Approval of the Investigation Work Plan for Consolidated SWMUs 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line) at Technical Area 16, Los Alamos National Laboratory, EPA-ID #NM0890010515 HWB-LANL-05-004” (NMED 2005, 091672)

Site Description

A highly contaminated surge bed located at a depth of 17.5 ft below ground surface (bgs) was sampled in 1997 from borehole (BH) 16-02700. Samples from BHs within 100 ft of BH 16-02700 indicated the highly contaminated surge bed was discontinuous to the south, north, and east. No BHs were located west of BH 16-02700, and additional BHs to the east were necessary to define the lateral extent of the contaminated surge bed. The New Mexico Environment Department (NMED), the U.S. Department of Energy (DOE), and Los Alamos National Laboratory (LANL or the Laboratory) representatives toured the site on December 2, 2005, and decided to drill three shallow (30 ft deep) BHs to the northwest, southwest, and east of BH 16-02700 (Figure C-1.0-1). These three BHs would sufficiently bound the extent of the highly contaminated surge bed.

C-2.0 GENERAL FIELD PROCEDURES

C-2.1 Field Personnel

Table C-2.1-1 lists the building 16-260 outfall area drilling field team members. All field team members who were on-site during each workday are listed in the field log notebook.

C-2.2 Health and Safety

The activities, work steps, hazards, and hazard controls associated with the building 260 Outfall area drilling are set forth in the integrated work document (IWD) for TA-16 Ponds characterization and the characterization of TA-16 Ponds site-specific health and safety plan (SSHASP). All work was performed according to the most current revisions of the applicable Environment Programs Directorate standard operating procedures (SOPs).

Before initiation of the project, all active field personnel were required to sign a statement acknowledging that they had read, understood, and agreed to abide by the TA-16 Ponds IWD and SSHASP. Additionally, employee records were evaluated to ensure that all training requirements were current.

As required by the SSHASP, daily tailgate safety meetings were conducted before fieldwork begins to ensure the scheduled field activities of the day were understood, all potential hazards were identified, and all appropriate safety controls were defined and in place. In addition to the daily tailgate meeting, the equipment user and/or site safety officer (SSO) was responsible for completing a variety of field forms including daily drill rig inspection checklist, daily safety inspection checklist, daily heavy equipment inspection checklist, forklift inspection, and spark and flame permits, depending on the objectives identified in the tailgate safety meeting.

C-3.0 OBJECTIVES

The objective of the investigation was to identify the lateral extent of HE contamination previously sampled from BH 16-02700 in surge bed material. To accomplish this objective, three BHs were drilled to a depth of 30 ft bgs. The locations of the BHs were within 80 ft of BH location 16-02700 (Figure C-1.0-1). The BHs were geologically logged with special emphasis on the identification of surge beds. Downhole video and gamma logging were also performed to identify surge beds in the case of incomplete core recovery from core barrel sampling and drilling. Surge bed should have a low gamma signal because of their high coarse grain content and attendant low concentrations of gamma-emitting elements such as potassium, thorium, and uranium. Field screening for RDX [research department explosive (hexahydro-1,3,5-trinitro-1,3,5-triazine)] was conducted at 5-ft intervals for the top 15 ft and at 2-ft intervals for the bottom 15 ft of each BH. Results from the RDX field screening were used to bias analytical sample selection. As directed by the guidance documents (LANL 2006, 092554; NMED 2006, 093551), analytical samples were preferentially selected by the following criteria: (1) surge bed material; (2) elevated RDX screening results; (3) projected elevation of previously sampled surge bed material at BH 16-2700; and (4) total depth of the BH.

C-4.0 FIELD PREPARATIONS

Readiness reviews were conducted in preparation for TA-16 building 16-260 Outfall area drilling on July 20 and November 21, 2006, and February 28, 2007, to ensure all documentation, permitting, authorization, and planning were complete before mobilization. The following documents were prepared by C/P/E Environmental Services, LLC, and were subsequently approved by the Subcontract Technical Representative and affected Laboratory organizations: the investigation work plan (LANL 2005, 089653), the field implementation guidance document, SSHASP, waste characterization strategy form (WCSF), and readiness review checklist.

C-5.0 FIELD INVESTIGATION RESULTS

Field activities for the building 16-260 Outfall area drilling began on March 1, 2007, and were completed on April 20, 2007. All activities were conducted in accordance with applicable Environmental Programs SOPs, quality procedures, Laboratory implementation requirements, Laboratory implementation guidance, and Laboratory performance requirements. Daily activities performed were documented in field log notebooks.

C-5.1 Drilling Activities

Drilling began on March 2, 2007, and was completed on March 4, 2007. The BHs were drilled using a Central Mine Equipment 85 hollow-stem auger (HSA) drill rig. HSA drilling utilized 4.25-in.-inside-diameter (I.D.) augers with a 9-in. cutter head bit and a continuous core sampling system. The continuous core sampling system consisted of a 3-in. I.D., split-barrel, core sampler retrieved with hex rods. Approximately 80% to 90% core was recovered using this system.

Surface casing (10-in.-I.D. and 10-ft length) was installed at BHs 16-27665 and 16-27666 to facilitate geophysical logging and to keep the BH open for future use. For BH 16-27667, a temporary 4-ft section of casing was installed to the bedrock surface. BH 16-27667 is located in the main outfall drainage and will be plugged and abandoned following completion of BH logging to prevent any infiltration from the drainage channel. Figure C-5.1-1 shows drilling and access to BH 16-27667.

No groundwater was encountered during drilling activities; therefore, no groundwater monitoring wells were installed and no groundwater samples were collected.

C-5.2 Borehole Logging

Lithological core logs were prepared in accordance with SOP-12.01, Field Logging, Handling, and Documentation of BH Materials. The logs contain lithological descriptions, field-screening results, sample numbers, and significant events that occurred during the drilling process. Unsampled core was archived and stored in the field trailers for possible future review. The boring logs are presented in Attachment C-1.

C-5.3 Field Screening

The SSO screened all recovered core samples for volatile organic compounds (VOCs). Organic vapor monitoring was performed using a MiniRae 2000, Model PGM-7600 photoionization detector (PID) with an 11.7-electron volt bulb to monitor the core immediately after opening the core barrels. Screening was conducted in accordance with SOP-06.33, Headspace Vapor Screening with a PID. The workers' breathing zone was also monitored. No elevated PID readings were recorded in core material or in the breathing zone; the results are presented in the boring logs (Attachment C-1).

Screening for RDX was performed using Strategic Diagnostics, Inc. (SDI) field-screening kits. RDX field-screening samples were collected at 5-ft intervals in the upper 15 ft and at 2-ft intervals in the lower 15 ft of each BH. Specifically, 10 RDX field-screening samples were collected from each 30-ft BH at the following depths: 5, 10, 15, 17, 19, 21, 23, 25, 27, and 30 ft bgs. Figure C-5.3-1 lists the sample intervals and the corresponding results. RDX field-screening samples were analyzed using SDI DTECH field-screening test kits. The test results were interpreted using a reflective photometer called a DTECHTOR. The DTECHTOR displays the percent difference between the reference and sample colors, which corresponds to a specific concentration range (ppm) provided by SDI.

C-5.4 Subsurface Sampling

The three BHs were continuously cored. The subsurface sampling protocol used during this field investigation followed that stated in the NMED letter and the Laboratory’s response (LANL 2006, 092554; NMED 2006, 093551). The sampling priorities were as follows: (1) surge bed material; (2) elevated RDX screening results; (3) projected elevation of previously sampled surge bed material at BH 16-02700; and (4) total depth of the BH. Using these criteria, a minimum of two analytical samples were submitted from each BH. Table C-5.4-1 summarizes the subsurface samples collected. The analytical suite for all samples included VOCs, semivolatile organic compounds (SVOCs), target analyte list metals, NMED HE, and uranium.

Sample containers, sample labels, and quality assurance/quality control (QA/QC) samples were prepared in accordance with SOP-01.02, Sample Containers and Preservation, and SOP-01.05, Field Quality Control Samples. Samples were documented, handled, and shipped in accordance with SOP-01.03, Handling, Packaging, and Shipping of Samples, and SOP-01.04, Sample Control and Field Documentation. Samples were collected and submitted to the Sample Management Office (SMO) for laboratory analysis. Results of the fixed laboratory analyses are presented in Table C-5.4-2. The full data results are provided electronically as Attachment C-2 (on the CD included with this document).

All sample collection logs and chain-of-custody forms from samples collected during drilling operations are provided in Attachment C-3 (on the CD included with this document).

Sampling Selection Justification

Borehole Location 16-27665

As stated in the guidance document (NMED 2006, 093551), "…If no HE is detected during field screening, the laboratory samples would be collected from the deepest interval and the interval at the extrapolated depth of the surge bed in borehole 16-2700."

All 10 RDX field-screening results were below detection limits, and no surge bed material was identified in core material (Figure C-5.3-1). Two samples were collected from the deepest interval (29.5 to 30.0 ft bgs), and the extrapolated depth interval of the surge bed in BH 16-2700 following the sample selection protocols. According to boring logs and cross-sections from the Phase II Resource Conservation and Recovery Act facility investigation report for TA-16, SWMU 16-021(c) (LANL 1998, 059891), the HE-contaminated surge bed sample collected from BH 16-02700 was encountered at 15.5 to 17 ft bgs; BH 16-02700 has a surveyed elevation of approximately 7540 ft. According to contour maps of the building 260 area, the location of 16-27665 is approximately 5 ft upgradient of BH 16-2700, at an approximate elevation of 7545 ft. Therefore, the extrapolated depth of the surge bed/required sampling interval in BH 16-27665 is approximately 20.5 to 23 ft bgs.

Although a surge bed was not observed at extrapolated depth (20.5 to 23 ft bgs) in BH 16-27665, a clay-filled fracture was encountered at approximately 22.7 ft bgs, and an analytical sample was collected from 22.5 to 23 ft bgs. This sample meets the requirements specified in the letter to NMED (LANL 2006, 092554) and represents both the extrapolated depth of the surge bed described in BH 16-02700 and a clay-filled fracture.

Borehole Locations 16-27666 and 16-27667

As stated in the Laboratory's response letter (LANL 2006, 092554), "[l]aboratory samples for metals, HE, [VOCs], [SVOCs] and uranium would be collected and submitted from at least two intervals per [BH]–the deepest interval and the interval showing the highest HE based on field screening, as well as any surge bed materials."

No surge beds were identified in core material from BHs 16-27666 and 16-27667, but elevated RDX field-screening measurements were detected in both (Figure C-5.3-1). Therefore, the sampling requirements for BHs 16-27666 and 16-27667 are as follows: (1) sample the deepest interval (29 to 30 ft bgs), and (2) sample from the depth interval showing the highest HE (specifically RDX concentration) based on field-screening results.

The highest RDX field-screening result from BH 16-27666 was 1.5 to 3.0 ppm at 19 ft bgs. An analytical sample was collected from 19 to 20 ft bgs. The highest RDX field-screening measurement recorded from BH 16-27667 was 1.5 to 3.0 ppm at 15 ft bgs. An analytical sample was collected from 14 to 15 ft bgs. Total depth samples were collected from 29 to 30 ft bgs at BHs 16-27666 and 16-27667.

C-5.5 Downhole Gamma and Video Logging

Gamma and video surveys were completed at BHs 16-27665, 16-27666, and 16-27667 on April 20, 2007. Gamma surveys were used to measure gamma radiation from natural radioisotopes and are potentially helpful for identifying significant changes in lithology such as the transition from welded tuff to surge material. The three BHs were gamma-logged to identify the presence of surge bed deposits that may not have been identified (or recovered) in core material collected during drilling. BHs 16-26665, 16-26666, and 16-26667 were advanced 30 ft bgs into unit Qbt 4. BHs 16-26665 and 16-26666 were cased to approximately 10 ft bgs, and BH 16-26667 was cased to approximately 1 ft bgs. Gamma radiation measured in counts per second (cps) ranged from 150 to 200 cps in the open-hole portion of each BH. No anomalies were identified in the gamma logs. This finding confirms observations from the recovered core material where surge bed deposits were not identified, suggesting that no surge beds are present in intervals that were not recovered with the core-barrel sampler. The gamma data collected from the three BHs are presented in Figure C-5.5-1.

The camera-logging results are provided on the DVD included with this appendix (Attachment C-4). The camera images show fairly uniform ash flow tuff. An ashy matrix, occasional crystals, and pumice clasts are the primary lithologic features visible in the video. Caliper striations and the surface casing are also visible. No surge beds are visible in the three BHs.

C-5.6 Quality Assurance/Quality Control Sample Collection

QA/QC samples were collected in accordance with SOP-01.05 R.1, Field Quality Control Samples. For the six analytical samples submitted, one duplicate sample, one trip blank, and one field rinsate were submitted. The QA/QC samples were submitted to the SMO for fixed laboratory analyses. The results for each QA/QC sample are provided as Attachment C-2 on the CD included with this report.

C-6.0 WASTE MANAGEMENT

Solid waste generated during the investigation included the following four separate investigation-derived waste streams: (1) contact waste, including personal protective equipment, plastic, glass, disposable sampling supplies, and solid decontamination wastes; (2) borehole cuttings; (3) empty chemical containers from sample preservation and field screening; and (4) spent solvent and spent solvent/soil mixture from field screening. All wastes are being managed in accordance with the approved WCSF and amendments and are pending disposal.

C-7.0 DEVIATIONS

This drilling investigation was conducted in accordance with all specified documentation. No deviations occurred.

C-8.0 CONCLUSIONS

Three 30-ft BHs were drilled in the building 260 Outfall area. The locations of the three BHs surrounded a 1997 BH location where elevated levels of HE (4500 ppm of RDX) were previously sampled from a surge bed at 17.5 ft bgs. No evidence of surge beds was observed in core samples, downhole gamma logs, or downhole video logs. HE screening results and fixed analytical results both reported RDX concentrations of less than 3 ppm. The surge bed deposits and associated HE contamination do not extend more than 80 ft to the northwest, southeast, or east from BH location 16-02700.

C-9.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and ER ID number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Programs Directorate's Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; the U.S. Environmental Protection Agency, Region 6; and the Directorate. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

LANL (Los Alamos National Laboratory), September 1988. "Phase II RFI Report for Potential Release Site 16-021(c)," Los Alamos National Laboratory document LA-UR-98-4101, Los Alamos, New Mexico. (LANL 1998, 059891)

LANL (Los Alamos National Laboratory), March 2005. "Investigation Work Plan for Consolidated Solid Waste Management Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line) at Technical Area 16," Los Alamos National Laboratory document LA-UR-05-1694, Los Alamos, New Mexico. (LANL 2005, 089331)

LANL (Los Alamos National Laboratory), August 5, 2005. "Response to Notice of Disapproval for the Investigation Work Plan for Consolidated Solid Waste Management Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line) at Technical Area 16, Los Alamos National Laboratory, EPA-ID #NM0890010515, HWB-LANL-05-004 Revision 1," Los Alamos National Laboratory document LA-UR-05-5178, Los Alamos, New Mexico. (LANL 2005, 089653)

LANL (Los Alamos National Laboratory), May 26, 2006. "Response to Informal Requests for Supplemental Information on the TA-16-260 Outfall [Consolidated Unit 16-021(c)-99] Corrective Measure Study," Los Alamos National Laboratory letter (ER2006-0435) to D. Goering (NMED-HWB) from D. McInroy (LANL), Los Alamos, New Mexico. (LANL 2006, 092554)

NMED (New Mexico Environment Department), August 19, 2005. "Approval of the Investigation Work Plan for Consolidated Solid Waste Management Units 16-007(a)-99 (30s Line) and 16-008(a)-99 (90s Line) at Technical Area 16," New Mexico Environment Department letter to D. Gregory (DOE LASO) and R.W. Kuckuck (LANL Director) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2005, 091672)

NMED (New Mexico Environment Department), August 17, 2006. "Notice of Approval, Proposal to Drill Boreholes to Support the Corrective Measures Study and Remedy Selection at Solid Waste Management Unit (SWMU) 16-021(c)," New Mexico Environment Department letter to D. Gregory (DOE LASO) and D. McInroy (LANL) from J.P. Bearzi (NMED-HWB), Santa Fe, New Mexico. (NMED 2006, 093551)

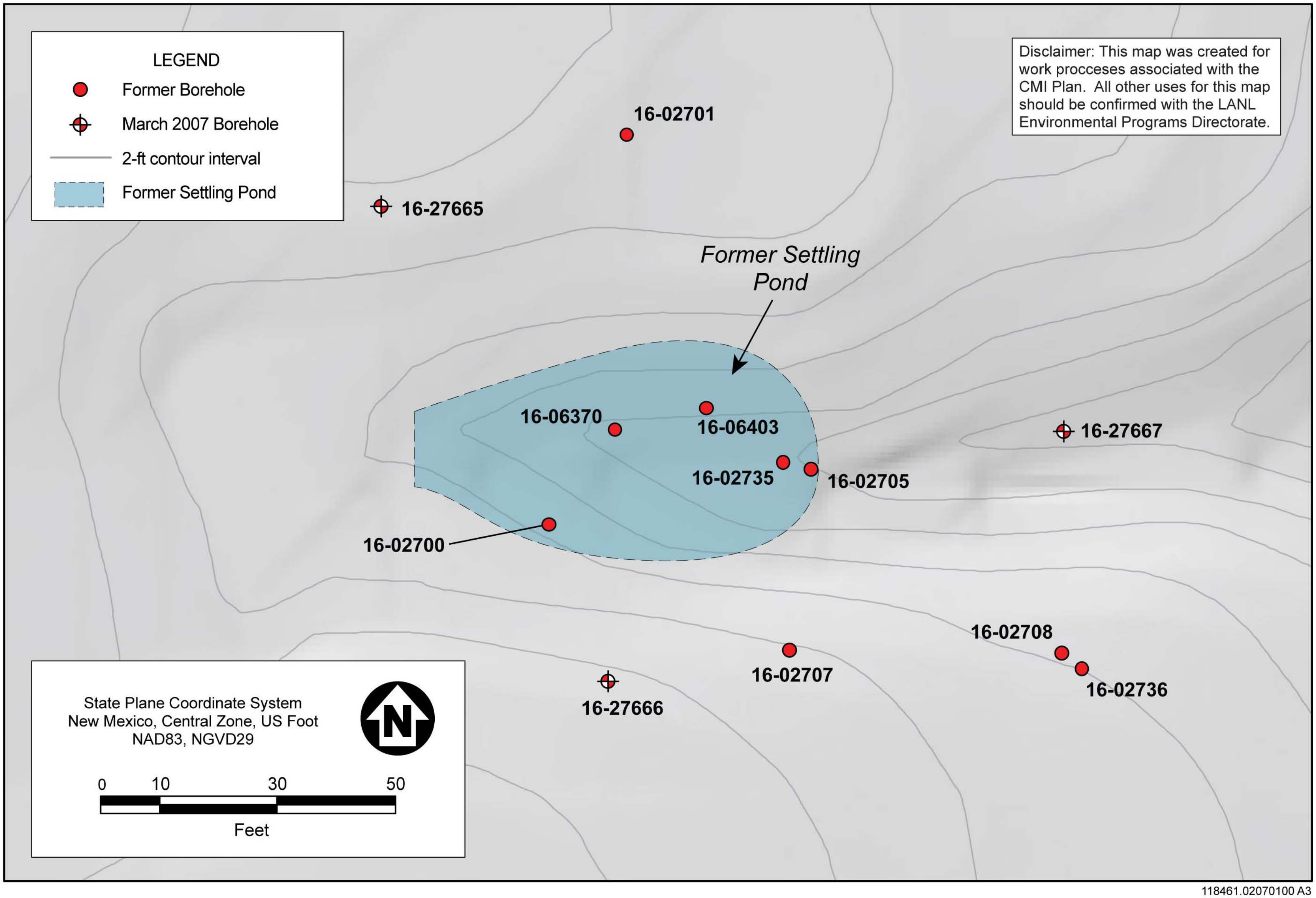
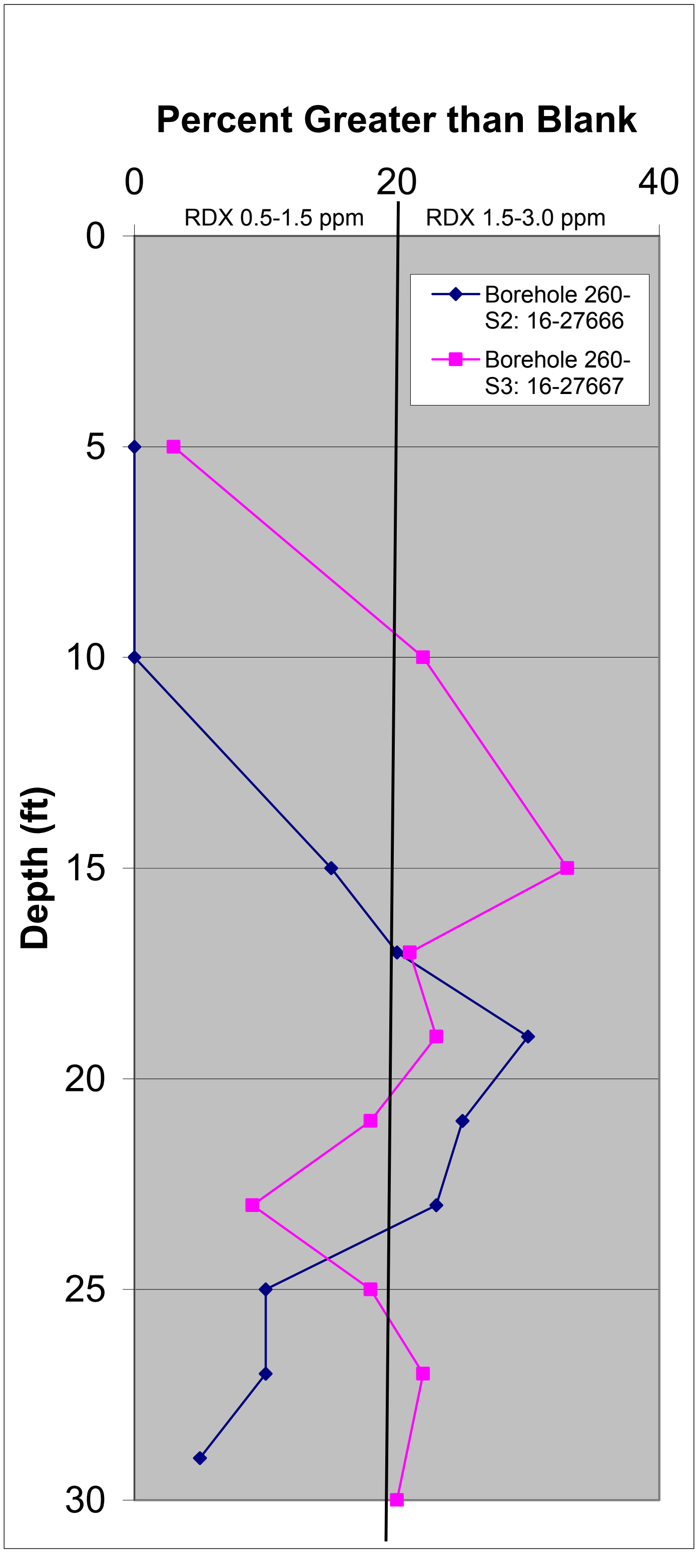


Figure C-1.0-1 Building 16-260 Outfall borehole locations

Figure C-5.1-1 Drilling and accessing borehole location 16-27667 in the 260 drainage, March 2, 2007



Borehole 260-S1: 16-27665		
Depth (ft)	Percent greater than blank	RDX Equivalent (ppm)
5	0	Not Detected
10	0	Not Detected
15	0	Not Detected
17	0	Not Detected
19	0	Not Detected
21	0	Not Detected
23	0	Not Detected
25	0	Not Detected
27	0	Not Detected
29	0	Not Detected

Borehole 260-S2: 16-27666		
Depth (ft)	Percent greater than blank	RDX Equivalent (ppm)
5	0	Not Detected
10	0	Not Detected
15	15	0.5-1.5
17	20	0.5-1.5
19	30	1.5-3.0
21	25	1.5-3.0
23	23	1.5-3.0
25	10	0.5-1.5
27	10	0.5-1.5
29	5	0.5-1.5

Borehole 260-S3: 16-27667		
Depth (ft)	Percent greater than blank	RDX Equivalent (ppm)
5	3	0.5-1.5
10	22	1.5-3.0
15	33	1.5-3.0
17	21	1.5-3.0
19	23	1.5-3.0
21	18	0.5-1.5
23	9	0.5-1.5
25	18	0.5-1.5
27	22	1.5-3.0
30	20	0.5-1.5

Figure C-5.3-1 RDX screening results from borehole locations 16-27665, 16-27666, and 16-27667

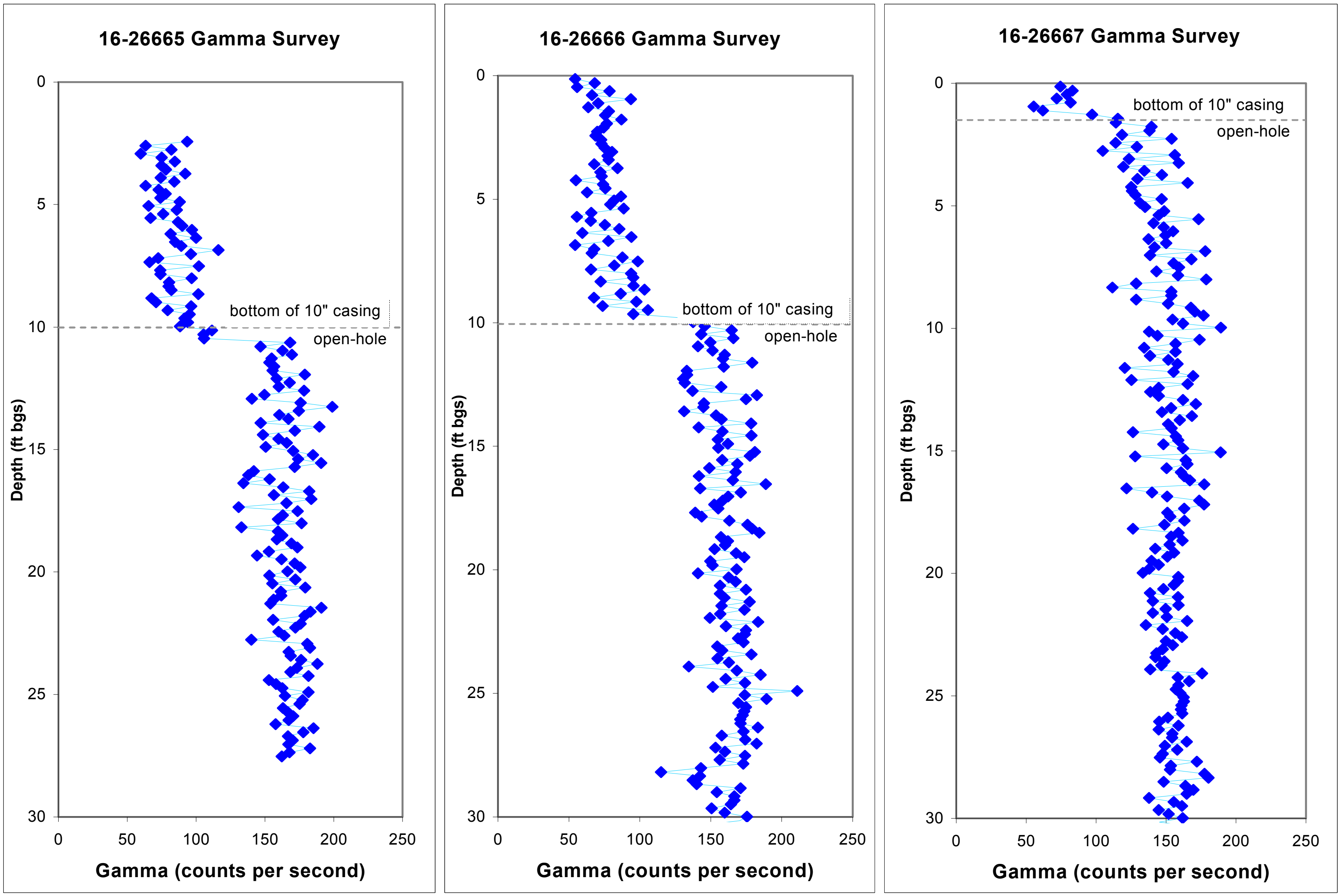


Figure C-5.5-1 Downhole gamma logging results from boreholes 16-27665, 16-27666, and 16-27667. Projected depth of surge bed: 15 to 25 ft bgs

Table C-2.1-1
Project Personnel

Field Team Member	Role(s)	Organization
John McCann	Subcontract Technical Representative	LANS[a]
Don Hickmott	Subcontract Technical Representative	LANS
Peter Gram	Program Manager	CPE[b]
Pattie Baucom	Field Team Leader (PIC[c])	CPE
Kevin Reid	Project Manager (PIC)	CPE
Steve White	Field Team Leader (PIC)	CPE
Candace Christensen	Field Team Member	CPE
Dan Thompson	Site Safety Officer	CPE
Jesse Garcia	Driller	WDC[d] Exploration
Jared Edmondson	Driller Helper	WDC Exploration
Chris Gaines	Driller Helper	WDC Exploration
Steve Pearson	Geophysical Logger	LANS
Greg Helland	Geophysical Logger Helper	LANS

[a] LANS = Los Alamos National Security.

[b] CPE = C/P/E Environmental Services, LLC.

[c] PIC = Person in charge.

[d] WDC = Water Development Corporation.

Table C-5.4-1
Sample Collection Information

LOCATION INFORMATION										SAMPLE DESCRIPTION			ANALYTICAL SUITE				
SWMU	Name	Event ID	Borehole ID	Location ID	Sample ID	Event ID	Date	Top Depth	Bottom Depth	Evaluation Class	Matrix	Sample Type	VOC (8260B)	SVOC (8270C)	HE (NMED Explosives List)	TAL Metals	Uranium
16-021(c)-99	260 Outfall	11882	260-S1	16-27665	RE16-07-76333	11882	3/3/2007	22.5	23	QBT4	R	INV	X	X	X	X	X
			260-S1	16-27665	RE16-07-76332	11882	3/3/2007	29	30	QBT4	R	INV	X	X	X	X	X
			260-S2	16-27666	RE16-07-76343	11882	3/4/2007	19	20	QBT4	R	INV	X	X	X	X	X
			260-S2	16-27666	RE16-07-76362	11882	3/4/2007	19	20	QBT4	R	FD	X	X	X	X	X
			260-S2	16-27666	RE16-07-76342	11882	3/4/2007	29	30	QBT4	R	INV	X	X	X	X	X
			260-S3	16-27667	RE16-07-76353	11882	3/2/2007	14.5	15	QBT4	R	INV	X	X	X	X	X
			260-S3	16-27667	RE16-07-76352	11882	3/2/2007	29	30	QBT4	R	INV	X	X	X	X	X
			NA	NA	RE16-07-76371	11882	3/4/2007	NA	NA	NA	W	FR			X	X	X
			NA	NA	RE16-07-76368	11882	3/2/2007	NA	NA	NA	S	FTB	X				

FD = Field duplicate.
FR = Field rinsate.
FTB = Field trip blank.
ID = Identification.
INV = Investigation.
NA = Not applicable.
R = Rock.
S = Soil.
TAL = Target analyte list.
W = Water.

Table C-5.4-2
Summary of Detected Chemicals

Location ID	Sample ID	Analyte Name	Result (mg/kg)	Qualifier	Begin Depth (ft)	End Depth (ft)	Media Code	Analytical Suite	Collection Date
16-27665	RE16-07-76333	HMX[a]	0.45	J[b]	22.5	23	QBT4	HEXP[c]	3/3/2007
16-27665	RE16-07-76333	Aluminum	2090		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Arsenic	2.73		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Barium	28.5		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Beryllium	0.187		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Calcium	606		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Chromium	2.13		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Cobalt	0.701		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Copper	1.38		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Iron	6760		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Lead	2.72		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Magnesium	382		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Manganese	295		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Mercury	0.0056	J	22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Nickel	0.833		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Potassium	369		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Selenium	0.763	J	22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Silver	0.0677	J	22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Sodium	172		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Uranium	0.36		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Vanadium	3.25		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Zinc	27.2		22.5	23	QBT4	METALS	3/3/2007
16-27665	RE16-07-76333	Carbon Disulfide	0.0113		22.5	23	QBT4	VOC	3/3/2007
16-27665	RE16-07-76332	Aluminum	4780		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Arsenic	1.73		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Barium	36		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Beryllium	0.217		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Calcium	796		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Chromium	3		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Cobalt	0.723		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Copper	1.8		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Iron	6760		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Lead	3.24		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Magnesium	681		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Manganese	246		29	30	QBT4	METALS	3/3/2007

Table C-5.4-2 (continued)

Location ID	Sample ID	Analyte Name	Result (mg/kg)	Qualifier	Begin Depth (ft)	End Depth (ft)	Media Code	Analytical Suite	Collection Date
16-27665	RE16-07-76332	Mercury	0.0229		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Nickel	0.712		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Potassium	561		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Selenium	0.876	J	29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Silver	0.0451	J	29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Sodium	191		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Thallium	0.16	J	29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Uranium	0.325		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Vanadium	4.34		29	30	QBT4	METALS	3/3/2007
16-27665	RE16-07-76332	Zinc	22.5		29	30	QBT4	METALS	3/3/2007
16-27666	RE16-07-76343	Amino-4,6-dinitrotoluene[2-]	0.17	J	19	20	QBT4	HEXP	3/4/2007
16-27666	RE16-07-76343	HMX	0.385	J	19	20	QBT4	HEXP	3/4/2007
16-27666	RE16-07-76343	RDX	1.85		19	20	QBT4	HEXP	3/4/2007
16-27666	RE16-07-76343	Trinitrobenzene[1,3,5-]	2.28		19	20	QBT4	HEXP	3/4/2007
16-27666	RE16-07-76343	Trinitrotoluene[2,4,6-]	0.252	J	19	20	QBT4	HEXP	3/4/2007
16-27666	RE16-07-76343	Aluminum	859		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Arsenic	3.25		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Barium	14.8		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Beryllium	0.177		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Calcium	592		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Chromium	1.21		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Cobalt	0.435	J	19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Copper	0.798	J	19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Iron	5490		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Lead	1.16		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Magnesium	128		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Manganese	168		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Mercury	0.0025	J	19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Nickel	0.39	J	19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Potassium	463		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Sodium	326		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Uranium	0.426		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Vanadium	1.92		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76343	Zinc	15.5		19	20	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Amino-2,6-dinitrotoluene[4-]	0.126	J	29	30	QBT4	HEXP	3/4/2007

Table C-5.4-2 (continued)

Location ID	Sample ID	Analyte Name	Result (mg/kg)	Qualifier	Begin Depth (ft)	End Depth (ft)	Media Code	Analytical Suite	Collection Date
16-27666	RE16-07-76342	Amino-4,6-dinitrotoluene[2-]	0.222	J	29	30	QBT4	HEXP	3/4/2007
16-27666	RE16-07-76342	HMX	0.723		29	30	QBT4	HEXP	3/4/2007
16-27666	RE16-07-76342	RDX	1.51		29	30	QBT4	HEXP	3/4/2007
16-27666	RE16-07-76342	Trinitrobenzene[1,3,5-]	1.05		29	30	QBT4	HEXP	3/4/2007
16-27666	RE16-07-76342	Trinitrotoluene[2,4,6-]	0.657		29	30	QBT4	HEXP	3/4/2007
16-27666	RE16-07-76342	Aluminum	756		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Arsenic	1.36	J	29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Barium	11.2		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Beryllium	0.227		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Calcium	596		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Chromium	1.65		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Cobalt	0.344	J	29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Copper	0.673	J	29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Iron	4590		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Lead	1.45		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Magnesium	220		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Manganese	196		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Nickel	0.327	J	29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Potassium	431		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Sodium	303		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Uranium	0.231		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Vanadium	0.93		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Zinc	19.1		29	30	QBT4	METALS	3/4/2007
16-27666	RE16-07-76342	Carbon Disulfide	0.0111		29	30	QBT4	VOC	3/4/2007
16-27667	RE16-07-76353	Amino-2,6-dinitrotoluene[4-]	0.191	J	14.5	15	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76353	Amino-4,6-dinitrotoluene[2-]	0.496	J	14.5	15	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76353	HMX	1.22		14.5	15	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76353	RDX	2.41		14.5	15	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76353	Trinitrobenzene[1,3,5-]	1.77		14.5	15	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76353	Trinitrotoluene[2,4,6-]	0.643		14.5	15	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76353	Aluminum	1390		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Arsenic	1.95		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Barium	25.5		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Beryllium	0.218		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Calcium	551		14.5	15	QBT4	METALS	3/2/2007

Table C-5.4-2 (continued)

Location ID	Sample ID	Analyte Name	Result (mg/kg)	Qualifier	Begin Depth (ft)	End Depth (ft)	Media Code	Analytical Suite	Collection Date
16-27667	RE16-07-76353	Chromium	1.89		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Cobalt	0.298	J	14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Copper	1.09	J	14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Iron	6830		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Lead	0.839	J	14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Magnesium	205		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Manganese	187		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Nickel	0.614		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Potassium	402		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Selenium	0.771	J	14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Silver	0.0505	J	14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Sodium	253		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Uranium	0.271		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Vanadium	2.26		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76353	Zinc	19.9		14.5	15	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Amino-2,6-dinitrotoluene[4-]	0.169	J	29	30	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76352	Amino-4,6-dinitrotoluene[2-]	0.21	J	29	30	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76352	HMX	0.681		29	30	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76352	RDX	2.69		29	30	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76352	Trinitrobenzene[1,3,5-]	1.89		29	30	QBT4	HEXP	3/2/2007
16-27667	RE16-07-76352	Aluminum	1050		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Arsenic	1.57		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Barium	11.5		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Beryllium	0.274		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Calcium	734		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Chromium	1.34		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Cobalt	0.272	J	29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Copper	0.391	J	29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Iron	4770		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Lead	0.805	J	29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Magnesium	246		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Manganese	250		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Nickel	0.338	J	29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Potassium	631		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Silver	0.0488	J	29	30	QBT4	METALS	3/2/2007

Table C-5.4-2 (continued)

Location ID	Sample ID	Analyte Name	Result (mg/kg)	Qualifier	Begin Depth (ft)	End Depth (ft)	Media Code	Analytical Suite	Collection Date
16-27667	RE16-07-76352	Sodium	433		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Uranium	0.382		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Vanadium	0.827		29	30	QBT4	METALS	3/2/2007
16-27667	RE16-07-76352	Zinc	21.3		29	30	QBT4	METALS	3/2/2007

[a] HMX = High-melting explosive (1,3,5,7-tetranitro-1,3,5,7-tetrazocine).

[b] J = The analyte was positively identified, and the associated numerical value is estimated to be more uncertain than would normally be expected for that analysis.

[c] HEXP = High explosive(s).

Attachment C-1

Boring Logs

Borehole ID: 16-27665 (260-S1)	TA: 16-007(a)-99 (30s Line Pond)	Drill Depth: 0 to 30 ft bgs	Total Pages: 1
Driller: Jessie Garcia (WDC)	Start Date/Time: 03/03/07: 1235	End Date/Time: 03/03/07: 1430	
Drilling Equipment/Method: CME 85 Hollow-Stem Auger			
Sampling Equipment/Method: 3" ID 5' Length Split-Barrel Sampler	Logged By: Kevin Reid, TPMC		

DEPTH (ft bgs)	RECOVERY (ft/ft)	FIELD SCREENING RESULTS: PID (ppm)/HE Spot Test (pos./neg.)	SAMPLE ID	LITHOLOGICAL DESCRIPTION	LITHOLOGICAL UNIT	NOTES
0	2/5			0-1.2' Clayey silty loam	SOIL	1st run: 1235
1						
2				1.2-2' Fine- to coarse-grained sand, silt, 15% pebbles, moist		
3						
4	NR			2-5' NO RECOVERY	NR	
5		0.0/neg				2ft: RDX Field Screen = ND
6	1/5			5-6' Same as above, clay lens at 5.5-5.7', dacite clast from 5.7-6'		**INFERRED QBT4 CONTACT: 6 ft bgs**; 2nd run: 1250
7						10" casing set to 10 ft bgs; Annulus filled with bentonite chips
8	NR			6-10' NO RECOVERY	NR	
9						
10		0.0/neg				6ft RDX Field Screen = ND
11	1/5			10-11' Tuff, weathered, nonwelded, pumice clasts (1-3 cm)		3rd run: 1320
12						
13	NR			11-15' NO RECOVERY	NR	
14						
15		0.0/neg				11ft RDX Field Screen = ND
16	5/5			15-16.3' Tuff, densely welded, tan to orange, 15% quartz, 15% sanidine, 5% glassy pumice 1% mafics		4th run: 1350
17		0.0/neg				17ft: RDX Field Screen = ND
18				16.3-20' Tuff, moderately to densely welded, gray, 15% quartz, 10% sanidine, 5% devitrified pumice, At 18.5 ft, clay-coated fracture (1-2 mm aperture)		
19		0.0/neg				19ft: RDX Field Screen = ND
20					QBT 4	
21	5/5	0.0/neg				21ft: RDX Field Screen = ND 5th run: 1410
22				20-22.9' Tuff, same as above, clay-filled fracture from 22.7-22.9'		
23		0.0/neg	22.5-23 ft bgs RE16-07-76333			23ft: RDX Field Screen = ND
24				22.9-25' Tuff, crystal-rich, 30% phenocrysts, 5% pumice		
25		0.0/neg				25ft: RDX Field Screen = ND
26	5/5					6th run: 1430
27		0.0/neg				27ft: RDX Field Screen = ND
28				25-30' Tuff, same as above, 25% phenocrysts, 5% pumice, dry, clay and crystal-filled fracture from 25.2-25.5'		
29			29-30 ft bgs RE16-07-76332			30ft: RDX Field Screen = ND
30		0.0/neg				**TOTAL DEPTH = 30 ft bgs**

Borehole ID: 16-27666 (260-S2)	TA: 16-007(a)-99 (30s Line Pond)	Drill Depth: 0 to 30 ft bgs	Total Pages: 1
Driller: Jessie Garcia (WDC)	Start Date/Time: 03/04/07: 0940	End Date/Time: 03/04/07: 1110	
Drilling Equipment/Method: CME 85 Hollow-Stem Auger			
Sampling Equipment/Method: 3" ID 5' Length Split-Barrel Sampler		Logged By: Kevin Reid, TPMC	

DEPTH (ft bgs)	RECOVERY (ft/ft)	FIELD SCREENING RESULTS: PID (ppm)/HE Spot Test (pos./neg.)	SAMPLE ID	LITHOLOGICAL DESCRIPTION	LITHOLOGICAL UNIT	NOTES
0	2/5				SOIL	1st run: 0940
1				0-2' Soil; clayey loam with dacite cobbles, moist		
2						
3					NR	
4	NR			2-5' NO RECOVERY		
5		0.0/neg				2ft: RDX Field Screen = 0.5-1.5ppm
6	4.5/5			5-6' Tuff; highly weathered, 5% pumice clasts (1-3 cm in diameter)		2nd run: 0950 **INFERRED QBT4 CONTACT: 5ft bgs**
7						
8				6-10' Tuff, moderately weathered, 25% phenocrysts, 2% mafic minerals, 5% fibrous pumice		
9						
10	NR	0.0/neg			NR	9.5ft: RDX Field Screen = 0.5-1.5ppm
11	3/5					3rd run: 1025
12				10-13' Tuff, same as above		
13						
14	NR			13-15' NO RECOVERY	NR	
15		0.0/neg				13ft: RDX Field Screen = 1.5-2.5ppm
16	5/5				QBT4	4th run: 1040
17		0.0/neg				17ft: RDX Field Screen = 1.5-2.5ppm
18				15-20' Tuff, moderately to densely welded, dry, 30% phenocrysts, 5% devitrified pumice		
19		0.0/neg	19-20 ft bgs RE16-07-76343 RE16-07-76363 (FD)			19ft: RDX Field Screen = 1.5-2.5ppm
20						
21	3/5	0.0/neg				21ft: RDX Field Screen = 1.5-2.5ppm 5th run: 1050
22				20-23' Tuff, same as above		
23		0.0/neg				23ft: RDX Field Screen = 1.5-2.5ppm
24	NR			23-25' NO RECOVERY	NR	
25		0.0/neg				25ft: RDX Field Screen = 0.5-1.5ppm
26	5/5					6th run: 1110
27		0.0/neg				27ft: RDX Field Screen =0.5-1.5ppm
28				25-30' Tuff, same as above		
29			29-30 ft bgs RE16-07-76342			30ft: RDX Field Screen = 0.5-1.5ppm
30		0.0/neg				**TOTAL DEPTH = 30 ft bgs**

Borehole ID: 16-27667 (260-S3)	TA: 16-007(a)-99 (30s Line Pond)	Drill Depth: 0 to 30 ft bgs	Total Pages: 1
Driller: Jessie Garcia (WDC)	Start Date/Time: 03/02/07: 1120	End Date/Time: 03/02/07: 1240	
Drilling Equipment/Method: CME 85 Hollow-Stem Auger			
Sampling Equipment/Method: 3" ID 5' Length Split-Barrel Sampler		Logged By: Kevin Reid, TPMC	

DEPTH (ft bgs)	RECOVERY (ft/ft)	FIELD SCREENING RESULTS: PID (ppm)/HE Spot Test (pos./neg.)	SAMPLE ID	LITHOLOGICAL DESCRIPTION	LITHOLOGICAL UNIT	NOTES
0	3.5/5			0-0.5' Soil; coarse sand, clay and gravel, saturated	FILL	1st run: 1120
1				0.5-3.5' Tuff, moderately to densely welded, gray ashy matrix (5YR 7/3), 30% coarse-grained phenocrysts (15% quartz, 15% sanidine), 5% altered pumice, moist		**QBT4 CONTACT: 0.5 ft bgs**
2						
3						
4	NR			3.5-5' NO RECOVERY	NR	
5		0.0/neg				3.5ft: RDX Field Screen = 0.5-1.5ppm
6	4.5/5					2nd run: 1200
7						
8				5-10' Tuff, densely welded, same as above		
9						9ft: RDX Field Screen = 1.5-2.5ppm
10	NR	0.0/neg			NR	
11	1/5			10-11' Tuff, same as above		3rd run: 1208
12						
13	NR			11-15' NO RECOVERY	NR	
14			14.5-15 ft bgs RE16-07-76353			
15		0.0/neg				15ft: RDX Field Screen = 1.5-2.5ppm
16	4.5/5					4th run: 1215
17		0.0/neg		15-19.5' Tuff, densely welded, moist, 30% phenocrysts (15% sanidine, 15% quartz), 2% pumice; thin 1-2mm horizontal clay-filled fracture at 19.5'		17ft: RDX Field Screen = 1.5-2.5ppm
18						
19		0.0/neg				19ft: RDX Field Screen = 1.5-2.5ppm
20	NR			19.5-20' NO RECOVERY	NR	
21	5/5	0.0/neg				21ft: RDX Field Screen = 0.5-1.5ppm 5th run: 1227
22				20-25' Tuff, same as above, more crystalline than above (35% phenocrysts of quartz and sanidine), trace mafic minerals in pumice, slightly moist to dry	QBT4	
23		0.0/neg				23ft: RDX Field Screen = 0.5-1.5ppm
24						
25		0.0/neg				25ft: RDX Field Screen = 0.5-1.5ppm
26	5/5					6th run: 1240
27		0.0/neg				27ft: RDX Field Screen = 1.5-2.5ppm
28				25-30' Tuff, same as above, more gray (7.5YR 10/3)		
29			29-30 ft bgs RE16-07-76352			30ft: RDX Field Screen = 1.5-2.5ppm
30		0.0/neg				**TOTAL DEPTH = 30 ft bgs**

Attachment C-2

Analytical Data
(on CD included with this document)

Attachment C-3

Sample Collection Logs and Chain-of-Custody Forms
(on CD included with this document)

Attachment C-4

Downhole Video DVD

Appendix D

Consolidated Unit 16-021(c)-99
Specifications and Design Drawings

Corrective Measures Implementation Plan Specifications

Table of Contents

This document follows format guidelines established by the Engineers' Joint Contract Documents Committee and the Construction Specifications Institute (CSI). Sections are numbered sequentially through the document and pages are numbered sequentially beginning with "1" within each Section. Section titles are for identification only and shall not modify the contents of the Section.

31 Earthwork

32 Exterior Improvements

33 Utilities

44 Pollution Control Equipment

SECTION 01 1000

SUMMARY OF WORK

PART 1 GENERAL

1.1 PROJECT BACKGROUND

A. This Section summarizes the contractor's scope of work for the implementation of several groundwater and soil remediation actions at TA-16 of Los Alamos National Laboratory. These actions are designed to remediate explosives and other contaminants present in soil, alluvial groundwater, and springs.

1.2 WORK INCLUDED

A. Work covered by the Corrective Measures Implementation Plan (CMI), specifications, and drawings.

1.3 RELATED DOCUMENTS

A. Contract documents issued separately by Los Alamos National Laboratory upon award of the contract.

B. Drawings

C. Specifications

D. Corrective Measures Implementation Plan

E. Quality Management Plan for the Environmental Programs Directorate (QMP), current revision

1.4 DEFINITIONS

A. LANL or the Laboratory: Los Alamos National Laboratory or Los Alamos National Security, LLC.

B. Contractor: firm contracted to LANL to perform this scope of work.

C. Subcontractor: any firm hired by the contractor to perform a portion of the scope of work.

D. Contractor Quality Control Manager: a contractor supplied person on site with the contractor to ensure quality.

E. TA-16: Laboratory Technical Area 16

F. CMI: corrective measures implementation plan for Consolidated Unit 16-021(c), as approved by the New Mexico Environment Department

G. 260 Outfall: former outfall for explosives contaminated water associated with TA-16 Building 260 operations.

H. 260 Outfall drainage channel: drainage channel leading from the 260 Outfall into Cañon de Valle

I. PRB: permeable reactive barrier for the remediation of alluvial groundwater

J. STR: LANL subcontractor technical representative

1.5 CONTRACT SCOPE OF WORK

A. GENERAL

1. Overview: The contractor shall provide all labor, equipment, materials, and all additional items necessary to implement corrective measures for soils, alluvial groundwater, and springs at TA-16 in accordance with the CMI. The work consists of the following items:

    a. Preparation of a health and safety plan, modification of the Construction Quality Control Plan (CQCP), and preparation of other LANL required safety and security documentation, including readiness review and preparation of a project schedule.

    b. Demolition of a portion of the concrete drainage channel at the 260 Outfall, testing and potential removal and disposal of contaminated soil beneath the concrete, backfilling of the excavation, and testing and disposal of concrete debris. Target soil cleanup levels are presented in the CMI.

    c. Excavation of soils from four areas within a former settling pond and within the 260 Outfall drainage channel, support field and laboratory testing (laboratory testing conducted by LANL) of the residual soil to determine compliance with soil cleanup goals, support characterization testing (laboratory testing conducted by LANL) and disposal of the excavated soils, and reinstallation of a low permeability clay cap over excavations within the former settling pond. Target soil cleanup levels are presented in the CMI.

    d. Injection grouting of a contaminated surge bed within tuff beneath the former settling pond.

    e. Installation of a water collection box and subgrade carbon filter system at Burning Ground Spring in Cañon de Valle to remove dissolved explosives from spring water.

    f. Modification of the existing subgrade carbon filter system located at Martin Spring by installation of a second water collection box.

    g. Installation of a pilot PRB in Cañon de Valle, including installation of test pits, soil sampling and geotechnical testing, installation of the

PRB cell and groundwater diversion walls, installation of three new alluvial groundwater monitoring wells, and site civil survey of all construction features.

1.6 CONTRACT METHOD

A. LANL will develop a single contract for completion of the scope of work as described by the drawings, specifications, and the CMI.

1.7 WORK BY OTHERS

A. LANL will provide a draft CQCP and a draft waste management plan to be modified by the contractor.

B. LANL will perform the following permitting tasks: area of concern (AOC) designation and contained in approval for potential RCRA wastes, US Army Corps of Engineers 401/404 wetland permitting, storm water pollution prevention plan

C. LANL will provide the seed mix and fertilizer for wetlands restoration.

D. LANL will conduct the risk calculation for assessing the attainment of soil cleanup standards.

E. LANL will provide quality assurance personnel to verify contractor quality control program is implemented and functioning as required.

F. LANL will conduct laboratory testing for various media disposal characterization, and compliance with soil cleanup goals.

1.8 CONTRACTOR USE OF PREMISES

A. Access to the site is limited because of operations at TA-16. In addition, the presence of the Northern Spotted Owl in Cañon de Valle imposes date restrictions. See 01 1400 Work Restrictions.

1.9 WORK SEQUENCE

A. Demolition of the concrete drainage channel, excavation of the settling pond and drainage channel locations (hot spots), and injection grouting are related activities that shall be performed in close sequence or concurrently. Moreover, these activities will generate soil for disposal that shall be campaigned together to minimize the duration of on-site waste storage.

2.0 SCHEDULE

A. Work shall commence upon Notice to Proceed and shall be conducted in accordance with the construction schedule.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 ADHERENCE TO APPROVED DESIGN AND LANL PROCEDURES

A. Work shall be conducted according to LANL-approved and controlled design and LANL-approved design media (specifications, drawings, and the CMI).

B. Work shall comply with the design processes and work processes described in the LANL approved CQCP document, the applicable Environmental Programs Directorate Quality Management Plan, and associated Quality Procedures (QP) and Standard Operating Procedures (SOP).

C. Work shall comply with LANL health and safety and security procedures.

END OF SECTION

SECTION 01 1400

WORK RESTRICTIONS

PART 1 GENERAL

1.1 SUMMARY

A. Implementation of the scope of work at TA-16 is restricted to certain times of the year and certain days.

B. Use of a percussion hammer for the demolition of the concrete 260 Outfall channel is not allowed.

C. Personal electronic communication equipment, cameras, or computers are not allowed at TA-16.

1.2 RELATED SECTIONS/DOCUMENTS

A. None

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 RESTRICTIONS ON WORKING HOURS AND DAYS

A. Work on the 260 Outfall channel demolition, excavation of the settling pond and drainage channel locations, and injection grouting, or access to this area, shall not occur when Building 260 is in operation. Building 260 is not in operation on weekends, at nights, and on certain Fridays. All operations in this area must be approved by LANL.

B. Installation of the PRB and the Burning Ground Spring carbon filter cannot occur during the months of March, April and May because of the presence of a threatened and endangered species, the Mexican Spotted Owl.

C. Work shall comply with LANL health and safety and security procedures.

D. Installation of the PRB should not occur during the months of July and August during the “monsoon season.”

3.2 RESTRICTIONS ON ELECTRONIC COMMUNCATIONS AND OTHER EQUIPMENT

A. Cell phones or other electronic communications equipment are not allowed at TA-16.

B. Portable computers, laptop computers, personal digital equipment, and cameras are not allowed at TA-16 without specific written authorization from LANL Security.

END OF SECTION

SECTION 01 3300

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Transmittal of submittals

B. Submittal procedures

C. Definition of submittal types for construction

D. Submittals for contract closeout

E. Submittal list

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 01 7839, Project Record Documents

B. QMP, Quality Management Plan for the Environmental Programs Directorate, current revision

C. QP-2.1, Personnel Qualification and Selection Process

D. QP-5.3, Readiness Planning and Review

E. QP-8.1, Inspection and Acceptance Testing

F. EP-DIR-SOP-4003, Records Management

1.3 TRANSMITTAL OF SUBMITTALS

A. Provide submittals as indicated in the specific specification sections.

B. Use a Routing Sheet to transmit submittals in the proper sequence.

1. Obtain copies of the routing sheet from LANL at the preconstruction conference for use during construction.

1.4 SUBMITTAL PROCEDURE

A. Review submittals prior to transmittal to determine and verify field measurements, field construction criteria, manufacturers' catalog numbers, and conformance of submittals with Contract Documents. To certify compliance with these specifications:

1. Sign or initial each sheet of shop drawings.

2. Sign or initial each label on samples.

3. As a minimum, sign or initial the cover sheet of bound material.

B. For any proposed deviation from the Contract Documents, submit a written request to the Contract Administrator.

C. Submit for review the following number of copies of submittals:

1. Five copies for LANL use.

2. Additional number of copies for Contractor use as determined by the Contractor.

D. Submittal Clarity:

1. Drawings shall be clear and legible.

2. Manufacturer's Literature: Submit a minimum of one original of all manufacturers' printed material. Remaining number of submittals may be reproductions. Reproductions of original material shall be clear and legible.

E. A partial submittal consists of only a portion of the total required for a project. This is acceptable when it is prudent to submit for review certain submittals before the remaining submittals are available. Submit all items concurrently for which, due to coordination concerns, a simultaneous review is required. Include a separate Routing Sheet indicating the submittals transmitted with each numbered submittal package.

F. After review of the submittal package the "Action Code" will be indicated on the Routing Sheet and returned to the Contractor. Review of submittals will be indicated on each Routing Sheet by appropriate signature, stamp, and date. The number of copies of each submittal noted above for LANL use will be retained and the balance will be returned to the Contractor. The Contractor shall allow a minimum of [14] calendar days for return of submittals.

G. LANL will utilize the following "Action Codes" to indicate the status of submittals resulting from the review, and the action required of the Contractor.

1. A - Reviewed. No comments.

2. B - Reviewed. Make corrections noted. Resubmission not required.

3. C - Reviewed. Revise and resubmit.

H. Use a Routing Sheet with all resubmittals indicating each item's submittal number and type suffixed "R1" for the first resubmittal, "R2" for the second resubmittal, and so forth.

I. Do not fabricate products or begin Work that requires submittals before such submittals are approved.

1. Exceptions: Field tests and inspection reports, concrete batch test reports, and contract closeout submittals.

1.5 DEFINITIONS OF SUBMITTAL TYPES FOR CONSTRUCTION

A. Excavation plan covering the outfall channel demolition, settling pond and drainage channel excavations, installation of the carbon filter system at Burning Ground Spring, including a local topographic survey, the findings of three test pits installed along the PRB route, stream diversion plan, and dewatering (if necessary) plan for the PRB.

B. Grouting plan covering method of grouting, grout formulation needed to meet performance standard, and method of permeability testing in two borings to demonstrate attainment of the performance standard.

C. Revised Construction Quality Control Plan, which will be prepared using the Rev 0 document included with the Corrective Measures Implementation (CMI) plan.

D. Shop Drawings: Drawings necessary to show fabrication details to ensure compliance with contract documents, including the prefabricated PRB reaction cell, and the metal spring water collection (weir) boxes.

E. Catalog cut sheets, including the filter fabric for the PRB reaction cell, and material specifications, including the bentonite used for the diversion wall.

F. Test Reports: Results of specified test requirements, including the compaction and permeability testing of the soil/bentonite mixture for the groundwater diversion walls, concrete testing, and sieve analysis of the PRB reactive materials.

G. Civil Survey of PRB and associated monitoring wells showing location of PRB components.

1.6 SUBMITTALS FOR CONTRACT CLOSEOUT

A. Project Record Documents

1. Provide the following Project Record Documents in accordance with Section 01 7839, Closeout Procedures, and EP-DIR-SOP-4003, Records Management:

a. As-built drawings and Installation Report

b. Master Equipment list and Master Document list per Eng Standards Manual Chapter 1 Section Z10

c. Quality control conformance and receipt inspection test reports, as specified in the Construction Quality Control Plan and QP-8.1.

1.7 SUBMITTAL LIST

A. Submittal List: Submittals shall be made for the items of hardware, equipment, and materials indicated in the attached Submittal List. Submittals marked with an asterisk (*) shall be in reproducible form.

B. The preliminary submittal list (Table 1.7) is a tabulation of the requirements identified in other specification sections. Any omission of an item from this list does not relieve the Contractor from the responsibility for submitting the item required by other specification sections.

C. Obtain a final copy of submittal list, including submittals that will be reviewed concurrently by LANL and AE, at the preconstruction meeting. A preliminary submittal list is provided in Table 1.7. This list may be revised prior to the preconstruction meeting by LANL or the Contractor.

1.8 HOLD POINTS

A. Hold points are points for mandatory inspection by the on-site Contractor Quality Control Manager and LANL QA Representative. Construction cannot proceed beyond a hold point without LANL approval. Hold points are summarized in the Table 1.8.

Table 1.7 Preliminary Submittal List

Sub No.	Description	Drawing No.	Required Construction Submittals	Required Closeout Submittals
C1	Excavation plan for all installation and excavation activities, including local civil survey, test pit results, permeability testing results, stream diversion plans, and dewatering plans (if necessary)	C-4001, C-5003	Plan required 8 weeks prior to construction.	None
C1	Revised Waste Management Plan	N/A	Plan required 8 weeks prior to construction	None
C1	Revised Construction Quality Control Plan (CQCP)	N/A	Plan required 8 weeks prior to construction	None
C1	Prefabricated plastic reaction cell, final dimensions based on test pit results	C4001, C5001, C5002	Shop drawings of cell required prior to fabrication	None

Sub No.	Description	Drawing No.	Required Construction Submittals	Required Closeout Submittals
C1	Surge Bed Grouting Plan		Plan detailing grout mix, grouting method, and plan for permeability testing in grouted areas – Grouting Plan required 8 weeks prior to grouting.	None
C1	Metal reaction cell grate	C4001, C5001, C5002	Shop drawings required prior to fabrication	None
C1	Catalog sheet or specifications on bentonite for use in the groundwater diversion walls	C4001, C5001	Material description	
C1	Reaction cell reactive media	C5003	Test report of sieve size distribution.	None
C1	Martin Spring weir box installation drawing	C3002	Drawing for installation reflecting current seep position	None
G0	As-builts prepared in accordance with the CQCP	N/A	N/A	Installation report
G0	Other CQCP deliverables as specified in the CQCP	N/A	N/A	Installation report

Table 1.8 Hold Point List

Hold Point	Section Location	Description
1	02 3000 – 3.1.B	LANL approval of location of PRB test pits
2	02 3000 – 3.1.F	LANL visually inspects tuff surface in each PRB test pit
3	02 3000 – 3.2.C	LANL approval of soil-bentonite mixture for diversion wall
4	02 4116 – 3.1.F 02 6100 – 3.2.G	LANL approval of confirmation testing prior to backfilling after trough removal
5	02 6100 – 3.1.H	LANL approval of confirmation testing prior to backfilling at former settling pond and drainage channel hotspots
6	03 6100 – 2.1	LANL approval of cement as received
7	31 2333 – 2.1.B.2	LANL acceptance of backfill material
8	31 2333 – 3.1.F	LANL inspection of Spring Filter piping
9	31 2333 – 3.2.B	LANL approval of location of Martin Spring weir box
10	31 2333 – 3.3.C.4	LANL approval of PRB excavation dimensions/depth

Hold Point	Section Location	Description
		relative to grade (prior to construction of PRB cell)
11	31 2333 – 3.3.C.11	LANL specification of compaction/density requirements for soil-bentonite mixture
12	31 3526.13 – 3.1.C	LANL approval of soil-bentonite mixture for cap material
13	32 7000 – 3.2.E	LANL approval of seed bed preparation
14	33 2413 – 1.1	LANL approval of monitoring well locations

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 01 3300 Rev. 1, dated July 10, 2006.

SECTION 01 4000

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. This Section summarizes administrative and procedural requirements for quality assurance and quality control for the implementation of corrective measures for soils, alluvial groundwater, and springs at TA-16 in accordance with the Corrective Measure Implementation Plan (CMI). Complete requirements are presented in the CMI for Consolidated Unit 16-021(c) Project Construction Quality Control Plan (CQCP).

B. Testing and inspecting services are required to verify compliance with design and construction specifications and for production of standard products. These services do not relieve Constructor of responsibility for compliance with the Subcontract Documents.

1. Requirements for Constructor to provide quality-assurance and -control services may be supplemented by provisions of other sections, including the CQCP referenced in item 1.1.A above and the Quality Management Plan for the Environmental Programs Directorate and applicable quality plans (QP) and standard operating procedures (SOP).

2. Other Sections may contain QA activities specific to those work results.

3. Constructor is responsible to assure that any activities subcontracted to lower-tier constructors or agencies are contractually “passed-down” and Constructor shall assure that their sub-tier entities follow these requirements.

C. Related Sections/Documents

1. Section 01 3300, Submittal Procedures

2. Section 01 4219, Reference Standards

3. Section 01 7830, Project Record Documents

4. Divisions 02 through 49 Sections for task-specific test and inspection requirements.

5. Construction Quality Control Plan (CQCP)

6. QMP, Quality Management Plan for the Environmental Programs Directorate

7. QP-2.1, Personnel Qualification and Selection Process

8. QP-5.2, Control of Measuring and Test Equipment

9. QP-5.3, Readiness Planning and Review

10. QP-5.7, Notebook Documentation for Environmental Restoration Technical Activities

11. QP-8.1, Inspection and Acceptance Testing

12. EP-DIR-SOP-4001, Document Control

13. EP-DIR-SOP-4003, Records Management

14. MAQ-005, Work Safety Review and Authorization

15. SOP-01.04, Sample Control and Field Documentation

16. SOP-01.07, Operational Guidelines for Taking Soil and Water Samples in Explosive Areas

1.2 DEFINITIONS

A. Constructor: The entity performing fabrication or physical construction activity; normally the general contractor (a subcontractor to LANL).

B. Field Quality-Control Testing: Tests and inspections that are performed on-site for receipt of materials and equipment, installation of the Work, and for completed Work. Field quality control testing and inspections are described in the CQCP and specifications.

C. Installer/Applicator/Erector: Constructor or another entity engaged by Constructor as an employee, Subcontractor, or lower-tier subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

D. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before products and materials are incorporated into the Work to verify performance or compliance with specified criteria. Field quality control testing is described in the CQCP and specifications, and includes the installation of test pits, sieve testing of proposed reactive cell media, permeability testing of soil/bentonite mixture, and moisture-density compaction of soil/bentonite mixture.

E. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction complies with requirements.

F. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Services do not include subcontract enforcement activities performed by LANL Subcontract Tech Rep (STR).

G. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.3 CONFLICTING REQUIREMENTS

A. General: If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to LANL for a decision before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. Specified numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to LANL for a decision before proceeding.

1.4 SUBMITTALS

A. Coordination by Constructor: Coordinate sequence of activities to accommodate required quality-assurance and -control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

2. Distribute schedule to LANL, AE, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

B. Licenses and Certificates: For LANL's records, submit copies of licenses, certifications, correspondence, records, and similar documents used to establish compliance with standards and regulations that pertain to performance of the Work, where necessary.

1.5 QUALITY ASSURANCE

A. Qualification requirements specified below establish the minimum qualification levels for the skills or organizations listed; individual Specification Sections specify additional requirements.

1. Installer: A firm or individual with 5 years experience in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

2. Manufacturer: A firm with 5 years experience in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

3. Fabricator: A firm with 5 years experience in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

4. Professional Engineer: A professional engineer who is legally qualified to practice in New Mexico and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installation of systems, assembly, or product design that is similar to those indicated for this Project in material, design, and extent.

5. Testing Agency: An independent testing laboratory (geotechnical or analytical) with the experience and capability to conduct testing and inspecting indicated; with additional qualifications specified in individual Sections; and approved by LANL. Analytical chemistry testing may be performed by LANL or LANL designated testing laboratory.

B. Preconstruction Testing:

1. Constructor responsibilities include the following:

   a. Submit material samples of reactive cell media to a certified materials testing laboratory (testing agency) for sieve analysis per ASTM C-136 in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

   b. Install test pits in accordance with the construction quality assurance plan to verify depths to top of bedrock, test ability to excavate within bedrock to key in the diversion wall and reactive cell, visually inspect bedrock surface for fractures, and observe groundwater recharge into the excavation to assess the need for construction dewatering.

   c. Submit soil/bentonite mix samples to testing agency for moisture-density testing per ASTM D-698 or D-1557, as applicable, in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

   d. Submit soil/bentonite mix samples to testing agency for permeability testing per ASTM D-5084 in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.

2. Testing Agency Responsibilities: Submit certified written reports of each test on the candidate reactive cell media and soil/bentonite mixture.

1.6 QUALITY CONTROL

A. LANL Responsibilities: Where quality-control services are indicated as LANL's responsibility, LANL will engage a qualified testing agency to perform these services.

1. Costs for retesting and re-inspecting construction that replaces or is necessitated by work that failed to comply with the Subcontract Documents will be charged to Constructor, and the Subcontract Sum will be adjusted by Change Order.

B. Constructor Responsibilities: Tests and inspections not explicitly assigned to LANL are Constructor's responsibility. Unless otherwise indicated, provide quality-control services specified.

1. Constructor shall pass quality requirements down to lower-tier subcontractors and shall enforce such requirements.

2. Notify LANL STR at least **48** hours in advance of time when Work that requires testing or inspecting will be performed, such as test pitting.

3. Testing and inspecting requested by Constructor and not required by the Subcontract Documents are Constructor's and shall be at Constructor's expense.

4. Submit additional copies of each written report to LANL, when so directed.

5. Perform testing and inspections as identified in the CQCP.

C. Retesting/Re-inspecting: Provide, at Constructor's expense, quality-control services for retesting and re-inspecting, for replacement construction Work resulting from work that failed to comply with the Subcontract Documents.

D. Testing Agency Responsibilities (services retained by Constructor): Cooperate with AE and Constructor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify AE and Constructor promptly of irregularities or deficiencies observed in the Work during performance of its services.

2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.

3. Submit a certified written report of each test, inspection, and similar quality-control service through Constructor.

4. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.

5. Do not release, revoke, alter, or increase the Subcontract Document requirements or approve or accept any portion of the Work.

6. Do not perform any duties of Constructor.

1.7 SPECIAL INSPECTIONS

A. Special Inspections shall be conducted by LANL-approved special inspectors or LANL QA Representative, as indicated in the CQCP.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 USE OF APPROVED DESIGN

Work shall only be accomplished to LANL-approved and controlled design and LANL-approved design media (specifications and drawings). This design, along with the subcontract and applicable codes and standards included in the subcontract, specifications, and drawings shall be complied with and must be contractually “passed-down” to any sub-tier fabricators, testing agencies, or other constructors assigned by the Constructor. Work shall comply with the design processes and work processes described in the LANL Quality Assurance Program (QAP) document or the LANL QA-PQ approved CQCP document.

3.2 ACCEPTABLE TESTING AGENCIES

A. See LANL for listing (e.g., from Institutional Evaluated Suppliers List maintained by LANL QA-PQ Group internally: http://ps.lanl.gov/source/orgs/ps/ps1/pdfs/IESL.pdf). NOTE: Failure to meet requirements may result in their removal from listing (ref. ESM Ch 16 Section IBC-TIA).

3.3 REPAIR AND PROTECTION

A. On completion of testing, inspecting, sample taking, and similar services, restore site to original condition to the extent possible.

B. Repair and protection are Constructor's responsibility, regardless of the assignment of responsibility for quality-control services.

C. Constructors must comply with all LANL standard procedures and processes as specified in the Subcontract including safety, quality (such as hold points), environmental, and other signs, tags, warnings, etc.

END OF SECTION

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 01 4000 Rev. 0, dated October 27, 2006.

SECTION 01 4219

REFERENCE STANDARDS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality Assurance.

B. Schedule of References.

1.2 QUALITY ASSURANCE

A. Conform to reference standard by date of issue current on date for receiving bids.

B. Should specified reference standards conflict with Contract Documents, request clarification from Contract Administrator before proceeding.

1.3 SCHEDULE OF REFERENCES

To the extent specified elsewhere in these Contract Documents, comply with the requirements of the following standards and associations.

AASHTO	American Association of State Highway and Transportation Officials www.aashto.org 202-624-5800
ACI	American Concrete Institute International www.aci-int.org 248-848-3700
AGC	Associated General Contractors of America www.agc.org/ 703-837-5312
ANSI	American National Standards Institute www.ansi.org 212-642-4980
ASCE	American Society of Civil Engineers www.asce.org 800-548-2723
ATSM	American Society for Testing and Materials International www.astm.org 610-832-9585
CFR	Code of Federal Regulations www.gpoaccess.gov/cfr/index.html

CSI	Construction Specifications Institute www.csinet.org 800-689-2900
ETL	Environmental Testing Laboratories www.etlsemko.com 607-753-6711
LANL	Los Alamos National Laboratory Environmental Programs Directorate Procedures and Plans www.LANL.gov Contact Don Hickmott (STR) 505-667-8753
NIST	National Institute of Standards and Technology U. S. Department of Commerce www.nist.gov 301-975-6478
NMED	New Mexico Environment Department Compliance Order on Consent, March 2005 www.**lanl**.gov/environment/h2o/**consent_order**.shtml
NMWQCC	New Mexico Water Quality Control Commission 20 NMAC 6.2.3103
OSHA	Occupational Safety and Health Administration www.osha.gov 800-321-6742 877-889-5627

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 01 4219 Rev. 0, dated January 6, 2006.

SECTION 01 5705

TEMPORARY CONTROLS AND COMPLIANCE REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Erosion and Sediment Control

B. Storm Water Management

C. Site Stabilization

D. Spill Control and Response

E. Debris Control

F. Air Quality

G. Dust Suppression

H. Rodent Control

I. Environmental Restoration Sites

J. Hazardous Waste

K. Grading, Excavating and Trenching

L. Test Pits

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 01 3300, Submittal Procedures

B. Section 01 3545, Water Discharge Requirements

C. Section 31 2333, for Trenching and Backfilling

D. Section 32 7200, Wetlands Restoration

E. QMP, Quality Management Plan for the Environmental Programs Directorate

F. QP-5.3, Readiness Planning and Review

1.3 SUBMITTALS

A. Submit the following in accordance with Section 01 3300, Submittal Procedures.

1. For projects operating under a National Pollutant Discharge Elimination System (NPDES) permit:

   a. Submit all requested information for the Storm Water Pollution Prevention (SWPP) plan within 14 days after award of the contract. Submit information in sufficient format and detail as may be required by LANL for completion of the SWPP plan amendment, including the calculations required by the New Mexico Environmental Department (NMED) Surface Water Quality Bureau (SWQB) state certification of the proposed NPDES permit NMR 150000 sections 9.c.1.a.i and 9.c.1.b: http://www.nmenv.state.nm.us/swqb/PSRS/NMR150000-Info.html The completed SWPPP Plan shall be certified by both LANL and a responsible corporate officer of the Contractor prior to the Notice of Intent (NOI) submittal. The Contractor agrees to continue to submit such additional information to and otherwise cooperate and work with LANL to maintain/modify the SWPP Plan throughout the duration of this contract.

   b. Construction shall not begin until at least 7 days after the United States Environmental Protection Agency (EPA) has acknowledged receipt of the complete NOI on their website at http://www.epa.gov/npdes/stormwater/cgp and the (EPA) has not delayed the authorization. The Contractor shall submit a complete Notice of Intent (NOI) for review to LANL at least 20 days prior to start of construction. The SWPP Plan shall be completed and approved prior to submission of the NOI. Once LANL has reviewed and approved the NOI, the Contractor shall submit the NOI to the EPA at least 8 days prior to start of construction.

   c. Following a review and approval by LANL, submit a Notice of Termination (NOT) to the EPA within 10 days after final stabilization of the site. Release of the site before final stabilization may be negotiated through LANL prior to termination of the contract.

2. New Mexico Environment Department Notice of Intent (NMED NOI)

   a. The LANL Construction Inspector will contact the LANL Water Quality & Hydrology Group (ENV-RCRA) at 665-0453 prior to the Contractor using fertilizer, hydraulically applied mulches, Bonded Fiber Matrix, dust suppression additives, and other substances that are applied to the ground. ENV-RCRA will determine whether the substances will require a Notice of Intent (NOI) to Discharge be submitted to the New Mexico Environment Department (NMED) by Contractor. Provide information as necessary to obtain the NMED NOI and follow all conditions of the NOI.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

3.1 EROSION AND SEDIMENT CONTROL

A. Properly install best management practices (BMPs), as identified in the SWPP Plan, prior to any earth disturbing activity.

B. Maintain BMPs in accordance with SWPP Plan and manufacturer's recommendations.

C. When practical, implement permanent BMPs during the construction phase to meet the objectives of temporary sediment and erosion controls.

D. Disturb only the minimum amount of soil necessary. Give special attention to protecting established vegetation.

3.2 STORM WATER MANAGEMENT

A. Provide methods to control surface water as identified in the SWPP Plan to prevent damage to the Project, the site, and in adjoining areas.

B. Ensure temporary and permanent storm water management controls are properly installed per the design drawings and the SWPP Plan. Maintain controls per drawings, the SWPP Plan, and manufacturer's installation recommendations.

3.3 SITE STABILIZATION

A. Stabilize all disturbed areas as shown in the design drawings. Do not leave any disturbed areas as barren soil unless specified by design drawings and/or specifications. Final stabilization shall be accepted by LANL Utilities and ENV-RCRA. The LANL Construction Inspector will contact LANL Utilities at 665-0106 and ENV-RCRA at 665-0453 to schedule the final walk down and acceptance.

B. For seeded areas, establish an evenly distributed native perennial vegetative cover with no large bare areas and an average density of 70% of the native background vegetative cover for the area. Refer to Section 32 7200, Wetlands Restoration.

C. Begin stabilizing disturbed areas no more than 14 days after construction activities have finally or temporarily ended in the area.

D. Do not apply fertilizer, hydraulically applied mulches, or Bonded Fiber Matrix in watercourses.

3.4 SPILL CONTROL AND RESPONSE

A. In the event of a spill, immediately notify the LANL Construction Inspector who will contact Emergency Management and Response (EM&R) at 667-6211. The Contractor shall be responsible for remediation of any spill.

B. Store all fuels, lubricants, chemical storage, material stockpiles, and other potential pollutants in a designated area on-site. Provide secondary containment and controls including berming lined with an impervious material, covering, or other appropriate BMPs. When aboveground petroleum storage capacity is greater than 1,320 gallons (including all containers 55 gallons or larger), notify the LANL Construction Inspector who will contact ENV-RCRA at 665-0453 to initiate the development of a Spill Prevention Control and Countermeasure (SPCC) Plan.

3.5 DEBRIS CONTROL & SOILS MANAGEMENT

A. Use good housekeeping practices to keep sites free of construction debris and trash. Provide containers for deposit of debris and trash.

B. Do not drive or move any vehicle on any public road unless the vehicle is constructed, loaded, secured or covered in a manner that will prevent any of its load from dropping, sifting, leaking, or otherwise escaping (except when purposefully cleaning, maintaining, or sanding for traction).

C. Securely fasten all load covers to vehicles prior to driving on public roads so that the covering does not come loose or become a hazard to others.

D. Do not bury construction waste, sanitary waste, or trash on-site.

E. Do not move soil or other material between Technical Areas (TAs) without first obtaining written approval from the receiving TA. Material must be clean of all contaminants before movement; all transferred soil must be characterized. See Part 3.9C.

F. Segregate all materials prior to sending material to the LANL Material Recycle Facility (MRF). The LANL Construction Inspector will contact LANL Solid Waste Regulatory Compliance (ENV-RCRA) at 667-0666 to obtain instruction on required sampling and documentation procedures. Material shall be clean of all contaminants.

3.6 AIR QUALITY

A. The LANL Construction Inspector will contact the ENV-EAQ Group (665-8855) prior to the Contractor operating portable and stationary fuel burning equipment (e.g., generators, rock crushers, asphalt plants). Drivable equipment does not require notification of ENV-EAQ.

B. The LANL Construction Inspector will contact ENV-EAQ Group Office (665-8855) if the Contractor stores over 500 pounds of chemicals at the site.

3.7 DUST SUPPRESSION

A. Only use potable water for dust control.

B. Do not add additives to potable water for dust control until receiving approval. Notify the LANL Construction Inspector who will contact ENV-RCRA. Comply with all conditions specified by ENV-RCRA and the applicable federal and state agencies. Apply all liquids in a manner that does not result in runoff.

C. Do not apply dust suppression additives or other substances in watercourses.

3.8 RODENT CONTROL

A. Do not use any pesticide (rodenticide) without the written approval of LANL. Comply with New Mexico Pesticide Control Act, Chapter 76, Article 4, Sections 1-39.

3.9 ENVIRONMENTAL RESTORATION SITE

A. No storm water runoff shall be allowed across a Potential Release Site (PRS), including Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs) that are identified in the contract documents.

B. A PRS cannot be disturbed without LANL Remediation Services (ERSS-RS) Project approval and oversight. The LANL Construction Inspector will contact ERSS-RS at 665-5138 or 665-2198. Any worker conducting work within the boundary of a PRS must be made aware, by the LANL Project Manager, of the potential contaminants present in soils and other materials at the site and the potential hazards associated with those contaminants.

C. Any soil or other material removed from a PRS boundary and not returned to the point of excavation must be managed, characterized, and disposed of by the Contractor in accordance with all applicable LANL waste management requirements including approved Waste Profile forms, waste accumulation areas, etc., or if the project causes additional runoff to cross the site, install appropriate sediment and erosion controls prior to construction activities. Best Management Practices (BMPs) for the Storm Water Pollution Prevention (SWPP) Plan and/or soil erosion control must be in place for all projects prior to the start of any soil disturbing activities within a PRS to prevent potential contaminant migration.

3.10 HAZARDOUS AND MIXED WASTE

A. Store, treat, and/or dispose of hazardous or mixed wastes in accordance with applicable laws and regulations, and LANL requirements.

B. Register satellite accumulation areas or less than 90 days storage areas with LANL ENV-RCRA Group prior to storing, handling, treating, or disposing of hazardous or mixed waste.

C. Contact the ENV-RCRA Group (667-0666) for more information on the management of hazardous or mixed waste, New Mexico special waste (such as petroleum contaminated soil, spills, chemical products, asbestos waste, infectious waste, etc.), PCBs, construction and demolition debris, and other types of solid waste.

3.11 GRADING, EXCAVATING, AND TRENCHING

A. Follow Section 31 2333, for Trenching and Backfilling requirements.

3.12 TEST PITS

A. Contact the LANL Water Quality Group prior to performing any test pitting activities to ensure activities are covered under an amended SWPPP.

END OF SECTION

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 01 5705, Rev. 1, dated November 28, 2006.

SECTION 01 7700

CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Closeout Procedures.

B. Final Cleaning.

C. Adjusting.

D. Instructions for LANL personnel

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 01 7839, Project Record Documents

B. QMP, Quality Management Plan for the Environmental Programs Directorate

C. EP-DIR-SOP-4001, Document Control

D. EP-DIR-SOP-4003, Records Management

E. SOP-01.12, Field Site Closeout Checklist

1.3 CLOSEOUT PROCEDURES

A. Upon completion of the work certify that:

1. Contract Documents have been reviewed;

2. Work has been inspected for compliance with Contract Documents;

3. Work has been completed in accordance with the Contract Documents;

4. Equipment and systems have been tested as required, and are operational;

5. All required operations and maintenance procedures/manuals have been turned over to LANL.

6. Work is completed and ready for final inspection.

B. Should the Work be found to be incomplete or defective, LANL will notify the Contractor in writing, listing the incomplete or defective work.

C. Contractor shall correct the deficiencies promptly, and notify LANL when the Work is ready for reinspection.

D. When the Work is determined to be acceptable, the Contract Administrator will request Contractor to make closeout submittals.

1.4 FINAL SITE RESTORATION

A. Complete site restoration prior to final inspection.

B. Remove waste and surplus materials, rubbish, and construction facilities from project site.

PART 2 PRODUCTS

Not used.

PART 3 EXECUTION

Not used.

END OF SECTION

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 01 7700 Rev. 0, dated January 6, 2006.

SECTION 01 7839

PROJECT RECORD DOCUMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Project Record Documents.

1.2 RELATED SECTIONS/DOCUMENTS

A. QMP, Quality Management Plan for the Environmental Programs Directorate

B. QP-5.7, Notebook Documentation for Environmental Restoration Technical Activities

C. EP-DIR-SOP-4001, Document Control

D. EP-DIR-SOP-4003, Records Management

E. MAQ-011, Logbook Use and Control

F. SOP-01.04, Sample Control and Field Documentation

G. SOP-01.08, Field Documentation of Drilling and Sampling Equipment

H. SOP-15.09, Chain-of-Custody for Analytical Data Record Packages

1.3 SUBMITTALS

A. Submit the following in accordance with Section 01 3300, Submittal Procedures:

1. Deliver the Project Record Documents to the Site Technical Representative (STR). Submit electronic files and paper copies as specified in Sections 1.6 and 1.7.

a. The LANL Construction Inspector will request that the STR deliver a set of the Project Record Documents to the ERSS RPF per EP-DIR-SOP-4003. All Drawings must be signed originals.

2. Transmit the Project Record Documents with a cover letter listing:

a. Date,

b. Project title and number,

c. Contractor's name, address, and telephone number,

d. Number and title of each Record Document, and

e. Signature of Contractor or authorized representative.

1.4 MAINTENANCE OF DOCUMENTS

A. During construction maintain at project site a record copy of the following Project Record Documents.

1. Construction Drawings
2. Specifications
3. Construction Quality Control Plan
4. Reviewed shop drawings and product data
5. Field test records
6. Inspection certificates
7. Manufacturer's certificates
8. Specified installer/tradesman certificates
9. Storm Water Pollution Prevention Plan
10. Submittals after review and approval
11. Corrective Measure Implementation Plan (CMI)

B. Store Project Record Documents apart from other documents. Provide separate files, racks, and secure storage for Project Record Documents.

C. Label and file Project Record Documents in accordance with Section number listings in Table of Contents of these Specifications. Label each document "PROJECT RECORD DOCUMENTS" in large, legible, printed letters.

D. Maintain Project Record Documents in a clean, dry and legible condition.

E. Keep Project Record Documents available for periodic inspection by the LANL Construction Inspector and other applicable parties.

1.5 RECORDING

A. Use an erasable red pencil (not ink or indelible pencil) to clearly record information or changes on the drawings by graphic line and note as required. Use an erasable yellow pencil to clearly mark all major components where constructed as shown.

B. Use different colors for the overlapping changes if required for clarification.

C. Record information concurrently with construction progress. Do not conceal any work until required information is recorded. Date entries reflecting change.

D. Legibly mark each item on the drawings to record actual construction, including:

1. Measured depths of elements.

2. Surveyed actual building placement, referenced to LANL Labwide Network, indicating the origin of the New Mexico State Plane Coordinates.

3. Measured locations appurtenances concealed in construction, referenced to visible and accessible features of construction.

4. Field changes of dimension and detail.

5. Changes made by Contract modifications.

6. Details not on original Drawings.

7. References to related shop drawings and Contract modifications.

E. Specifications: Legibly mark each item to record actual construction, including changes made by amendment and Contract modifications.

1.6 FINAL RECORD DOCUMENTS (AS-BUILTS)

A. At completion of construction verify accurate transposition of all site information onto Final Record Documents and deliver the following to Contract Administrator:

1. Record Drawings: Provide [stamped], dated, and signed Final Record Drawings in both reproducible (full-sized paper) and electronic media in accordance with the LANL Drafting Manual, Section 200, Electronic CAD File Conventions.

2. Specifications: Provide single sided paper copy and electronic copy, Microsoft Word 97 or later versions, on 3 1/2 inch diskettes or CDs.

B. Verify accurate transposition of all site information onto the Final Record Documents.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

Not Used.

END OF SECTION

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 01 7839 Rev. 1, dated July 25, 2006.

SECTION 02 2113

SITE SURVEYS

PART 1 GENERAL

1.1 SUMMARY

A. Topographical survey of the PRB construction area shall be conducted after excavation of the three test pits (see Section 02 3000, Subsurface Investigations). Results will be reported in the excavation plan.

B. Civil survey of all soil sample locations shall be conducted. Results will be submitted for inclusion in the ERSS GIS database.

C. Civil survey of the completed PRB components shall be conducted. Results will be submitted to support final as-built drawings.

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 02 3000, Subsurface Investigations

B. Section 33 2413, Groundwater Monitoring Wells

C. QMP, Quality Management Plan for the Environmental Programs Directorate

D. QP-5.16, Access to Digital GIS Resources by Non-Project Personnel

E. SOP-03.11, Coordinating and Evaluating Geodetic Surveys

F. ENV-WQH-SOP-068, Global Positioning System (GPS) Data Preparation and Collection

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 SITE TOPOGRAPHICAL SURVEY OF THE PRB CONSTRUCTION AREA

A. A site topographical horizontal and elevation survey of the PRB construction area (approximate area 2500 ft^2) shall be conducted using either GPS or traditional rod and level technique. Traditional rod and level techniques may be required due to the inaccessibility of GPS satellites in Cañon de Valle.

B. Existing monitoring wells 16-02658 and CdV-16-1(i) can be used as benchmarks for the survey.

C. Data shall be of adequate accuracy for results to be used to develop a 1 foot contour AutoCAD map of the construction area.

3.2 CIVIL SURVEY OF ALL SOIL SAMPLE LOCATIONS

A. A civil survey of all soil sampling locations, including samples collected for field and laboratory analysis, shall be conducted. Either GPS or traditional techniques may be used, as available and applicable to the site conditions. Samples collected in the excavations in the settling pond and drainage channel hot spots and field and confirmation sampling along the 260 Outfall trough removal shall be surveyed and recorded.

B. Existing monitoring wells in the area can be used as benchmarks for the survey.

C. Civil survey shall be performed by a New Mexico Licensed Surveyor (see SOP-03.11). Qualification documentation (copy of license) shall be submitted with survey data.

D. Horizontal coordinates will be recorded in the New Mexico State Plane Coordinate System, Central Zone, referenced to the North American Datum of 1983 (SPCS 83, NM Central). Distances are expressed as ground distance in US survey feet (US ft). All elevation data must be reported relative to the National Geodetic Vertical Datum of 1929. Survey accuracy will be within 0.1 foot.

3.3 CIVIL SURVEY OF THE COMPLETED PRB COMPONENTS

A. A civil survey of the completed PRB components shall be conducted using either GPS or traditional techniques. Traditional techniques may be required due to the inaccessibility of GPS satellites in Cañon de Valle. Surveyed points (horizontal and vertical) shall include:

1. Four corner points of PRB cell at surface (top of cell)

2. End points of PRB diversion wall identifying lateral extent of wall and width of wall at wall top

3. Each side of PRB diversion wall at top of wall where stream bed crosses wall (center of stream)

4. Bottom of the PRB reaction cell excavation prior to placement of the PRB reaction cell.

B. Existing monitoring wells 16-02658 and CdV-16-1(i) can be used as benchmarks for the survey.

C. Civil survey shall be performed by a New Mexico Licensed Surveyor (see SOP-03.11). Qualification documentation (copy of license) shall be submitted with survey data.

D. Horizontal coordinates will be recorded in the New Mexico State Plane Coordinate System, Central Zone, referenced to the North American Datum of 1983 (SPCS 83, NM Central). Distances are expressed as ground distance in US survey feet (US ft). All elevation data must be reported relative to the

National Geodetic Vertical Datum of 1929. Survey accuracy will be within 0.1 foot.

3.4 CIVIL SURVEY OF PRB MONITORING WELLS

A. A civil survey of the three newly installed PRB monitoring wells shall be conducted using either GPS or traditional techniques (see Section 33 2413, Groundwater Monitoring Wells). Traditional survey techniques may be required due to the inaccessibility of GPS satellites in Cañon de Valle. Surveyed points (horizontal and vertical) shall include the location of the well and all appropriate elevations associated with the top-well equipment. The point on the well casing for which the elevation was determined shall be permanently marked on the casing.

B. Civil survey shall be performed by a New Mexico Licensed Surveyor (see SOP-03.11). Qualification documentation (copy of license) shall be submitted with survey data.

C. Horizontal coordinates will be recorded in the New Mexico State Plane Coordinate System, Central Zone, referenced to the North American Datum of 1983 (SPCS 83, NM Central). Distances are expressed as ground distance in US survey feet (US ft). All elevation data must be reported relative to the National Geodetic Vertical Datum of 1929. Survey accuracy will be within 0.01 foot.

END OF SECTION

SECTION 02 3000

SUBSURFACE INVESTIGATION

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Installation of three test pits in the PRB area to determine the depth to tuff, presence of fractures in the tuff surface, collect soil samples for laboratory testing to determine the optimal bentonite composition and field compaction, and to assess the need for dewatering during excavation of the groundwater diversion walls and PRB reactive cell.

B. Based on the boring log for monitoring well 16-02658, expected depth to tuff is approximately 5.5 feet below grade.

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 31 2333 Trenching and Backfilling

B. QMP, Quality Management Plan for the Environmental Programs Directorate

C. ENV-DO-207, Handling, Packaging, and Transporting Field Samples

D. QP-5.2, Control of Measuring and Test Equipment

E. QP-5.7, Notebook Documentation for Environmental Restoration Technical Activities

F. QP-8.1, Inspection and Acceptance Testing

G. MAQ-011, Logbook Use and Control

H. SOP-01.04, Sample Control and Field Documentation

I. SOP-06.09, Spade and Scoop Method for Collection of Soil Samples

J. SOP-15.09, Chain-of-Custody for Analytical Data Record Packages

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 TEST PITS EXCAVATION

A. Prior to excavation of test pits, provide 48 hour notice to the LANL QA Representative.

B. Excavate three test pits along the route of the PRB; one along each wall and the third at the location of the PRB reactive cell. Exact locations will be determined in conjunction with LANL QA Representative (HOLD POINT). Segregate soil by type, including top soil and alluvium.

C. Ensure that the excavation is sloped properly to allow for safe entry and inspection.

D. Collect approximately 50 pounds of soil from each test pit (or sufficient material to perform moisture-density compaction testing per ASTM D-698 or D-1557, as applicable, as described in 3.2 below), approximately half from 3 feet below grade and half from the alluvium adjacent to the top of tuff (see SOP-06.09 or equivalent). Label each sample container with location and a unique sample name (see ENV-DO-207).

E. Record the dimensions of the test pit (± 0.5 foot), ensuring that the test pit walls are sloped properly to allow personnel to enter the excavation.

F. Visually inspect the exposed tuff in each test pit, and arrange for a LANL photographer to photograph the tuff surface in each test pit. Note the density of fractures, weathering, and the slope of the tuff surface. The slope of the tuff surface is important information for installing the reactive cell. HOLD POINT – Notify LANL QA Representative.

G. Estimate the flow rate of groundwater into the excavation in gallons per minute and record (± 10%).

H. Barricade/secure the excavations until laboratory soil testing is completed. Excavations will be integrated into the PRB cell and diversion wall construction identified in Section 31 2333, Trenching and Backfilling.

3.2 LABORATORY SOIL TESTING

A. Submit samples for mixing with 10% and 20% by weight bentonite and conduct moisture-density compaction testing and permeability testing of samples.

B. Moisture-density compaction testing will be performed by an approved testing agency using ASTM D-698 or ASTM D-1557, as applicable. Testing results shall be submitted per Section 01 3300, Submittal Procedures, for both bentonite fractions.

C. Permeability testing will be performed by an approved testing agency using ASTM D-5084. Testing results shall be submitted per Section 01 3300, Submittal Procedures, for both bentonite fractions. LANL will review and approve final mixture (HOLD POINT).

END OF SECTION

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 02 3000 Rev. 0, dated January 6, 2006.

SECTION 02 4116

STRUCTURE DEMOLITION

PART 1 GENERAL

1.1 SUMMARY

A. This section applies to the demolition of a portion of the 260 Outfall concrete trough.

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 02 6100, Removal and Disposal of Contaminated Soils

B. Section 32 7200, Wetlands Restoration

C. QMP, Quality Management Plan for the Environmental Programs Directorate

D. QP-5.7, Notebook Documentation for Environmental Restoration Technical Activities

E. SOP-01.01, General Instructions for Field Investigations

F. Appendix F, Waste Management Plan and referenced documents.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 DEMOLITION OF THE 260 OUTFALL CHANNEL CONCRETE DRAINAGE TROUGH

A. Remove topsoil to expose the concrete trough and steel covering.

B. Remove the steel covering and segregate for LANL recycling.

C. Breakup the concrete trough and remove in sections using an excavator. NOTE: A percussion hammer shall NOT be used in this area. Segregate the concrete.

D. Conduct soil sample collection for LANL testing of underlying soil, as described in Section 02 6100, Removal and Disposal of Contaminated Soils

E. Conduct additional excavation, if necessary, to attain the soil cleanup standards specified in Section 02 6100 Removal and Disposal of Contaminated Soils.

F. Backfill excavation using clean fill in 1 foot lifts, compacting with excavator bucket. HOLD POINT – prior to backfilling, LANL QA Representative shall be notified and approve adequate soil sampling has been performed. No minimum compaction density is required but Best Management Practices should be implemented to avoid excessive settling of the backfill.

G. Reseed the site per Section 32 7200, Wetlands Restoration, using a LANL supplied seed mixture for the area.

END OF SECTION

SECTION 02 6100

REMOVAL AND DISPOSAL OF CONTAMINATED SOILS

PART 1 GENERAL

1.1 SUMMARY

A. This section applies to the excavation of residual soils exceeding the soil cleanup standards in the former settling pond and drainage channel.

B. This section applies to the excavation of residual soils exceeding the soil cleanup standards beneath the concrete outfall trough.

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 31 3526.13, Clay Containment Cap

B. Section 02 2113, Site Surveys

C. QMP, Quality Management Plan for the Environmental Programs Directorate

D. ENV-DO-207, Handling, Packaging, and Transporting Field Samples

E. QP-5.7, Notebook Documentation for Environmental Restoration Technical Activities

F. QP-8.1, Inspection and Acceptance Testing

G. MAQ-005, Work Safety Review and Authorization

H. MAQ-011, Logbook Use and Control

I. SOP-01.01, General Instructions for Field Investigations

J. SOP-01.04, Sample Control and Field Documentation

K. SOP-01.05, Field Quality Control Samples

L. SOP-01.06, Management of ER Project Waste

M. SOP-01.07, Operational Guidelines for Taking Soil and Water Samples in Explosive Areas

N. SOP-01.08, Field Documentation of Drilling and Sampling Equipment

O. SOP-01.10, Waste Characterization

P. SOP-06.09, Spade and Scoop Method for Collection of Soil Samples

Q. SOP-10.06, High Explosives Spot Test

R. SOP-15.09, Chain-of-Custody for Analytical Data Record Packages

S. Appendix G, Waste Management Plan, and referenced documents

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 EXCAVATION OF HOTSPOTS IN THE FORMER SETTLING POND AND DRAINAGE CHANNEL

A. Locate the Hotspots from their sampling coordinates.

B. For locations in the former settling pond, excavate the existing cap, which is approximately 20 inches in thickness, within a five foot radius of the hotspot. Segregate and stockpile the cap soil for reuse.

C. For all excavations where high explosive residues may be present, follow SOP-01.07, Operational Guidelines for Taking Soil and Water Samples in Explosive Areas.

D. For all locations, excavate the soil within a five foot radius of the hotspots to a depth of approximately 2 feet below grade or to the top of tuff using a small skid loader equipped with a backhoe, tracked excavator, hand tools, or other acceptable alternative.

E. Stockpile the excavated potentially contaminated soil on plastic and cover with plastic at the end of the day.

F. Barricade/secure and cover (plastic) the excavations until laboratory confirmatory testing and risk assessment is completed. Excavation covers should be installed to prohibit run-on.

F. Perform confirmatory sampling

1. Collect one surface sample from residual soil (per SOP-01.07) in the hotspot and analyze using field analytical methods for high explosives.

2. Compare the field analytical results for high explosives to the soil cleanup standards identified in the Corrective Measure Implementation Plan (CMI).

3. Excavate additional soil if necessary and resample/test until the high explosives soil cleanup standards are attained.

4. Record field analytical results and submit a record of results to LANL per Section 01 3300, Submittal Procedures.

5. Once the hotspot residual soils meet the high explosives standard, collect one surface sample for laboratory analysis by LANL (see LANL soil

sample collection, handling, and transportation QPs and SOPs) and submit to approved Laboratory agency for HE, VOCs, SVOCS, uranium, and metals analyses.

6. Identify and survey per Section 02 2113 both field analytical sampling locations and laboratory confirmation sample locations.

G. Risk Assessment: LANL will conduct a risk assessment using the results of the field and laboratory confirmatory sampling to determine compliance with the risk based soil cleanup levels for the settling pond and drainage channel.

H. Upon completion and acceptance by LANL of the risk assessment results, backfill hotspot excavations with clean fill material in 1 foot lifts and machine compact with excavator bucket. HOLD POINT – DO NOT proceed with backfilling until receiving approval from LANL. No minimum compaction density is required but best management practices should be implemented to avoid excessive settling of the backfill.

I. For excavations in the former settling pond, install the low permeability cap material over the backfilled excavation in accordance with Section 31 3526.13 Clay Containment Cap.

J. Manage wastes (soil, plastic, etc.) in accordance with the waste management plan.

3.2 EXCAVATION AND CONFIRMATORY SAMPLING UNDER THE CONCRETE TROUGH

A. Collect samples for field analysis of high explosives every 1 meter or in locations of obvious soil staining.

B. Compare the field results with the high explosives soil cleanup levels identified in the CMI.

C. For hotspots that fail the soil cleanup levels for high explosives, excavate the soil within a one meter radius of the hotspot using excavator or hand digging to a depth of 6 inches. Stockpile the soil on plastic and cover with plastic at the end of the day.

D. Resample the surface soil of the hotspot and analyze for high explosives using field methods.

E. If field analytical results indicate attainment of the soil cleanup levels along entire length of excavated trough, collect three confirmatory samples along length of excavation for LANL laboratory analysis, approximately evenly spaced (or in the location where additional soil was removed) and submit to approved Laboratory agency for HE, metals, VOCs, SVOCs, and uranium analyses. (See LANL soil sample collection, handling, and transportation QPs and SOPs). If soil cleanup levels are not attained, repeat steps C and D.

F. Identify and survey per Section 02 2113 both field analytical sampling locations and three laboratory confirmation sample locations.

G. Backfill the excavation with clean fill in 1 foot lifts and machine compact using excavator bucket. HOLD POINT – prior to backfilling, LANL QA Representative shall be notified and approve adequate soil sampling has been performed. No minimum compaction density is required but best management practices should be implemented to avoid excessive settling of the backfill.

H. Manage wastes (soil, plastic, etc.) in accordance with the waste management plan.

END OF SECTION

SECTION 03 3053

MISCELLANEOUS CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.1 SUMMARY

A. This section specifies the cast in place concrete to be used for the Burning Ground Spring carbon filter, the PRB cell (see Section 06 8200, Glass-Fiber Reinforced Plastic), and the pads around the steel collars for the monitoring wells associated with the PRB (see Section 33 2413, Groundwater Monitoring Wells).

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 06 8200, Glass-Fiber Reinforced Plastic

B. Section 33 2413, Groundwater Monitoring Wells

C. QMP, Quality Management Plan for the Environmental Programs Directorate

D. SOP-05.01, Well Construction

E. ACI/MCP 205, Manual of Concrete Practice Part 2 - ACI 224R-01 to ACI 313R-97

F. ACI 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete

G. ACI/MCP 305, Manual of Concrete Practice Part 3:315-99 to 343R-95

H. ACI 318/318R, Building Code Requirements for Structural Concrete (ACI 318-05) and Commentary (ACI 318R-05)

I. ASTM C-143, Standard Test Method for Slump of Hydraulic-Cement Concrete

J. ASTM C-150, Standard Specification for Portland Cement

1.3 JOB CONDITIONS

A. Do not place concrete when base surface temperature is less than 40 degrees F.

B. Perform concrete washout of mixers in a designated and controlled area to prevent the runoff of washout material and the co-mingling of unset concrete with storm water. Properly dispose of all hardened concrete.

PART 2 PRODUCTS (NOT USED)

2.1 REDI-MIX CONCRETE

A. Concrete shall be ready-mix concrete and mix design data shall conform to ACI/MCP 205.

B. Nonexposed concrete elements: 3000 psi minimum compressive strength.

C. Direct-exposed concrete elements: 5000 psi minimum compressive strength shall be determined in 28 calendar days.

D. Slump: 1 inch to 4 inch according to ASTM C-143/C-143M and ACI 211.1.

E. Portland Cement shall conform to ASTM C 150, Type I-II

2.2 FORMS

A. Forms shall be of wood, steel, or other approved material and shall conform to ACI/MCP 305 and ACI 318/318R.

PART 3 EXECUTION

3.1 INSPECTION

A. Verify compacted, treated base is ready to support concrete and imposed loads.

B. Verify grades and elevations of base are correct.

C. Verify forms are set to the required grade and alignment and extend to the required depth.

3.2 PLACING CONCRETE

A. Concrete shall be placed in the forms in one layer. The concrete shall be consolidated with an approved vibrator, and the surface shall be finished to grade with a strike off.

3.3 CONCRETE FINISHING

A. The surface shall be finished true to grade and section with a wood float or darby to a smooth and uniformly fine granular or sandy texture free of waves, irregularities, or tool marks.

B. Finished surfaces of the PRB cell base shall not vary more than 1/4 inch from the testing edge of a 10-foot straightedge.

C. Slope top of concrete monitoring well bases to provide positive drainage (see Section 33 2413, Groundwater Monitoring Wells and SOP-05.01, Well Construction).

3.4 CURING AND PROTECTION

A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.

3.5 DEFECTIVE CONCRETE

A. Defective concrete is concrete not conforming to strength requirements and specifications, not being free from excessive cracking, discoloration, form marks, tool marks, honeycombs, embedded debris, or otherwise non-consistent with the overall appearances of the work.

B. Replace defective concrete at Contractor's expense.

END OF SECTION

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 03 3053 Rev. 2, dated January 17, 2007.

SECTION 03 6100
CEMENTITIOUS GROUT

PART 1 GENERAL

1.1 SUMMARY

A. Grout is used to seal any visible fractures in the tuff during installation of the PRB, and for providing a seal for the reactive cell to its concrete base. The grout mixture for this purpose shall be a 3% - 5% bentonite powder by dry weight mixed with neat Portland cement.

B. This section does not apply to injection grouting (see Section 03 6400)

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 03 6400, Injection Grouting

B. QMP, Quality Management Plan for the Environmental Programs Directorate

PART 2 PRODUCTS

2.1 PORTLAND CEMENT

Cement used in grout shall conform to the requirements of ASTM C 150, Portland cement Type I-II. The Contractor shall employ methods of handling, transporting, and storage that are satisfactory to the LANL QA Representative (HOLD POINT). Only cement furnished in cloth or paper bags will be accepted for use in the work unless bulk cement is approved. A sufficient quantity of cement shall be stored at or near the site of the work to ensure that grouting operations will not be delayed due to shortage of cement. Care shall be taken in storage and handling to protect the cement from contamination and moisture. In the event the cement contains lumps or foreign matter that will not pass through a standard #100 mesh screen, the cement shall be removed from the work site and replaced by the contractor at the contractor's expense.

2.2 WATER

The water used in the grout shall be furnished by the Contractor. It shall be fresh, clean, and free of sewage, oil, or organic matter and injurious amounts of acid, alkali, and salts or other damaging substances.

2.2 BENTONITE

Bentonite powder: The bentonite shall be free flowing, high swelling, powdered sodium bentonite manufactured by Wyo-Ben Inc. or Black Hills Bentonite or equivalent. A sufficient quantity of bentonite shall be stored at or near the site of the work to ensure that grouting operations will not be delayed due to shortage of bentonite. Care shall be taken in storage and handling to protect the bentonite from contamination and moisture. In the event the bentonite contains lumps or foreign matter that will not pass through a standard #100 mesh screen, the bentonite shall be removed from the work site and replaced by the contractor at the contractor's expense.

PART 3 EXECUTION

3.1 GROUT MIXING

A. Mix grout using a ratio of one 94 lb. bag of Portland cement with added 3% - 5% bentonite powder by dry weight to 6 to 8 gallons of water. Consistency of the grout shall be determined in the field for the work to be performed.

END OF SECTION

SECTION 03 6400

INJECTION GROUTING

PART 1 GENERAL

1.1 SUMMARY

A. This section specifies the injection grouting to be used for sealing the 17-foot below grade surge bed located beneath the former settling pond near the 260 Outfall. The overburden consists of welded volcanic tuff. The estimated maximum area for grouting is 1250 ft^2.

1.2 PERFORMANCE CRITERIA

A. The performance criteria for the grouting is to achieve a permeability of 5×10^{-5} centimeters per second (cm/s) or lower for the 17-foot below grade surge bed in the vicinity of BH 16-02700, located within the former settling pond for the 260 Outfall. Permeability tests on this surge bed have not been conducted; however, results from two such tests conducted on nearby surge beds showed hydraulic conductivities of 3.8×10^{-3} and 5.0×10^{-4} cm/s.

1.3 RELATED SECTIONS/DOCUMENTS

A. Section 01 1400, Work Restrictions

B. Section 01 3300, Submittal Procedures

C. Section 01 4000, Quality Requirements

D. Corrective Measure Implementation Plan (CMI)

E. QMP, Quality Management Plan for the Environmental Programs Directorate

F. QP-5.2, Control of Measuring and Test Equipment

G. QP-8.1, Inspection and Acceptance Testing

H. MAQ-005, Work Safety Review and Authorization

I. SOP-01.08, Field Documentation of Drilling and Sampling Equipment

J. ASTM C-618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete

K. ASTM D-6910, Standard Test Method for Marsh Funnel Viscosity of Clay Construction Slurries

L. NMWQCC groundwater standards, 20 NMAC 6.2.3103

1.4 SUBMITTALS

A. Submit a detailed grouting plan to LANL that describes the staging and laydown areas, BMP controls, proposed mix design to meet the permeability performance criteria, hole layout and spacing, estimate of the duration of the work time in the field, grout pump manufacturer, model number and pressure capacities, refusal criteria, details of the grouting operation, and plan for permeability testing in two grouted locations.

B. A field quality control program will be required as part of the grouting plan to ensure that the same grout approved of during the design phase is exactly what is injected.

PART 2 PRODUCTS

1.1 EQUIPMENT

A. The equipment used to mix and pump grout shall be specifically designed for this purpose. Because of the high pressure involved, all equipment, including hoses, couplings, gauges and pipes, shall be able to operate to the maximum requirements stated in these specifications. The mixing and grout pump system shall be designed to provide continuous flow of the grout mixture without interruption during any single hookup for a specific stage due to inadequate batching or pump feed capacity.

1.2 MATERIALS

A. Grouting materials used for the grout design shall not cause groundwater contamination in excess of State of New Mexico Water Quality Control Commission standards (NMWQCC).

B. Grout design and composition materials should be injectable at pressures below the hydrofracturing threshold.

C. Cement. Cement (if used) shall be Type I or Type II Portland and free of contamination. Cement shall be either supplied in water resistant paper bags or in bulk. Cement containing lumps shall be rejected or screened to remove lumps.

D. Fly ash (if used) shall conform to ASTM C-618 and be either Class C or Class F.

E. Lime. Lime (if used) shall be hydrated agricultural lime. Lime shall be supplied in water resistant paper bags or in bulk. Lime containing lumps shall be rejected or screened to remove lumps.

F. Water shall be clean and free from contamination. Volume shall be as necessary to achieve the desired viscosity.

G. Admixtures such as a superplasticizer or a pumping aid may be added to increase set time or improve pumpability.

H. A field quality control program will be required as part of the grouting plan to ensure that the same grout approved of during the design phase is exactly what is injected. This may be evaluated with simple production-level tests such as Marsh funnel (ASTM D-6910) and mud balance.

PART 3 EXECUTION

3.1 COORDINATION WITH OTHER OPERATIONS

A. Grouting operations should be conducted in coordination with the excavation of hotspots in the former settling pond.

3.2 GROUT HOLE AND PIPE INSTALLATION

A. Boreholes for grout injection cannot be installed by driving; non-percussion drilling of approximate 17-foot thick overburden of welded tuff will be required.

B. The injection pipes shall be installed to prevent grout leakage and/or premature upward movement of the casing during injection of high-pressure grout.

C. Pipes shall be steel of sufficient diameter and wall thickness to allow the grout to be injected at the pressures required.

3.3 GROUT INJECTION

A. A grid pattern for primary injection pipes shall be established and the grout shall be injected beginning at the lower depth of the grouting limits.

B. Grouting pressure shall be continuously monitored at the surface connection to the injection pipe with a suitable protected gauge.

C. The grouting process shall progress in stages within each injection pipe using the bottom up method. The bottom up method stages start at the bottom of the grouting pipe, at least 1 ft into the underlying dense material, progressing upward at 2 ft maximum intervals. Grout injection shall cease for any given stage when maximum injection pressure is reached or when a sudden drop in pressure is noted.

D. After completion of primary grouting, a secondary grid pattern, split spacing the first grid pattern injection points, shall be established. Grouting in secondary holes shall proceed as described for primary holes. Quantities for the secondary stage shall be compared with grout injected during the primary stage to ensure the subsurface material is becoming densified. LANL shall be notified of the quantities placed in the secondary holes before further split spacing or an area is determined complete.

E. Any hole lost due to Contractor negligence or error shall be replaced at no charge to LANL.

F. All daily drilling, grouting, and testing reports shall be submitted to the LANL QA Representative within 24 hours. Drilling reports shall contain at least the following information: Name of driller, type of drill, method used, date, location of hole, tip depth or elevation of injection pipe. Grouting reports shall contain at least the following information: name of grouting technician, grout mix, quantity injected per stage, date, rate of pumping, beginning and final pressure obtained in each stage. The reason for refusal, such as refusal pressure,

3.4 PROTECTION OF WORK AREA AND CLEANUP

A. During the work operations the Contractor shall take such precautions as may be necessary to prevent drill cuttings, equipment exhaust, oil, wash water and grout from defacing and/or damaging the surrounding area.

B. The Contractor shall furnish such pumps as may be necessary to care for wastewater and grout from his operations and shall clean up all waste resulting from grouting operations.

C. All drill cuttings should be containerized and tested according to the Waste Management Plan.

END OF SECTION

SECTION 05 5000

METAL FABRICATIONS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Shop fabricated metal items; galvanized, prime painted, or mill finish. These items include PRB inlet and outlet grates and spring collection (weir) boxes.

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 01 3300, Submittal Procedures

B. QMP, Quality Management Plan for the Environmental Programs Directorate

C. QP-2.1, Personnel Qualification and Selection Process

D. QP-8.1, Inspection and Acceptance Testing

E. ASTM A-123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

F. ASTM B-209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

1.2 DESIGN REQUIREMENTS

A. Submit the following in accordance with Section 01 3300, Submittal Requirements:

1. Shop drawing describing each fabricated item.

a. Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size type of fasteners, and accessories.

b. Include erection drawings, elevations, and details where applicable.

c. Indicate welded connections using standard AWS welding symbols. Indicate net weld lengths.

2. Or, if manufactured, catalog data describing each manufactured metal item.

3. Welder’s certifications.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle metal items:

1. With equipment of adequate capacity;

2. Without overstressing or permanently deflecting material;

3. Without damaging finish.

B. Deliver manufactured material in original unopened packages, containers, or bundles with manufacturer's label intact and legible.

C. Store materials off ground, under cover, and away from damp surfaces.

D. Remove damaged unlabeled or unsatisfactory materials which do not meet this specification from job site.

PART 2 PRODUCTS

2.1 MATERIALS

A. Steel Grate: Provide hot-dipped galvanized steel grate sections for the PRB openings conforming to ASTM A-123.

B. Aluminum: Provide plate aluminum (5052-H32) for the weir boxes conforming to ASTM B-209.

C. Aluminum: Provide diamond tread aluminum plate (6061-T6) conforming to ASTM B-209.

2.2 FABRICATION

A. Verify dimensions on site prior to shop fabrication.

B. Fabricate items with joint tightly fitted and secured.

C. Fit and shop assemble in largest practical sections, for delivery to site.

D. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with design of structure, except where specifically noted otherwise.

E. Certify Welders in accordance with AWS D1.1 and AWS D1.2.

2.3 FINISH OF STEEL FABRICATIONS

A. Clean surfaces of rust, scale, grease, and foreign matter prior to galvanized finishing.

2.4 FINISH OF ALUMINUM FABRICATIONS

A. Alodine finish.

PART 3 EXECUTIONS

3.1 PREPARATION

A. Obtain Contract Administrator approval prior to site cutting or making adjustments to metal Items.

3.2 INSTALLATIONS

A. Install items plumb and level, accurately fitted, free from distortion or defects.

END OF SECTION

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 05 5000 Rev. 0, dated January 6, 2006.

SECTION 06 8200

GLASS-FIBER REINFORCED PLASTIC

PART 1 GENERAL

1.1 SUMMARY

A. This section specifies the fabrication and installation of the fiber reinforced plastic (FRP) permeable reactive barrier (PRB) reaction cell. Also included are instructions for loading the PRB reactive cell with reactive media. The associated drawings for the PRB represent a preliminary design that will be confirmed upon the completion of test pits and the collection of important depth to bedrock and other data. This data will be used to develop final shop drawings for fabrication of the PRB.

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 01 3300, Submittal Procedures

B. Section 02 3000, Subsurface Investigations

C. Section 03 3053, Miscellaneous Cast-in-Place Concrete

D. Section 31 2333, Trenching and Backfilling

E. Corrective Measure Implementation Plan (CMI)

F. QMP, Quality Management Plan for the Environmental Programs Directorate

G. QP-2.1, Personnel Qualification and Selection Process

H. QP-5.2, Control of Measuring and Test Equipment

I. QP-8.1, Inspection and Acceptance Testing

J. ASTM C-136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates

1.3 QUALITY ASSURANCE

A. Shop Fabricator Qualifications: Company specializing in architectural glass fiber and resin components with three years documented experience.

B. Final design drawings for the PRB shall incorporate the results of data and information from the test pits (Section 02 3000, Subsurface Investigations).

1.4 SUBMITTALS

A. Shop Drawings: Indicate design load parameters, dimensions, adjacent construction, materials, thicknesses, fabrication details, required clearances, field jointing, tolerances, proposed color, finishes, methods of support, integration of components, and anchorages.

PART 2 PRODUCTS

1.1 FRP COMPONENTS

A. Fabric Reinforcement: Glass fiber woven fabric, 200 ounces per square yard.

B. Roving: Continuous glass fiber strands, chemically sized, wound into tubeless packaging.

C. Mat: Chopped fine glass fiber strand, sized into mat form, 9.5 ounces per square yard, for polyester resin laminate reinforcement.

D. Polishing Cream: Compatible gel coat polishing cream to restore gloss surface finish.

1.2 REACTIVE CELL SHOP FABRICATION

A. Fabricate components with the open mold hand lay-up method.

B. Finish other surfaces not in contact with the mold to match the molded surfaces in appearance.

C. Finish trim corners and edges.

D. Coat exposed surfaces and surfaces in contact with moisture or earth with gel coat of approved colored resin.

1.3 REACTIVE CELL MEDIA

A. Submit sieve size analysis of proposed media (zero-valent iron, sand, gypsum and clinoptilolite zeolite) per ASTM C-136 (see Section 01 3300 Submittal Procedures).

B. Sources for zero-valent iron include Peerless Metal Powders & Abrasive, 124 S. Military Ave, Detroit, MI 48209, 1-800-959-0320 Fax: (313) 841-0240.

C. Sources for granular gypsum include AG Specialties, LLC, 12220 SW Grant Ave, Tigard, OR 97223, 503-906-1015.

D. Sources for clinoptilolite zeolite include St. Cloud Mining Company, PO Box 1670, Truth or Consequences, New Mexico 87901, (505) 743-5215

PART 3 EXECUTION

3.1 SUBSURFACE PREPARATION

A. Prepare the base tuff by grouting visible fractures and providing a level surface for installation of the reactive cell, ensuring that upstream and downstream openings of the reactive cell match the elevations of the alluvial groundwater zone. If necessary adjust the elevation of the tuff base by scraping and/or building up the base with concrete (Section 03 3053, Miscellaneous Cast-in-Place Concrete) to attain proper match of the openings to the alluvial horizon (see 31 2333 Trenching and Backfilling).

3.2 REACTIVE CELL INSTALLATION

A. Install the reactive cell according to Section 31 2333 Trenching and Backfilling, including lagging the cell to its concrete base/bedrock using ¾ x 10 inch (minimum) anchor bolts, wedge or drop in anchor type.

END OF SECTION

SECTION 31 1300

SELECTIVE TREE AND SHRUB REMOVAL AND TRIMMING

PART 1 GENERAL

1.1 SUMMARY

A. This section specifies clearing, removing, and disposing of all vegetation within the clearing limits except objects designated to remain. Work includes preserving vegetation designated to remain.

B. In consultation with the contractor, LANL will stake clearing and excavation limits on the ground, mark all trees to be removed, and provide a location for disposal of the removed vegetation.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 SURFACE PREPARATION

A. Clear all trees, brush and other objects not designated to remain.

B. Clear trees designated for removal. Cut stumps to within 12 inches of the ground surface.

C. Grub stumps, shrubs, brush, and roots (to a minimum 3” diameter) within the excavation limits.

3.2 TREE REMOVAL

A. Fall trees toward the center of the area to be cleared.

B. Use controlled falling to prevent injury or defacement to other trees.

3.3 TREATMENT OF TREES DAMAGED BY CONTRACTOR

A. Trim branches flush with tree.

B. Within 3 days of the damage, treat all cut or scarred surfaces of trees or shrubs designated to remain. Use a product prepared especially for tree surgery.

3.4 SNAGS AND UNSTABLE TREE REMOVAL OUTSIDE OF CLEARING LIMITS

A. In consultation with LANL, identify and mark all snags and unstable trees outside of the clearing limits.

END OF SECTION

SECTION 31 2333

TRENCHING AND BACKFILLING

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Trenching and backfilling specifications for installation of the Burning Ground Spring carbon filter, Martin Spring weir box installation, and the PRB installation.

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 01 3300, Submittal Procedures

B. Section 03 3053 Miscellaneous Cast-in-Place Concrete

C. Section 03 6100, Cementitious Grout

D. Section 06 8200, Glass-Fiber Reinforced Plastic

E. Section 32 7200 Wetlands Restoration

F. Section 44 4300 Water Filtration Equipment

G. QMP, Quality Management Plan for the Environmental Programs Directorate

H. QP-5.2, Control of Measuring and Test Equipment

I. QP-5.7, Notebook Documentation for Environmental Restoration Technical Activities

J. QP-8.1, Inspection and Acceptance Testing

K. MAQ-005, Work Safety Review and Authorization

L. MAQ-011, Logbook Use and Control

M. ASTM C-33, Standard Specification for Concrete Aggregates

N. ASTM D-448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction

O. ASTM D-5890, Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners

P. ASTM D-6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

1.3 LANL PERFORMED WORK

A. Obtain excavation/soil disturbance permit for Contractor.

B. Mark location of known underground utilities.

1.4 DEFINITIONS

A. Mechanical Excavation: Use of backhoes, jackhammers, trenchers, and similar powered digging machines; excludes vacuum excavators that are equivalent to hand digging.

B. Utility: Any active or inactive buried pipe, duct, conduit, or cable in a primary or secondary utility system.

1.5 SUBMITTALS

A. Submit the following in accordance with Section 01 3300, Submittal Procedures.

1. Excavation plan.

2. Results of field compaction testing.

3. Catalog data or material specification data on bentonite to be mixed with soil for the groundwater diversion wall.

4. Specifications on gravel to be used for the backfill for the carbon filter at Burning Ground Spring.

5. Specifications on pea gravel to be used for backfill around inlet and outlet of PRB cell.

1.6 QUALITY ASSURANCE

A. When work or portions of work of this Section requires field testing or other hold points, notify the LANL QA Representative (48 hour notice required).

B. Ensure compacted fills are tested in accordance with Paragraph 3.4 and in compliance before proceeding with placement of next lift.

C. Do not begin any groundbreaking until known utilities have been marked and an excavation/soil disturbance permit has been issued to Contractor.

D. Comply with OSHA 29 CFR 1926, Subpart P for excavation and trenching operation.

E. Maintain a copy of Excavation/Soil Disturbance Permit and paper work on site.

F. Perform pre-job briefing of Permit and associated safety and hazard documentation with workers performing the work.

G. Ensure that engineering controls and required Personnel Protective Equipment (PPE) are used by workers during work activities to maintain safety, especially during jack hammering.

H. Review and maintain the work within the boundaries established by the permit.

1.7 SITE CONDITIONS

A. Do not place and compact backfill material when the atmospheric temperature is below 35 degrees F, unless approved by LANL QA Representative.

PART 2 PRODUCTS

2.1 MATERIALS

A. Topsoil

1. Excavated on-site topsoil, graded free of rocks larger than 1 inch, subsoils, and debris.

B. Fill and Backfill Material

1. Native backfill material consists of excavated native soil. Fill material shall be free of rocks or stones or other deleterious materials of maximum particle size of 2 inches.

2. All fill material shall be accepted by the LANL QA Representative prior to use as backfill (HOLD POINT). In the event excavated material is unsuitable for use as fill, LANL may approve of a borrow/spoils area.

3. Aggregate backfill: backfill material for the Burning Ground Spring carbon filter. Use Grade 7 aggregate backfill per ASTM D-448 or ASTM C-33.

4. Pea gravel aggregate: Backfill material for faces of the PRB reactive cell (inlet and outlet). The material is to be a mix of rounded particles, sizes between 1/8 inch and 3/4 inch, and must conform to the specifications of ASTM C-33, paragraph 9.1, sizes 6, 67 or 7. No more than 5% (by weight) of the backfill may pass through a #8 sieve. The material is to be washed, free-flowing, and free of ice, snow and debris.

5. Bentonite: The bentonite for soil/bentonite wall shall be a free flowing, high swelling, granular sodium bentonite. Bentonite in fine powder form shall not be used due to loss from blowing dust. Bentonite shall be Envirogel 10 as manufactured by Wyo-Ben Inc. or Granular Bentonite 12/40 mesh manufactured by Black Hills Bentonite or equivalent. The bentonite shall have a free swell of at least 18 cc/2gm as measured by ASTM D-5890 and shall meet the following gradation requirements:

Bentonite Gradation Requirements

Sieve Size	Percent Passing
10	98-100
20	60-100
200	0-20

C. Riprap

1. Riprap rock shall be of sufficient hardness to resist weathering and shall be free of cracks and other blemishes. Porous rock, such as some limestones, and soft rock, such as shales, shall not be allowed for use as riprap.

2. Riprap rock shall be of a rounded shape, with a diameter of approximately 6” to 12”.

PART 3 EXECUTION

3.1 BURNING GROUND SPRING CARBON FILTER

A. The carbon filter system at Burning Grounds Spring shall be installed to minimize loss of wetlands caused by subgrade piping of spring water. The system, including the outfall pipe, should be installed as close as possible to the spring, while meeting minimum head requirements across the unit.

B. Install temporary bypass piping on the spring to bypass water for a distance of approximately 50 feet to include weir box to surface discharge point. Bypass piping can consist of 2” PVC rigid or flexible piping. Use existing weir, and re-install above the original location. Allow soils within the 50 foot reach to dry for one week.

C. Hand excavate for placement of the weir box in the location of the original weir. Place weir box and backfill to secure using native backfill. Allow room for the above-ground overflow pipe.

D. Location for the weir box must allow piping from the weir box to the carbon filter to be installed subgrade. If rocks do not allow for use of rigid piping, use 2” reinforced flexible PVC hose.

E. Excavate for installation of the carbon filter and the inlet and outlet pipes using a track mounted, low ground pressure small backhoe or excavator. Stockpile surface topsoil for re-use.

F. Install and backfill subgrade piping and the carbon filter. HOLD POINT: Hold for inspection of minimum hydraulic head by LANL QA Representative.

G. Backfill using aggregate backfill to 1 foot of original grade.

H. Install concrete collar around the carbon filter box.

I. Backfill with topsoil, and restore site according to Section 32 7200, Wetlands Restoration

J. Install carbon filters and prep unit for service as specified in Section 44 4300, Water Filtration Equipment.

3.2 MARTIN SPRING WEIR BOX INSTALLATION

A. Select optimal location and configuration for installation of the weir box in consultation with the LANL QA Representative (HOLD POINT). Objective is to capture water from a new seep. Revise drawing as indicated in Submittals.

B. Hand-excavate location for the weir box and backfill using native materials to secure. Allow room for the above-ground overflow pipe and drain pipe into the existing weir box reservoir.

C. Install surface drain pipe from new weir box to existing weir box reservoir. Maintain uniform slope on the pipe to prevent ice blockage. Anchor surface pipe using native rocks. .

D. Restore the site according to Section 32 7200, Wetlands Restoration.

3.3 PRB INSTALLATION

A. Install bypass piping for the stream to bypass the construction area.

B. Excavate topsoil along the location of the groundwater diversion wall and at the location of the PRB reaction cell. Note that test pits were previously excavated as part of Section 02 3000, Subsurface Investigations. Stockpile the topsoil for re-use.

C. Groundwater Diversion Wall and Reactive Cell Installation

1. Excavate the groundwater diversion wall and reaction cell according to the excavation limits detailed in the excavation plan. Stockpile soil for later use.

2. Excavate the specified depth into tuff.

3. Seal tuff fractures that are visible along the groundwater diversion wall and reactive cell location using grout as specified in Section 03 6100, Cementitious Grout.

4. In conjunction with the LANL QA Representative (HOLD POINT), check all dimensions, including reactive cell, depth to bedrock, elevations of top and bottom of alluvial horizons and remove additional tuff surface as

required to ensure proper match of the PRB reactive cell opening to the alluvial horizon, including the concrete pad used to level the reactive cell.l A LANL geologist familiar with local lithologies will conduct an inspection of the tuff for the purpose of geological classification.

5. Install a concrete pad sufficient to level the reactive cell and align the openings with the alluvial horizon. Concrete specifications are given in Section 03 3053 Miscellaneous Cast-in-Place Concrete.

6. Lay down a thin (1”-2”) layer of grout on the concrete pad and set the PRB reaction cell including the attached opening grates in position on the wet grout and concrete pad. Bolt the cell to its concrete base/bedrock using ¾ x 10 inch (minimum) anchor bolts with wedge or drop-in anchor type.

7. Precondition the native backfill for mixing with the bentonite by removing rocks (3” or greater) and other debris and by use of a soil pulverizer or hammermill.

8. Mix the approved bentonite/soil mixture (see Section 02 3000 for determination and approval of bentonite/soil mixture) using a pug mill.

9. Backfill the soil/bentonite mixture in 6 inch lifts along the length of the wall. Use the backfill mixture that was established in the approved excavation plan to achieve the maximum 1×10^{-7} cm/s conductivity.

10. Ensure a good seal between the sides of the reactive cell and the soil/bentonite wall to preclude groundwater bypass of the reactive cell. Fan the width of the bentonite/soil mixture wall out to 4 feet (minimum) at the point of contact with the PRB reactive cell.

11. Each lift shall be compacted as necessary to make the density of the bentonite treated earth fill material not less than the minimum density (95% of maximum from moisture-density curve ASTM D-698, standard Proctor). The moisture content on the bentonite treated earth fill material shall be maintained within the range (0-3% wet of optimum) necessary to achieve the permeability performance standard.

12. The interface between the lifts shall be roughened or scarified a minimum of ½ inch prior to placement of the next lift.

13. Compaction with a sheepsfoot roller or a track type tractor shall not be allowed.

14. At and around the reactive cell openings (inlet and outlet), backfill with pea gravel to at least 2 feet out from the openings. Scarify the alluvium face if necessary to breakup any clay skin.

15. Do not mechanically compact the pea gravel backfill. Backfill with pea gravel to 18 inches (± 3 inches) above the top of the reactive cell openings.

16. To control surface water infiltration, place 10 mil HDPE sheeting over the top of the pea gravel fill, extending 1 foot (minimum) out from the edge of the pea gravel (away from the reactive cell openings). Lay the HDPE layer up the side of the reactive cell to surface grade.

17. Place native fill material above 10 mil HDPE liner to a level 6 to 12 inches below surface grade.

18. A protective cover layer of at least 12 inches of topsoil shall be applied immediately after compaction, over the bentonite/soil wall to protect it from forming drying cracks and from weathering.

19. Install a concrete collar around the PRB reactive cell.

20. Place stockpiled top soil over native fill to surface grade.

21. Restore the surface, including the stream channel, as specified in Section 32 7200 Wetlands Restoration and the design drawings.

22. Load reactive cell with media as specified in Section 06 8200, Glass-Fiber Reinforced Plastic.

3.4 SOIL COMPACTION AND TESTING

A. Control soil compaction during construction by ensuring backfilling and compaction in 6 inch lifts. Conduct compaction testing (ASTM D-6938 as applicable) to achieve the specified density (95% of standard Proctor-ASTM 698) and moisture (0-3% wet of optimum) for the groundwater diversion wall (see Section 01 3300 Submittal Requirements).

END OF SECTION

FOR LANL USE ONLY

This project specification is based on LANL Master Specification 31 2000 Rev. 1, dated January 17, 2007.

SECTION 31 3526.13

SOIL/BENTONITE CONTAINMENT CAP

PART 1 GENERAL

1.1 SUMMARY

A. This section applies to the installation of a low permeability soil/bentonite cap at the former settling pond in areas where hotspots were excavated.

B. The cap thickness is 1 foot and the area of the cap anticipated to be replaced consists of two approximately 10 foot-diameter circles.

C. The performance standard for the cap is 1×10^{-7} cm/s for hydraulic conductivity.

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 01 3300, Submittal Procedures

B. Section 02 6100, Removal and Disposal of Contaminated Soils

C. QMP, Quality Management Plan for the Environmental Programs Directorate

D. ENV-DO-207, Handling, Packaging, and Transporting Field Samples

E. SOP-06.09, Spade and Scoop Method for Collection of Soil Samples

F. ASTM D-698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3)

G. ASTM D-1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3)

H. ASTM D-5084, Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter

I. ASTM D-5890, Standard Test Method for Swell Index of Clay Mineral Component of Geosynthetic Clay Liners

PART 2 PRODUCTS

A. The bentonite for the soil/bentonite cap shall be a free-flowing, high-swelling, granular sodium bentonite. Bentonite in fine powder form shall not be used due to loss from blowing dust. Bentonite shall be Envirogel 10 as manufactured by Wyo-Ben Inc. or Granular Bentonite 12/40 mesh manufactured by Black Hills Bentonite or equivalent. The bentonite shall have a free swell of at least 18 cc/2gm as measured by ASTM D-5890 and shall meet the following gradation requirements:

Bentonite Gradation Requirements

Sieve Size	Percent Passing
10	98-100
20	60-100
200	0-20

B. Clean fill: Clean soil without rocks or debris larger that 3/4 inch.

PART 3 EXECUTION

3.1 SOIL TESTING OF FORMER CAP SOILS

A. Collect approximately 50 pounds of soil (or sufficient material to perform moisture-density compaction testing per ASTM D-698 or D-1557, as applicable) (see SOP-06.09 or equivalent) from the former cap soil stockpile (see Section 02 6100, Removal and Disposal of Contaminated Soils) for moisture-density compaction testing and for permeability testing. Label each soil sample container with location and a unique sample name (see ENV-DO-207).

B. Moisture-density compaction testing will be performed by an approved testing agency using ASTM D-698 or ASTM D-1557, as applicable. Testing results shall be submitted per Section 01 3300, Submittal Procedures.

C. Permeability testing will be performed by an approved testing agency using ASTM D-5084. Testing results shall be submitted per Section 01 3300, Submittal Procedures. LANL will review and approve final mixture/material (HOLD POINT).

D. Assess the results to determine if the existing cap soils can meet the 1×10^{-7} cm/s hydraulic conductivity standard. In addition, visually inspect the stockpiled cap soils to ensure soils do not contain rocks or other debris greater than three inches in diameter. Soils that do not meet either criterion are not suitable for reuse.

E. If the stockpiled former cap material does not meet the criteria in 3.1.D above, a mixture of clean fill material and bentonite (10 to 20%) shall be prepared and tested by an approved testing agency (moisture-density and permeability testing). Use additional soil permeability testing to determine the necessary weight fraction of bentonite in the soil/bentonite soil mixture to attain the hydraulic conductivity standard of 1×10^{-7} cm/s and to develop a moisture-density compaction curve.

3.2 MIXING OF THE SOIL/BENTONITE FOR THE SETTLING POND CAP REPLACEMENT

A. A pug mill shall be used to mix the soil and bentonite mixture for the cap.

3.3 PLACEMENT OF THE CAP MATERIAL

A. The soil/bentonite mix should be placed to achieve a maximum thickness of six inches per compacted lift and compacted to a minimum 95 percent of maximum density from ASTM D-698 (standard proctor), with moisture content 0-3% wet of optimum.

B. Do not place or compact frozen soil.

C. Install the cap to a thickness of one foot over the excavated area within the former settling pond.

END OF SECTION

SECTION 32 7200

WETLANDS RESTORATION

PART 1 GENERAL

1.1 OVERVIEW OF WETLANDS RESTORATION

A. The goal of wetlands restoration is to restore hydric soil conditions, hydrologic conditions, hydrophytic plant communities, and wetland functions that occurred on the disturbed wetland site prior to modification to the extent practicable. Wetland hydrology should be restored as close as possible to its original condition before it was manipulated. As a minimum, the hydrologic soil condition must be able to support hydrophytic vegetation.

B. Activities with potential for wetlands disturbance consist of the installation of the carbon filter at Burning Ground Spring, installation of the second weir box at Martin Spring, and the installation of the PRB, including the installation of the test pits.

C. Wetlands restoration best management practices consist of stockpiling and reuse of topsoil, seeding, erosion control, and construction of a stream channel.

1.2 RELATED SECTIONS/DOCUMENTS

Section 03 3053, Miscellaneous Cast-in-Place Concrete

Section 31 2333, Trenching and Backfilling

QMP, Quality Management Plan for the Environmental Programs Directorate

PART 2 PRODUCTS

2.1 SEED

A. LANL will provide the seed mixture for reseeding.

2.2 EROSION CONTROL BLANKET

A. Provide erosion control blankets of a uniform web of interlocking excelsior wood fibers, weed-free straw, or a combination of straw and coir fibers.

B. Use a machine produced erosion control blanket using 100 percent straw or excelsior fibers sewn into a medium weight photo degradable bottom net. Minimum weight of blanket 0.5 lbs/ square yard, such as Greenfix America WS05, etc.

C. Staples: U-shaped, 11 gauge or heavier steel wire, minimum leg length of 8 inches after bending, with a throat approximately 2 inches wide.

D. Wood Stakes: Use 2 x 2 x 12 inch pine or fir stakes, beveled at one end, in place of wire staples in tuff locations.

2.3 RIPRAP

A. Riprap rock shall be of sufficient hardness to resist weathering and shall be free of cracks and other blemishes. Porous rock, such as some limestones, and soft rock, such as shales, shall not be allowed for use as riprap.

B. Riprap rock shall be of a rounded shape, with a diameter of approximately 6” to 12”.

2.4 GEOTEXTILE FABRIC

A. Geotextile fabric: Use geotextile fabric TerraTex™ EP or similar.

PART 3 EXECUTION

3.1 STOCKPILING AND RESPREADING OF TOP SOIL DURING EXCAVATION

A. The topsoil from wetland excavated areas (Burning Ground Spring carbon filter system and Martin Spring weir box) shall be stockpiled and redistributed to maintain plant seedbanks. Reseeding in these areas will not be required.

3.2 SEEDING OF CAÑON DE VALLE PRB

A. Topsoil from the Cañon de Valle PRB excavated areas shall be stockpiled and redistributed over the completed PRB diversion wall as specified in Section 31 2333, Trenching and Backfilling.

B. General:

1. Avoid seeding between August 1 and September 30. Do not seed during windy weather, or when topsoil is dry, saturated or frozen.

2. Equip seed boxes used for drill and broadcast seeding with an agitator.

3. To prevent stratification of seed mix, do not run seed box agitators while seeding is not being performed.

4. If seed mix is transported to site in a seed box or other equipment that subjects mix to shaking or similar movement that has the potential to cause stratification, remix seed prior to application.

C. Preparation of the Seed Bed

1. Where necessary, prepare seedbed to a maximum depth of 4 inches by tilling with a disc harrow or chiseling tool. Uproot all competitive vegetation during

seedbed preparation and work soil uniformly, leaving surface rough to reduce surface erosion. Remove large clods and stones, or other foreign material that would interfere with seeding equipment.

2. Do not till on ground that is already loose to a depth of 2 inches or more that has undergone regrading and fill. Till newly cut slopes.

3. Perform tillage across slope when practical and perform in 2 directions whenever one pass is insufficient to adequately break up soil. Do not till up and down slopes, as this will create excessive surface erosion problems.

4. Do not do work when moisture content of soil is unfavorable or ground is otherwise in a non-tillable condition. To minimize dust problems for adjoining areas, do not till when wind speeds are over 10 mph.

5. The extent of seedbed preparation shall not exceed the area on which the entire seeding operation can be accomplished within a 24-hour period.

D. Soil Amendments/Additions (supplied by LANL): Uniformly apply slow release organic fertilizer, if necessary, in accordance with LANL recommendations.

E. Prepare seedbed again if prior to seeding LANL QA Representative determines that rain or some other factor has affected prepared surfaces and that it may prevent seeding to proper depth. (HOLD POINT for seedbed preparation).

F. Broadcast Seeding

1. When broadcast seeding, plant seed mix at a rate of 32 - 37 PLS lbs/acre.

2. Mechanically broadcast seed by use of a hydraulic mulch slurry blower, rotary spreader, or a seeder box with a gear feed mechanism. If seeding is done with a slurry blower, use highest pressure and smallest nozzle opening that will accommodate the seed.

3. Immediately following seeding operation, lightly rake seedbed or loosen with a chain harrow to provide approximately 1/4 inch of soil cover over most of the seed.

4. Prohibit vehicles and other equipment from traveling over the seeded areas.

3.4 EROSION CONTROL BLANKET

A. Place blankets over native grass seeding immediately following the raking/chaining operation.

B. When using single netted products for 3:1 or flatter slopes, place blanket with netting on top and the wood/ straw fibers in contact with soil over entire seeded area.

C. Staple blanket in place in accordance with manufacture’s recommendations.

3.5 STREAM CHANNEL

A. Construct stream channel to match contour and shape of existing upstream and downstream sections, using top soil previously stockpiled.

B. Prepare base by compacting soil to form the channel. Compact to 85% density (see Section 31 2333 Trenching and Backfilling).

C. Place geotextile fabric on compacted base, extending at least 2 feet laterally on both sides of stream channel (outside of channel) and at least 10 feet up- and down-stream in stream channel from location of PRB diversion wall crossing.

D. Bury leading edge (2 to 4 feet) of geotextile fabric along upstream end. Leading edge should be buried 1 foot (minimum) below bottom of stream channel. Compact soil in channel over buried geotextile, taking care not to damage geotextile fabric.

E. Staple geotextile filter fabric in place in accordance with manufacturer’s recommendations.

F. Place riprap over geotextile fabric within channel over entire length of geotextile fabric in channel extending 2 feet (minimum) past each end of fabric.

G. Cement the riprap into place (to stabilize) from upstream end of riprap to at least 5 feet down-stream of the PRB diversion wall crossing in the stream channel, extending to the lateral sides of the channel, leaving approximately 18 inches of geotextile fabric exposed on each side of channel.

H. Place erosion control blankets (per section 3.4 above) along sides of stream channel, overlapping the geotextile fabric by 18 inches (minimum), and staple in place in accordance with manufacturer’s recommendations.

END OF SECTION

SECTION 33 2413

GROUNDWATER MONITORING WELLS

PART 1 GENERAL

1.1 OVERVIEW OF WELL INSTALLATION

A. Three alluvial groundwater monitoring wells will be installed adjacent to the PRB for the purpose of monitoring PRB performance. Approximate locations are presented in the design drawings. Exact locations for the three wells will be determined in the field after the construction of the PRB in conjunction with the LANL QA Representative (HOLD POINT).

B. One shallow groundwater monitoring well will be installed down gradient from the former settling pond, outside of the injection-grouted area. The approximate location of the well is presented in the Corrective Measures Implementation Plan. Exact location and depth for the well will be determine in the field after injection grouting is complete and shall be approved by the LANL QA Representative (HOLD POINT).

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 02 2113, Site Surveys

B. Section 03 3053, Miscellaneous Cast-in-Place Concrete

C. QMP, Quality Management Plan for the Environmental Programs Directorate

D. ENV-DO-202, Manual Groundwater Level Measurements

E. QP-2.1, Personnel Qualification and Selection Process

F. EP-DIR-SOP-4003, Records Management

G. MAQ-005, Work Safety Review and Authorization

H. SOP-01.08, Field Documentation of Drilling and Sampling Equipment

I. SOP-03.11, Coordinating and Evaluating Geodetic Surveys

J. SOP-04.01, Drilling Plan Development

K. SOP-05.01, Well Construction

L. SOP-05.02, Well Development

M. NMED, Order on Consent

PART 2 PRODUCTS (NOT USED)

2.1 CASING, SCREEN, FILTER PACK, SEALS

A. Casing: The well casing shall be two inches in diameter stainless steel (304 or 316) Schedule 40 pipe, flush-thread, screw joint (no glue or solvents); polytetrafluorethylene (PTFE, such as Teflon) tape or O-rings in the joints; no collar couplings.

B. Screen: The screen shall be stainless steel (304 or 316) compatible with the casing, two inch Schedule 40 pipe, flush-thread, screw joint (no glue or solvents); polytetrafluorethylene (PTFE, such as Teflon) tape or O-rings in the joints; no collar couplings.

C. Filter Pack: The filter pack, placed between the screen and the well bore, shall consist of prepackaged, inert, clean silica sand or glass beads. The filter pack should have a uniformity coefficient less than 2.5.

D. Bentonite: Bentonite powder (for casing seal) and coarse-grain sodium bentonite, bentonite chips, or bentonite pellets (for annular seal).

E. Other requirements per the NMED (Order on Consent).

2.2 REDI-MIX CONCRETE

A. See Section 03 3053, Miscellaneous Cast-in-Place Concrete for redi-mix concrete specifications.

2.3 PROTECTIVE STEEL CASING

A. For the monitoring wells located in Cañon De Valle, a 6-foot length (minimum) of protective steel casing—black iron or galvanized – 6-, or 8-inches in diameter (depending on well casing size – 6 inch diameter for 2 inch diameter casing).

B. For the monitoring well down gradient from the former settling pond, a 5-foot length (minimum) of protective steel casing—black iron or galvanized – 6 inches in diameter..

PART 3 EXECUTION

3.1 SCHEDULE FOR WELL INSTALLATION

A. Install the groundwater monitoring wells after the PRB has been installed.

3.2 DRILLING

A. Monitoring wells must be drilled by a New Mexico licensed driller who is qualified to drill and install monitoring wells. The installation and development shall be supervised by a licensed professional geoscientist or engineer who is familiar with the geology of the area. See QP-2.1.

B. The well shall be drilled using the hollow-stem auger or similar method.

C. Work shall comply with LANL health and safety and security procedures (See MAQ-005).

D. The diameter of the boring shall be at least four inches larger than the diameter of the casing.

E. A log of the boring shall be made by or under the supervision of a licensed professional geoscientist or engineer who is familiar with the geology of the area, and shall be signed and dated by the licensed professional.

F. Soil cuttings shall be containerized and managed in accordance with the waste management plan.

G. Other requirements per the NMED (Order on Consent).

3.2 CASING, SCREEN, FILTER PACK, SEALS

A. The well casing shall be: two inch diameter stainless steel (304 or 316) Schedule 40 pipe, flush-thread, screw joint (no glue or solvents); polytetrafluorethylene (PTFE, such as Teflon) tape or O-rings in the joints; no collar couplings. For wells located in Cañon De Valle, the top of the casing shall be at least three feet above ground level. For other wells the top of the casing shall be at least two feet above ground level. The casing shall be cleaned and packaged at the place of manufacture; the packaging shall include a PVC wrapping on each section of casing to keep it from being contaminated prior to installation. The casing shall be free of ink, labels, or other markings. The casing (and screen) shall be centered in the hole to allow installation of a good filter pack and annular seal. The top of the casing shall be protected by a threaded or slip-on top cap or by a sealing cap or screw-plug seal inserted into the top of the casing. The cap shall be vented to prevent buildup of methane or other gases and shall be designed to prevent moisture from entering the well.

B. The screen shall be compatible with the casing and should be of the same material (304 or 316 stainless steel). The screen shall not involve the use of any glues or solvents for construction. A blank-pipe sediment trap, typically one to two feet, should be installed below the screen. A bottom cap shall be placed on the bottom of the sediment trap. Screen sterilization methods are the same as those for casing. Selection of the size of the screen opening should be done by a person experienced with such work and shall include consideration of the distribution of particle sizes both in the water-bearing zone and in the filter pack surrounding the screen. The screen opening shall not be larger than the smallest fraction of the filter pack.

C. The filter pack, placed between the screen and the well bore, shall consist of prepackaged, inert, clean silica sand or glass beads; it shall extend from one to four feet above the top of the screen. Open stockpile sources of sand or gravel are not permitted. The filter pack usually has a 30% finer grain size that is about four to ten times larger than the 30% finer grain size of the water-bearing zone; the filter pack should have a uniformity coefficient less than 2.5. The filter pack should be placed with a tremie pipe to ensure that the material completely surrounds the screen and casing without bridging. The tremie pipe shall be steam cleaned prior to the first well and before each subsequent well.

D. The annular seal shall be placed on top of the filter pack and shall be at least two feet thick. It should be placed in the zone of saturation to maintain hydration. The seal shall be composed of coarse-grain sodium bentonite, bentonite chips, or bentonite pellets. The bentonite shall be hydrated with clean water prior to any further activities on the well and left to stand until hydration is complete (4 hours minimum).

E. A casing seal shall be placed on top of the annular seal to prevent fluids and contaminants from entering the borehole from the surface. The casing seal shall consist of a commercial bentonite grout or a cement-bentonite mixture. Drilling spoil, cuttings, or other native materials are not permitted for use as a casing seal. Quick-setting cements are not permitted for use because contaminants may leach from them into the groundwater. The top of the casing seal shall be between five and two feet from the surface.

F. Other requirements per the NMED (Order on Consent).

3.3 CONCRETE PAD

A. High-quality structural-type concrete shall be placed from the top of the casing seal (two to five feet below the surface) continuously to the top of the ground to form a pad at the surface. This formed surface pad shall be at least six inches thick and not less than four square feet in area. The top of the pad shall slope away from the well bore to the edges to prevent ponding of water around the casing or collar. See Section 03 3053, Miscellaneous Cast-in-Place Concrete and SOP-05.01, Well Construction.

3.4 PROTECTIVE COLLAR

A. A steel protective pipe collar shall be placed around the casing "stickup" to protect it from damage and unwanted entry. The collar shall be set at least one foot into the surface pad during its construction and should extend at least three inches above the top of the well casing (and top cap, if present). The top of the collar shall have a lockable hinged top flap or cover. A sturdy lock shall be installed, maintained in working order, and kept locked when the well is not being bailed/purged or sampled. The well number or other designation shall be marked permanently on the protective steel collar; it is useful to mark the total depth of the well and its elevation on the collar. See SOP-05.01, Well Construction.

3.5 WELL DEVELOPMENT

A. After a monitoring well is installed, it shall be developed to remove artifacts of drilling (clay films, bentonite pellets in the casing, etc.) and to open the water-bearing zone for maximum flow into the well. Development should continue until all of the water used or affected during drilling activities has been removed and field measurements of pH, specific conductance, and temperature have stabilized.

3.6 SURVEY

A. Upon completion of a monitoring well, the location of the well and all appropriate elevations associated with the top-well equipment shall be surveyed by a licensed New Mexico professional surveyor (see Section 02 2113, Site Surveys). The elevation shall be surveyed to the nearest 0.01 foot above mean sea level (with year of the sea-level datum shown). The point on the well casing for which the elevation was determined shall be permanently marked on the casing.

END OF SECTION

SECTION 44 4300

WATER FILTRATION EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. This section describes the carbon filter to be installed at Burning Ground Spring for removal of high explosives from spring water.

1.2 RELATED SECTIONS/DOCUMENTS

A. Section 31 2333, Trenching and Backfilling

PART 2 PRODUCTS

2.1 CARBON FILTER

A. Use Contech Stormwater Solutions Inc steel catch basin storm filter, Model Cbsf2-sx or equivalent.

B. Use Contech carbon filter cartridges (2).

C. Unit shall be equipped with inlet and outlet stubs as shown in the drawings.

D. Unit shall have a bolted steel plate provided by the manufacturer instead of the inlet grate.

PART 3 EXECUTION

3.1 SUBGRADE INSTALLATION OF THE FILTER BOX SYSTEM

A. Install the filter box system according to Section 31 2333, Trenching and Backfilling.

3.2 INSTALLATION OF THE CARBON FILTER CARTRIDGES

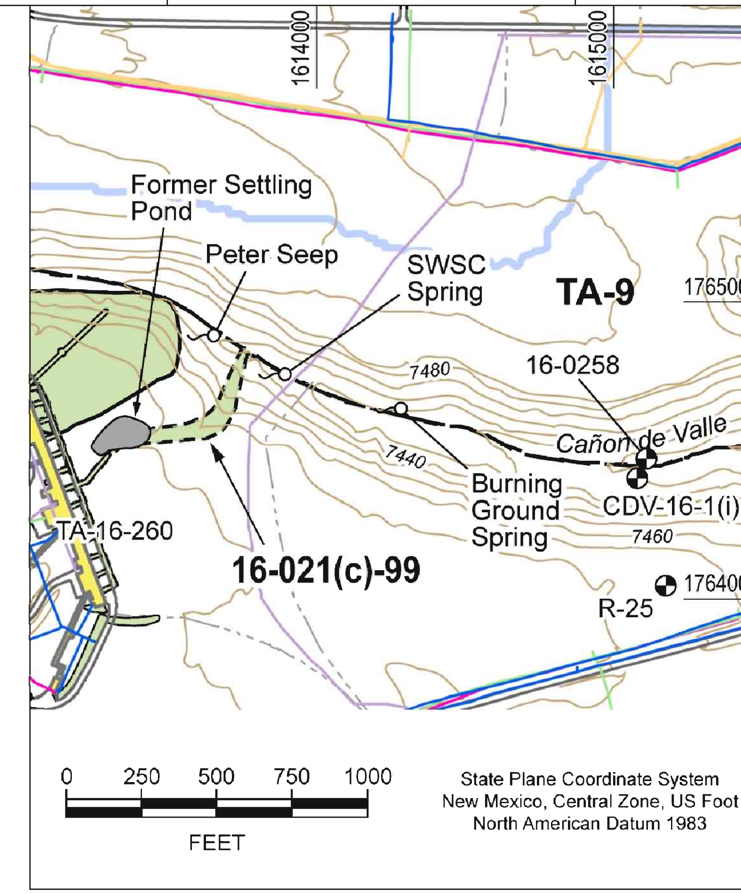
A. Install the filter cartridges in accordance with manufacturer’s instructions.

END OF SECTION

CORRECTIVE MEASURES IMPLEMENTATION

CONSOLIDATED UNIT 16-021(c)-99

CAÑON DE VALLE/ MARTIN SPRING CANYON TA-16



LOCATION PLAN
TA-16

LIST OF DRAWINGS

REVISION NUMBER	SHEET NUMBER	DISCIPLINE SHEET NUMBER	DRAWING TITLE
0	1	G-0001	TITLE SHEET
0	2	C-1001	PILOT PRB AREA PLAN
0	3	C-1002	BURNING GROUND SPRING CARBON FILTER SITE PLAN
0	4	C-1003	260 OUTFALL DRAINAGE CHANNEL SITE PLAN
0	5	C-1004	MARTIN SPRING SITE PLAN
0	6	C-1005	BOREHOLE 16-02658 BORING LOG
0	7	C-1006	REFRACTION SEISMICS AT MONITORING WELL 16-02658
0	8	C-3001	BURNING GROUND SPRING CARBON FILTER INSTALLATION PROFILE
0	9	C-3002	MARTIN SPRING CARBON FILTER INSTALLATION PROFILE
0	10	C-4001	PILOT PRB PLAN VIEW
0	11	C-5001	CARBON FILTER DETAIL
0	12	C-5002	PRB REACTION CELL DETAIL
0	13	C-5003	PILOT PRB DETAILS I
0	14	C-5004	PILOT PRB DETAILS II
0	15	C-5005	PILOT PRB DETAILS III
0	16	C-5006	260 OUTFALL DRAINAGE CHANNEL DETAIL
0	17	M-5001	WEIR BOX DETAIL
0	18	M-5002	WEIR BOX COVER DETAIL

"NOT FOR CONSTRUCTION"
NMED REVIEW

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

Shaw®
SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN	T. GAGLIANO
DESIGN	J. PIETZ
CHECKED	C. GIVENS
DATE	4/14/07

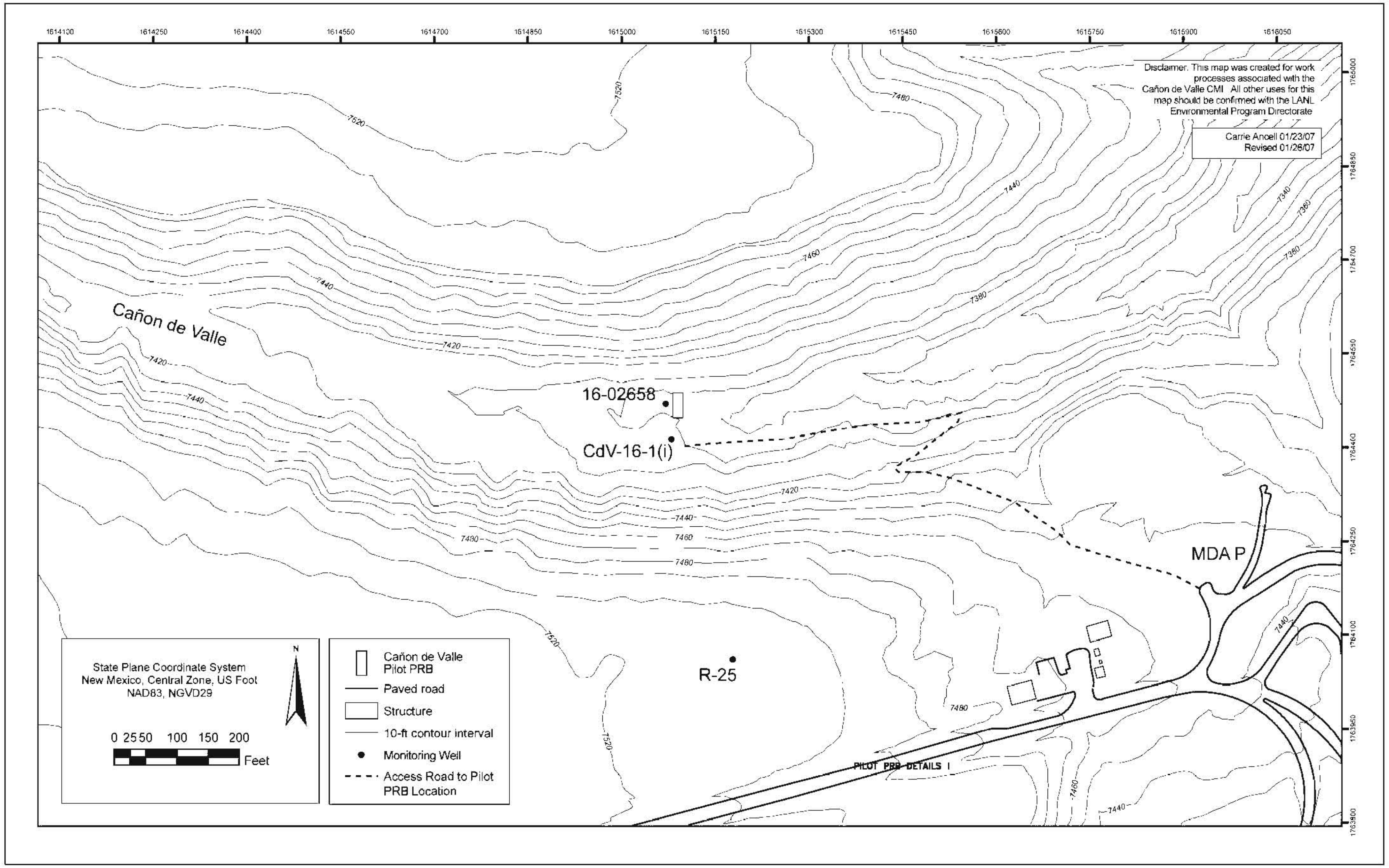
SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

SHEET G-0001
1 OF 18

CLASSIFICATION CLASSIFICATION
REVIEWER REVIEWER
DATE

PROJECT ID 5409
DRAWING NO 5409-G-0001-R0
REV 0



GENERAL NOTES

1. ACCESS TO SITE IS BY UNIMPROVED ROAD INTO CAÑON DE VALLE AT MDA P.
2. SITE OF PILOT PRB WILL REQUIRE SELECTIVE TREE REMOVAL.
3. LAYDOWN AREA AVAILABLE NEAR WELL CdV–16–1(i).

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

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SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16–021(c)–99
PILOT PRB AREA PLAN
CAÑON DE VALLE/MARTIN SPRING CANYON TA–16

DRAWN: E. CARPIO
DESIGN: J. PIETZ
CHECKED: C. GIVENS
DATE: 04/27/07

SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

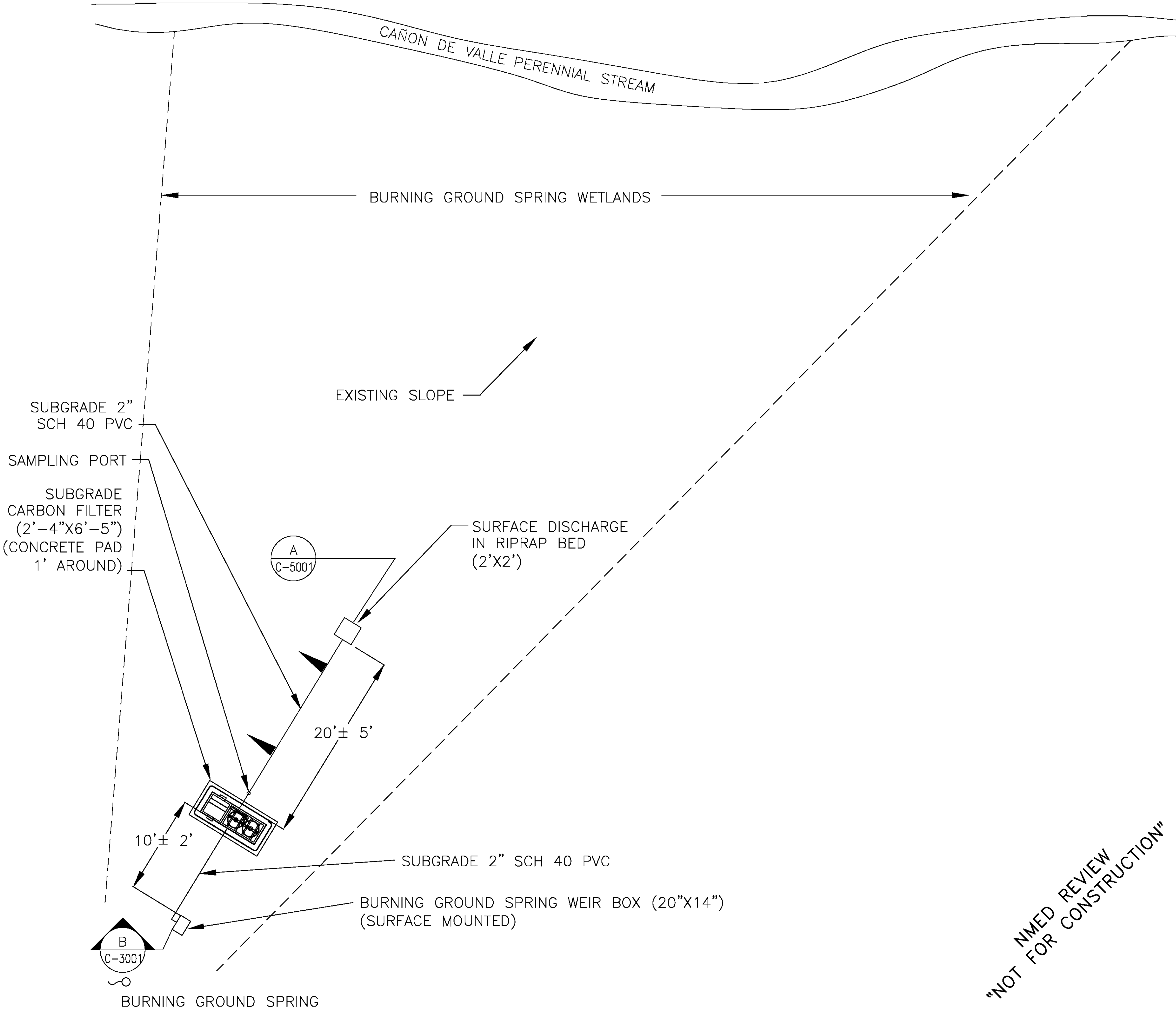
Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

SHEET: C–1001
2 OF 18

CLASSIFICATION: CLASSIFICATION
REVIEWER: REVIEWER
DATE:

PROJECT ID: 5409
DRAWING NO: 5409–C–1001–R0
REV: 0

NMED REVIEW
"NOT FOR CONSTRUCTION"



GENERAL NOTES

1. ALL DISTANCES ARE APPROXIMATE AND SHALL BE FIELD VERIFIED.
2. TO MINIMIZE LOSS OF WETLAND, LENGTH OF INSTALLATION FROM SURFACE DISCHARGE TO WEIR BOX SHOULD BE AS SHORT AS POSSIBLE WHILE MEETING MINIMUM HYDRAULIC HEAD (1.5') ACROSS THE CARBON FILTER.
3. DISTANCE FROM CARBON FILTER TO SURFACE OUTFALL IS APPROXIMATE AND WILL DEPEND ON THE LOCAL SLOPE.

SITE PLAN
SCALE: 1"=10'

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16–021(c)–99
BURNING GROUND SPRING CARBON FILTER
SITE PLAN
CAÑON DE VALLE/MARTIN SPRING CANYON TA–16

DRAWN: E. CARPIO
DESIGN: J. PIETZ
CHECKED: C. GIVENS
DATE: 04/17/07

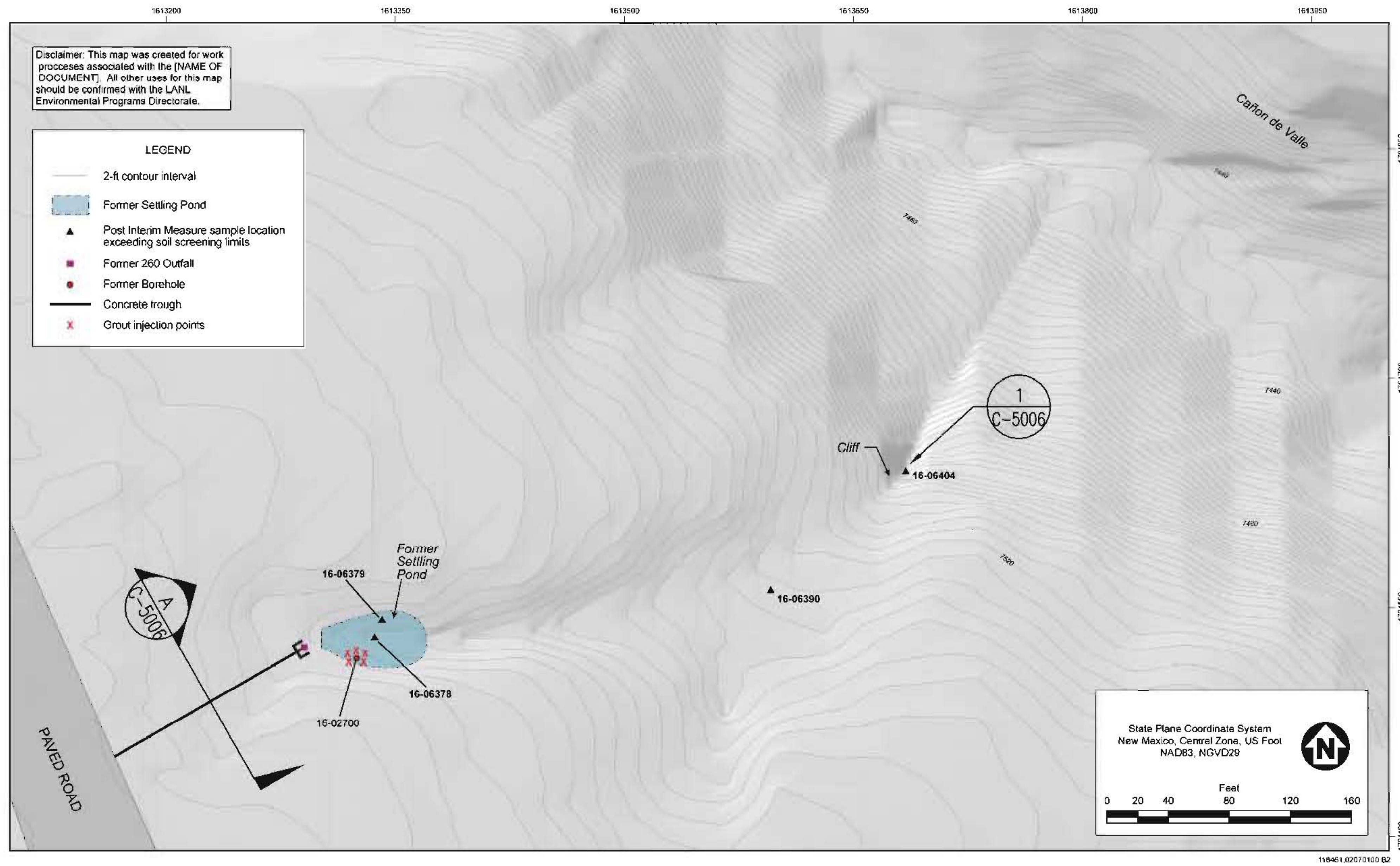
SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

SHEET: C–1002
3 OF 18

CLASSIFICATION: CLASSIFICATION
REVIEWER: REVIEWER
DATE:

PROJECT ID: 5409
DRAWING NO: 5409–C–1002–R0
REV: 0



GENERAL NOTES

1. DEMOLISH AND REMOVE EXISTING CONCRETE TROUGH BETWEEN FORMER 260 OUTFALL AND EAST EDGE OF PAVED ROAD. BACKFILL TO GRADE.
2. EXCAVATE (5' RADIUS) AROUND LOCATIONS 16-06378, 16-06379, 16-06390, AND 16-06404 TO REMOVE SOIL EXCEEDING CLEANUP STANDARDS.
3. RESTORE LOW PERMEABILITY CAP IF ORIGINALLY PRESENT AT LOCATION 16-06378 AND 16-06379.
4. GROUT SUBRADE SURGE BED FOUND AT FORMER BOREHOLE 16-02700.
5. RESTORE ALL EROSION BMPs TO ORIGINAL CONDITION IN DISTURBED AREAS.

NMED REVIEW
"NOT FOR CONSTRUCTION"

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

Shaw® SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99
260 OUTFALL DRAINAGE CHANNEL SITE PLAN
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN	T. GAGLIANO
DESIGN	J. PIETZ
CHECKED	C. GIVENS
DATE	04/27/07

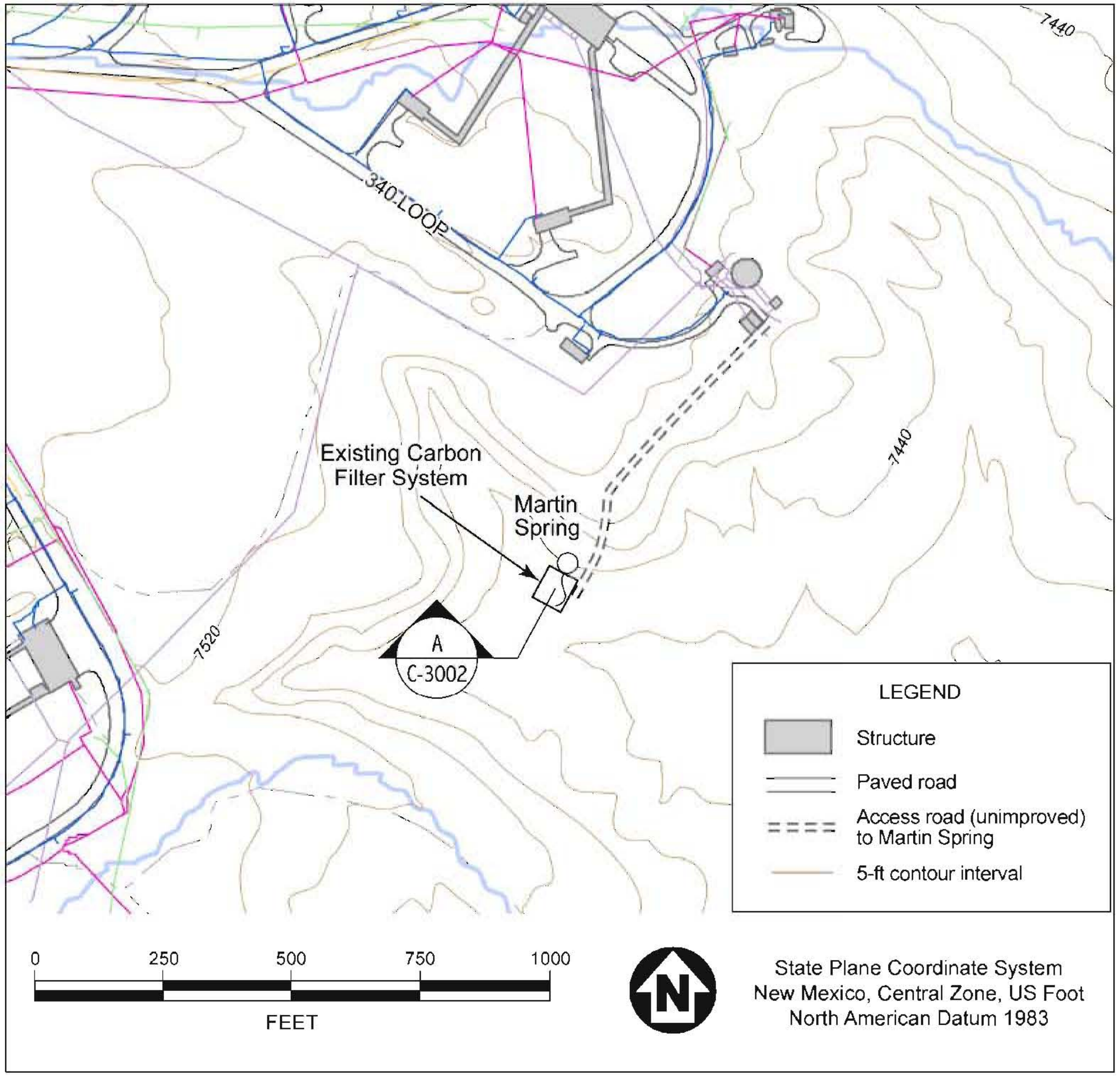
SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY — PO Box 1663 Los Alamos, New Mexico 87545

SHEET C-1003
4 OF 18

CLASSIFICATION: CLASSIFICATION
REVIEWER: REVIEWER
DATE

PROJECT ID: 5409
DRAWING NO: 5409-C-1003-R0
REV: 0



GENERAL NOTES

1. ACCESS TO SITE IS BY UNIMPROVED ROAD INTO MARTIN SPRING CANYON
2. MODIFY EXISTING CARBON FILTER SYSTEM BY INSTALLATION OF A NEW WATER COLLECTION (WEIR) BOX.

NMED REVIEW
"NOT FOR CONSTRUCTION"

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99
MARTIN SPRING SITE PLAN
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN: T. GAGLIANO
DESIGN: J. PIETZ
CHECKED: C. GIVENS
DATE: 04/27/07

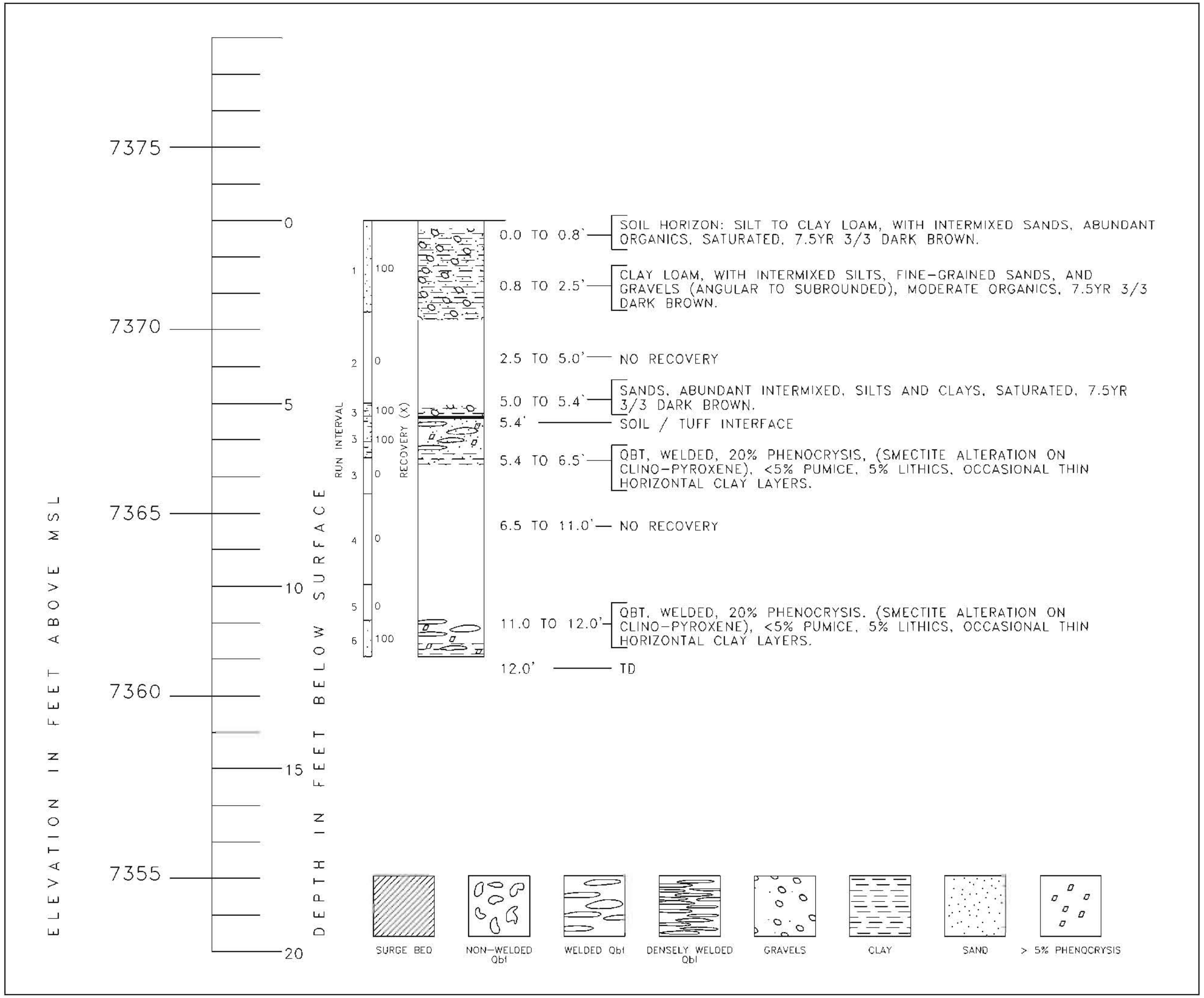
SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663 Los Alamos, New Mexico 87545

SHEET: C-1004
5 OF 18

CLASSIFICATION: CLASSIFICATION
REVIEWER: REVIEWER
DATE

PROJECT ID: 5409
DRAWING NO: 5409-C-1004-R0
REV: 0



GENERAL NOTES

1. BORING LOG IS OF BOREHOLE 16-02658 (MW-16-02658) LOCATED ADJACENT TO THE PILOT PRB LOCATION.

"NMED REVIEW NOT FOR CONSTRUCTION"

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99

BOREHOLE 16-02658 BORING LOG

CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN: E. CARPIO
DESIGN: J. PIETZ
CHECKED: C. GIVENS
DATE: 04/27/07

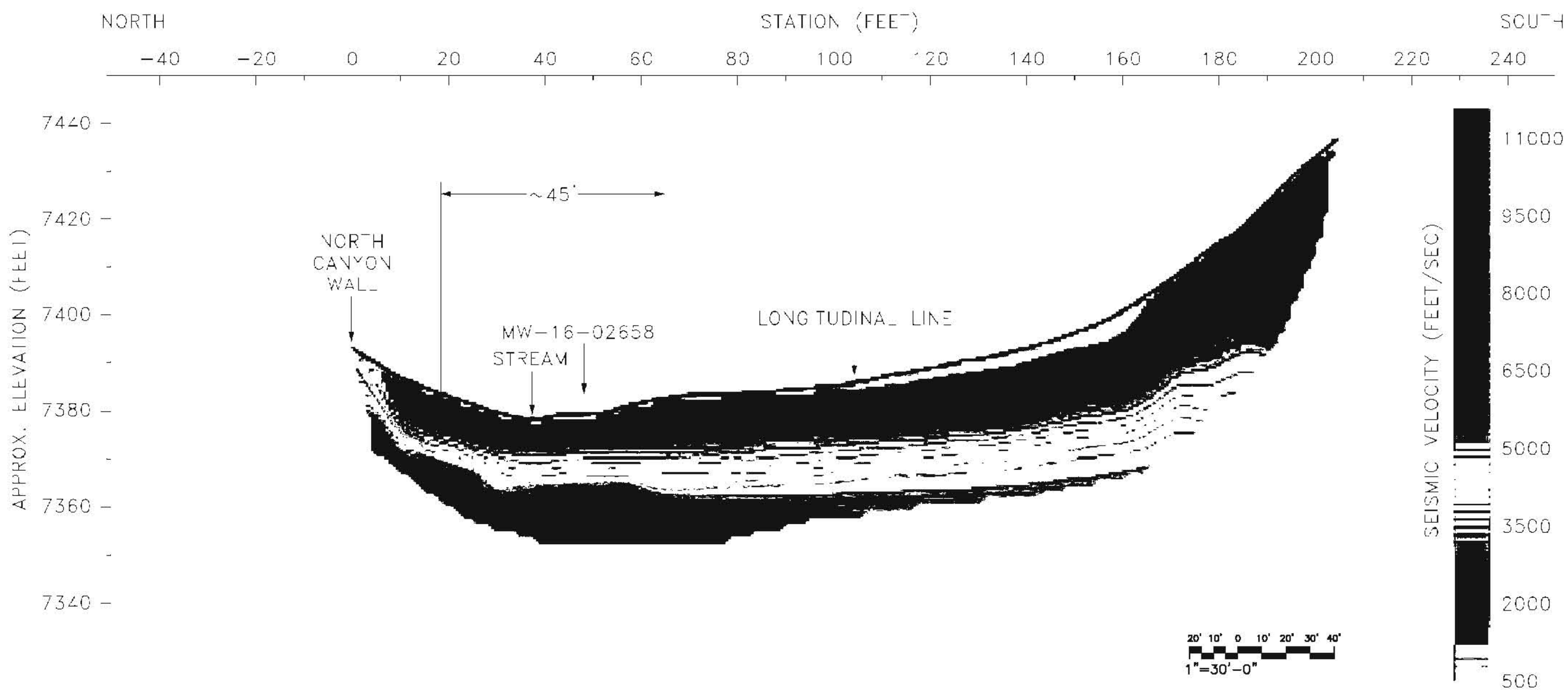
SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

SHEET C-1005
6 OF 18

CLASSIFICATION: CLASSIFICATION
REVIEWER: REVIEWER
DATE:

PROJECT ID: 5409
DRAWING NO: 5409-C-1005-R0
REV: 0



GENERAL NOTES

1. PROFILE IS OF REFRACTION SEISMICS AT MONITORING WELL (MW) 16-02658.
2. PERMEABLE REACTIVE BARRIER (PRB) TO SPAN INDICATED LENGTH OF APPROXIMATELY 45 FEET. PRECISE LENGTH TO BE DETERMINED DURING CONSTRUCTION.

"NMED REVIEW
"NOT FOR CONSTRUCTION"

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99
REFRACTION SEISMICS AT MONITORING WELL 16-02658
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN	E. CARPIO
DESIGN	J. PIETZ
CHECKED	C. GIVENS
DATE	04/27/07

SUBMITTED JOHN PIETZ
APPROVED FOR RELEASE PROJECT TEAM LEADER

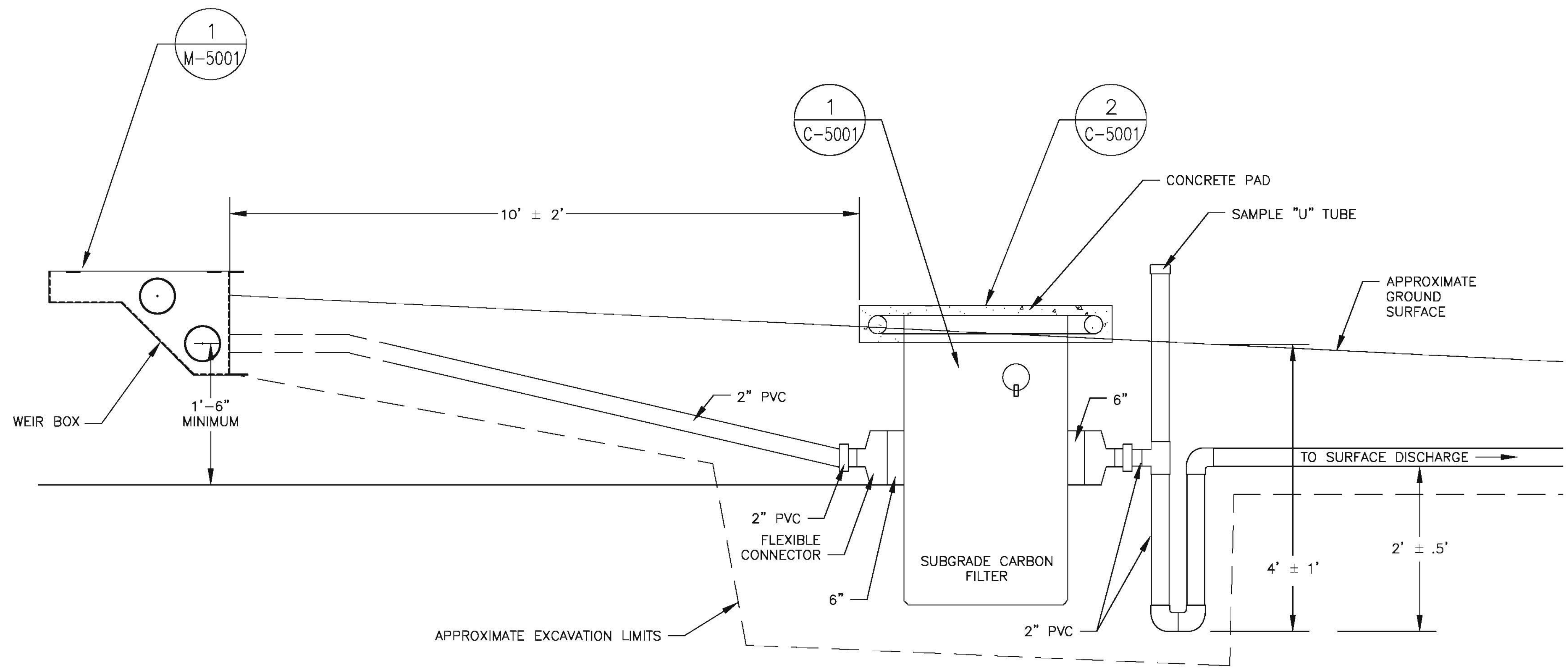
Los Alamos NATIONAL LABORATORY
PO Box 1663 Los Alamos, New Mexico 87545

SHEET C-1006
7 OF 18

CLASSIFICATION CLASSIFICATION
REVIEWER REVIEWER
DATE
PROJECT ID 5409
DRAWING NO 5409-C-1006-R0
REV 0

GENERAL NOTES

1. PLACEMENT OF SUBGRADE CARBON FILTER DEPENDENT ON ABILITY TO EXCAVATE TO APPROXIMATELY 4' BELOW GRADE.
2. MINIMUM 1'-6" OF WATER HEAD REQUIRED ABOVE INLET SIDE OF CARBON FILTER (MEASURED FROM THE CARBON FILTER INLET TO THE WEIR BOX OUTLET PIPE).
3. MINIMIZE OVERALL LENGTH (WEIR BOX TO SURFACE DISCHARGE) TO PRESERVE EXISTING WETLAND.
4. STOCKPILE AND SEGREGATE TOP SOIL FOR SITE RESTORATION.
5. BACKFILL CARBON FILTER WITH CRUSHED STONE ACCORDING TO SPECIFICATIONS.
6. PROVIDE 1' THICK SAND BEDDING FOR SUBGRADE PIPING.



A
C-1002

SECTION INSTALLATION PROFILE

SCALE: NONE

NMED REVIEW
"NOT FOR CONSTRUCTION"

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99
BURNING GROUND SPRING
INSTALLATION PROFILE
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN: E. CARPIO
DESIGN: J. PIETZ
CHECKED: C. GIVENS
DATE: 04/25/07

SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

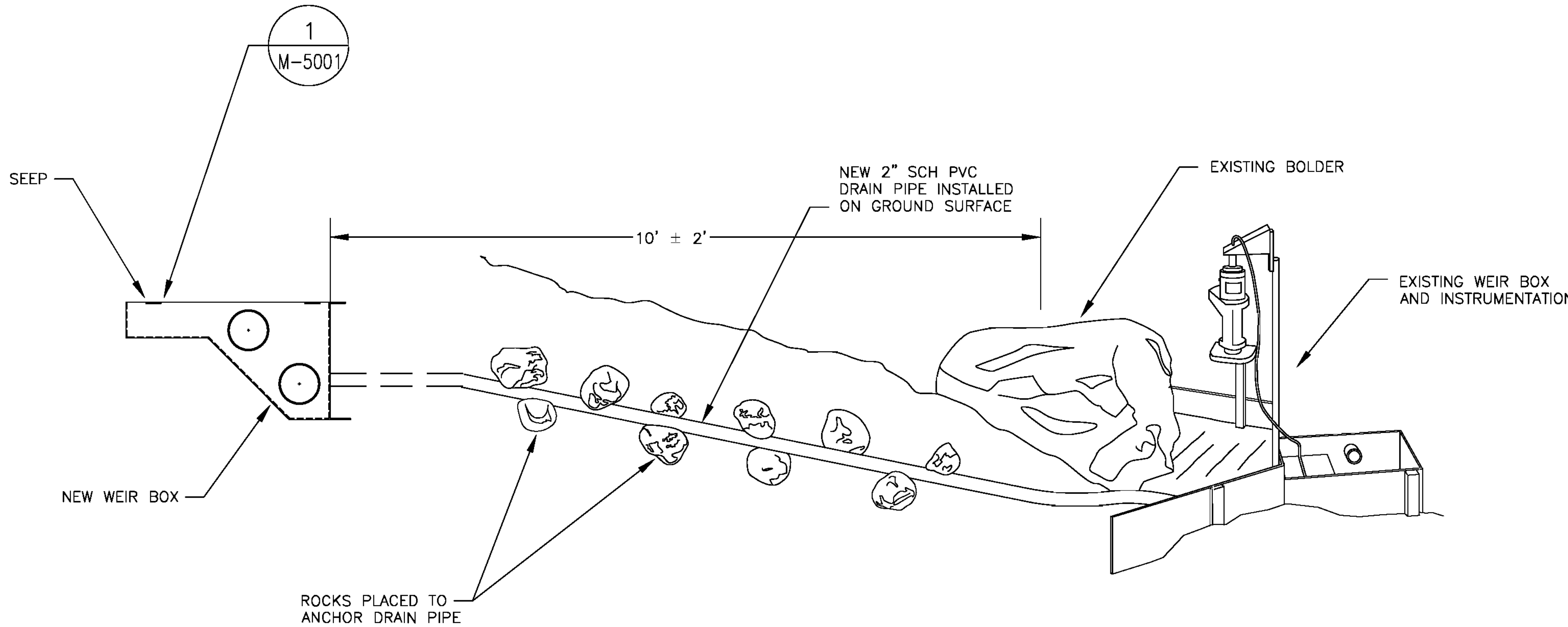
Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

SHEET C-3001
8 OF 18

CLASSIFICATION CLASSIFICATION
REVIEWER REVIEWER
DATE
PROJECT ID 5409
DRAWING NO 5409-C-3001-R0
REV

GENERAL NOTES

1. INSTALL NEW WEIRBOX ON SEEP BY HARD EXCAVATION. ANCHOR IN PLACE USING LOCAL ROCKS AND SOIL.
2. INSTALL 2" SCH 40 SURFACE PIPE TO DRAIN WATER FROM NEW WEIR BOX INTO EXISTING RESERVOIR ABOVE EXISTING WEIR BOX.
3. ANCHOR DRAIN PIPE USING ROCKS.
4. SUBMIT A REVISION OF THIS DRAWING THAT REFLECTS THE CURRENT SEEP LOCATION PRIOR TO CONSTRUCTION.
5. MAINTAIN CONSTANT SLOPE ON DRAIN PIPE TO AVOID ICE BLOCKAGE.



A
C-1004

FILTER INSTALLATION PROFILE

SCALE: NONE

NMED REVIEW
"NOT FOR CONSTRUCTION"

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99
MARTIN SPRING CARBON FILTER INSTALLATION PROFILE
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN	E. CARPIO
DESIGN	J. PIETZ
CHECKED	C. GIVENS
DATE	04/25/07

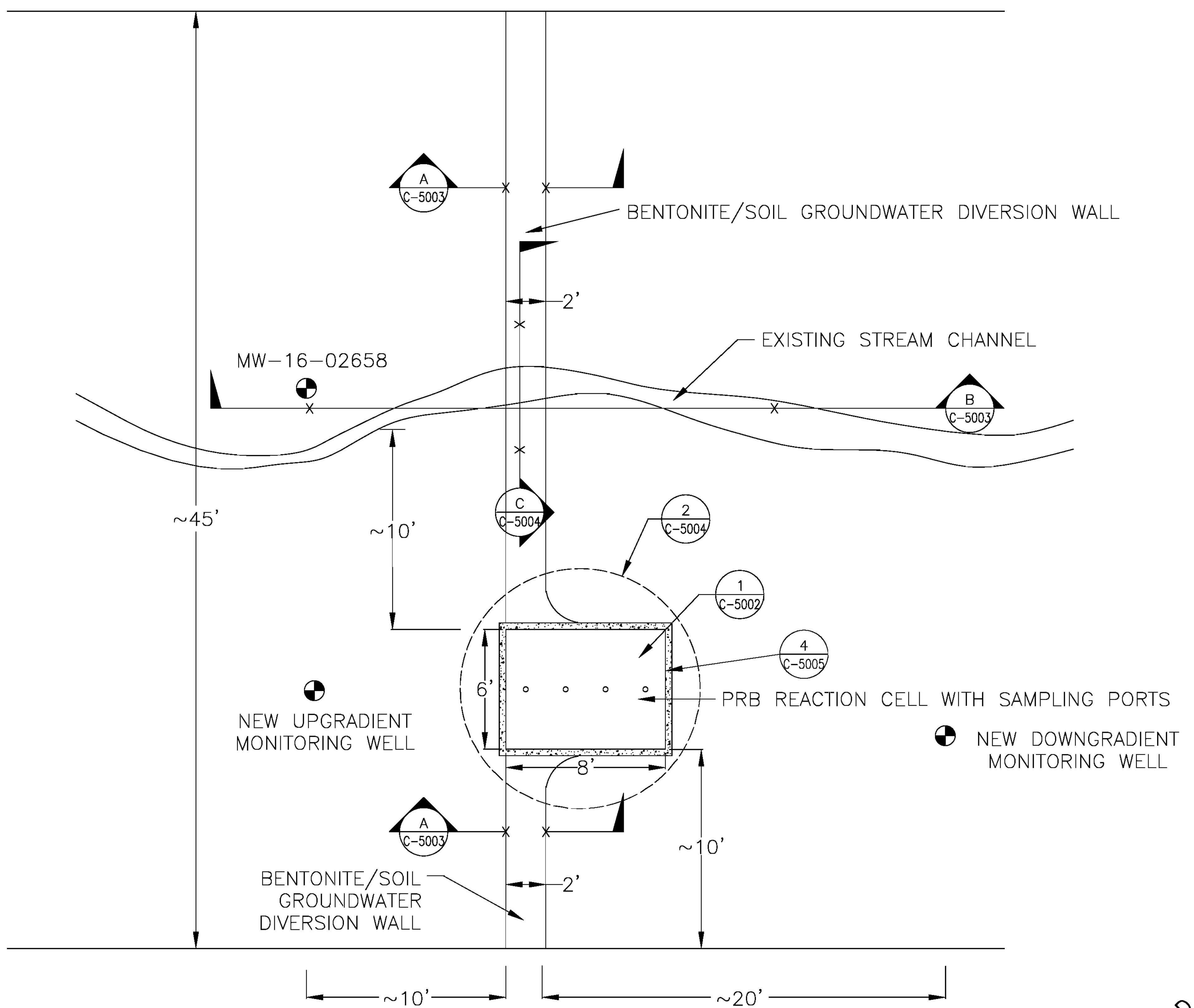
SUBMITTED JOHN PIETZ
APPROVED FOR RELEASE PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

SHEET C-3002
9 OF 18

CLASSIFICATION CLASSIFICATION
REVIEWER REVIEWER
DATE

PROJECT ID 5409
DRAWING NO 5409-C-3002-R0
REV 0



GENERAL NOTES

1. ALL APPROXIMATE MEASUREMENTS TO BE VERIFIED IN THE FIELD.
2. PRB REACTION CELL TO BE OFFSET FROM STREAM CHANNEL.
3. DIVERT STREAM AROUND CONSTRUCTION AREA DURING CONSTRUCTION.
4. CONSTRUCTION CONTRACTOR WILL EXCAVATE THREE TEST PITS, TWO ALONG THE ROUTE OF THE DIVERSION WALL AND ONE IN THE LOCATION OF THE REACTION CELL TO VERIFY DEPTH OF TUFF, ASSESS DEWATERING REQUIREMENTS, AND COLLECT SOIL SAMPLES.
5. CONSTRUCTION CONTRACTOR WILL CONDUCT A LOCAL TOPOGRAPHIC SURVEY OF THE INSTALLATION AREA AND PREPARE AN EXCAVATION PLAN WHICH INCORPORATES THE TOPOGRAPHICAL SURVEY, TEST PIT RESULTS, STREAM DIVERSION, AND DEWATERING, IF NECESSARY.
6. A THIRD DOWNGRADIENT MONITORING WELL (NOT SHOWN) WILL BE INSTALLED APPROXIMATELY 200 FEET DOWNGRADIENT.
7. INSTALL 6" WIDE X 4" THICK CONCRETE PAD AROUND PRB REACTION CELL.

DESIGN PLAN

SCALE: NONE

NMED REVIEW
"NOT FOR CONSTRUCTION"

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99
PILOT PRB PLAN VIEW
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN	E. CARPIO
DESIGN	J. PIETZ
CHECKED	C. GIVENS
DATE	04/27/07

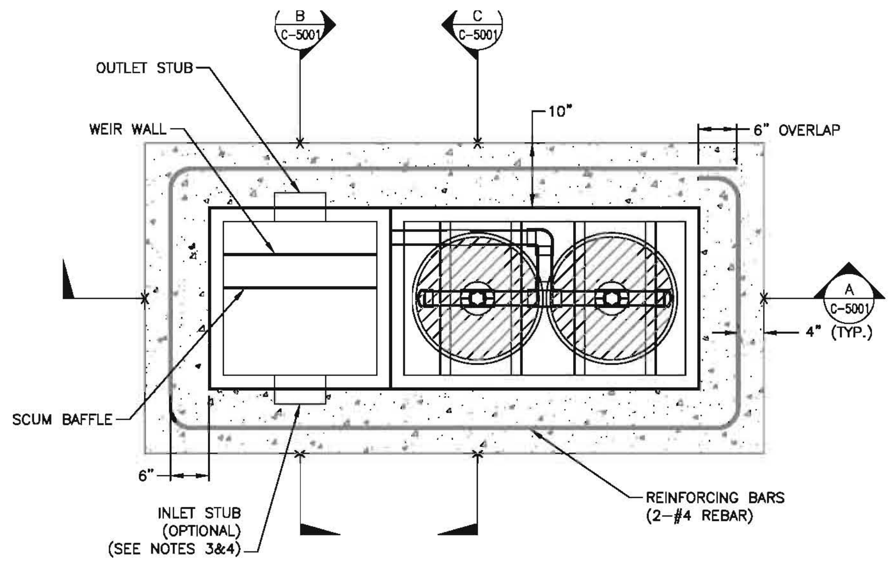
SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

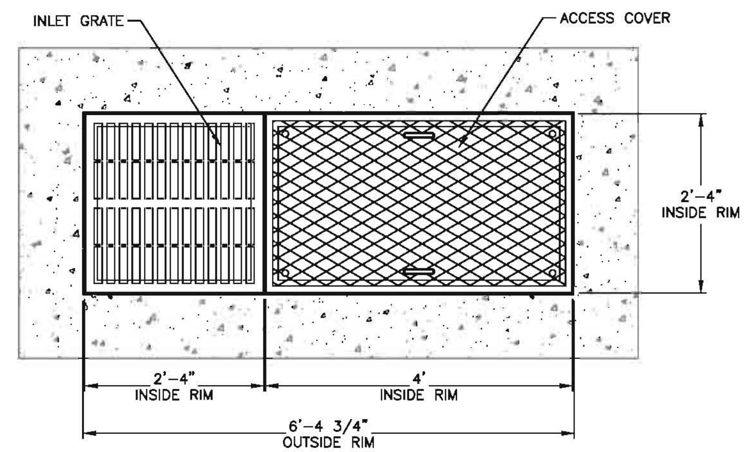
SHEET C-4001
10 OF 18

CLASSIFICATION CLASSIFICATION | REVIEWER REVIEWER | DATE

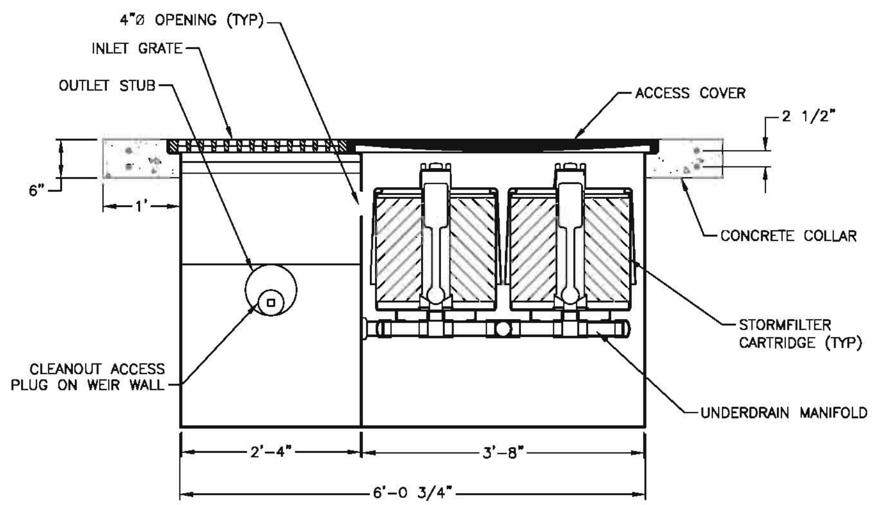
PROJECT ID 5409 | DRAWING NO 5409-C-4001-R0 | REV 0



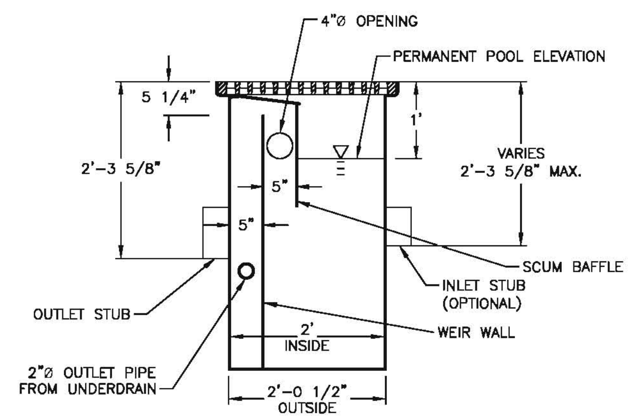
1 C-3001 DETAIL CATCH BASIN FILTER-PLAN VIEW
SCALE: NONE



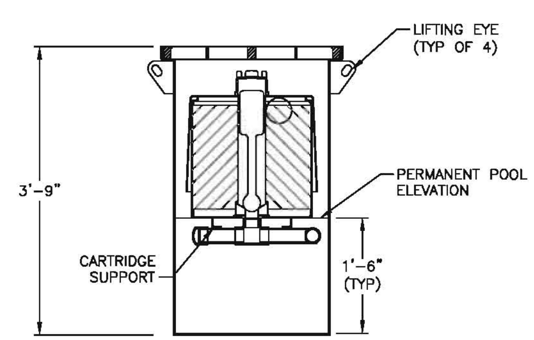
2 C-3001 DETAIL CATCH BASIN FILTER-TOP VIEW
SCALE: NONE



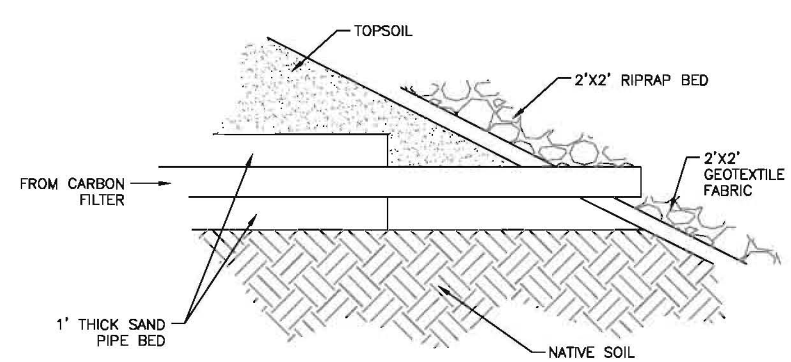
A C-5001 CATCH BASIN FILTER-SECTION VIEW
SCALE: NONE



B C-5001 CATCH BASIN FILTER-SECTION VIEW
SCALE: NONE



C C-5001 CATCH BASIN FILTER-SECTION VIEW
SCALE: NONE



D C-1002 SECTION SURFACE DISCHARGE
SCALE: NONE

GENERAL NOTES

1. UNIT IS CONTECH STORMWATER SOLUTIONS, INC. STEEL CATCH BASIN STORM FILTER (MODEL Cbsf2-sx OR EQUIVALENT).
2. OUTLET PIPE TO BE GROUTED INTO PROVIDED OUTLET STUB.
3. INLET PIPING TO BE CONNECTED TO WEIR BOX.
4. INLET GRATE TO BE REPLACED WITH REMOVABLE STEEL PLATE (BY MANUFACTURER).
5. INSTALL SURFACE DISCHARGE (2" SCH 40 PVC PIPE FROM CARBON FILTER) IN 2'X2' RIPRAP BED.

NMED REVIEW
"NOT FOR CONSTRUCTION"

NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(C)-99

CARBON FILTER DETAIL

CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN	E. CARPIO
DESIGN	J. PIETZ
CHECKED	C. GIVENS
DATE	04/27/07

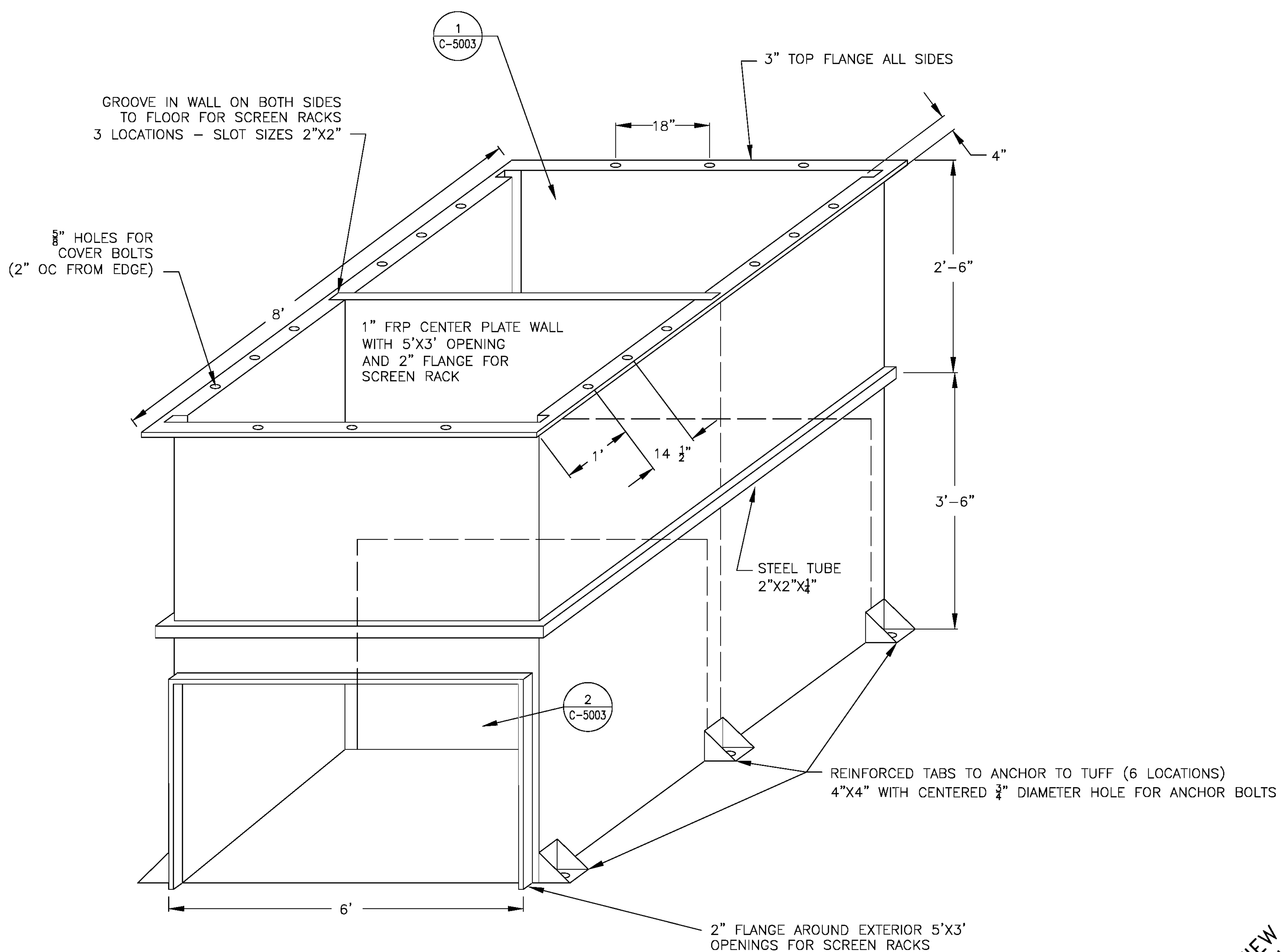
SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

SHEET C-5001
11 OF 18

CLASSIFICATION CLASSIFICATION | REVIEWER REVIEWER | DATE

PROJECT ID 5409
DRAWING NO 5409-C-5001-R0
REV 0



1 C-4001 DETAIL PRB REACTION CELL

SCALE: NONE

GENERAL NOTES

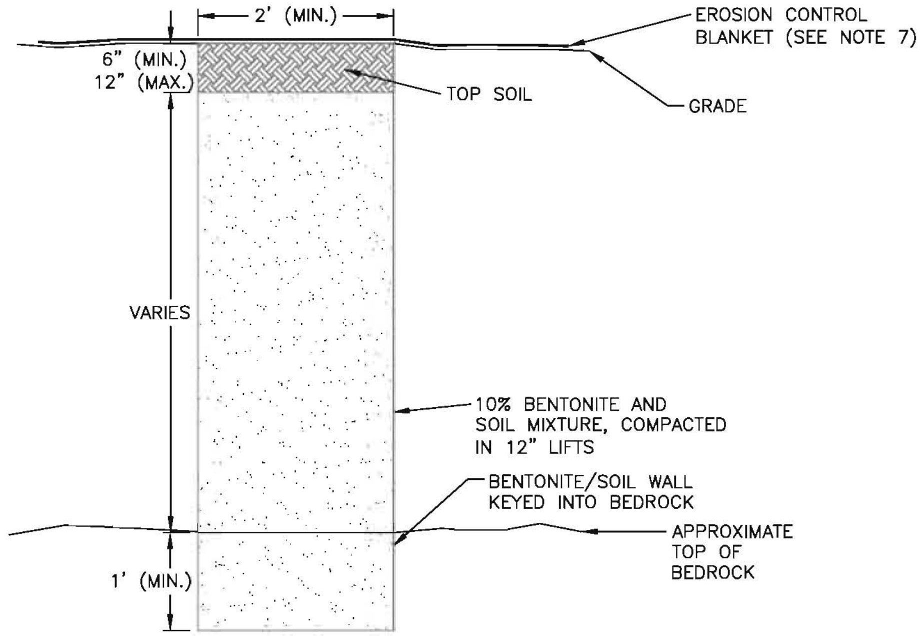
1. REACTION CELL CONSTRUCTED OF MOLDED FIBERGLASS REINFORCED POLYESTER (FRP) LAMINATED IN ONE PIECE.
2. FINISH INTERIOR SURFACE WITH 10 TO 15 MIL WHITE GEL COAT BACKED BY A RESIN RICH LAYER OF RESIN AND CHIPPED GLASS TO FORM A WATER AND CHEMICAL RESISTANT SURFACE.
3. LAMINATE OTHER THAN INTERIOR SURFACE SHALL BE FRP CONTAINING NOT LESS THAN 30% GLASS CONTENT BY WEIGHT.
4. WALL SHALL NOT BE LESS THAN 1/4" THICK AND WILL BE REINFORCED WITH 6"X2" FOAM BOARD RIBS 18" ON CENTER.
5. FLOOR TO BE REINFORCED WITH 6 LB. FOAM BOARD CORE.
6. REINFORCED TABS ON BOTTOM OF CELL TO ALLOW ANCHOR BOLTING TO WELDED TUFF. 3/4" BY 10" (MIN.) ANCHOR BOLT – WEDGE OR DROP IN ANCHOR TYPE.
7. FINAL SHOP DRAWINGS CONTINGENT ON FIELD DIMENSIONS OBTAINED FROM TEST PITS.
8. FABRICATOR TO PROVIDE SHOP DRAWINGS FOR APPROVAL ACCORDING TO SPECIFICATIONS.

NMED REVIEW
"NOT FOR CONSTRUCTION"

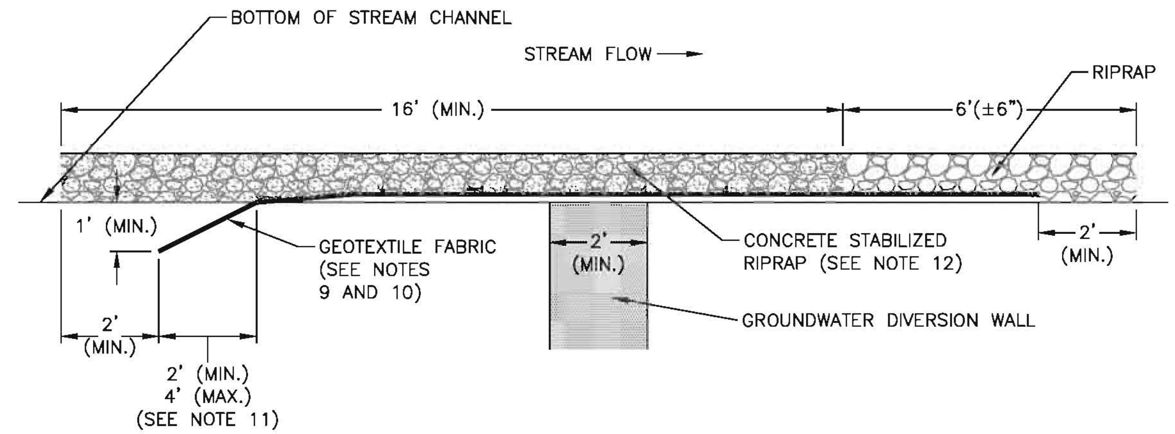
NO	DATE	CLASS REV	ADC	DESCRIPTION	DWN	DSGN	CHKD	SUB	APP

Shaw® SHAW ENVIRONMENTAL AND INFRASTRUCTURE, INC.

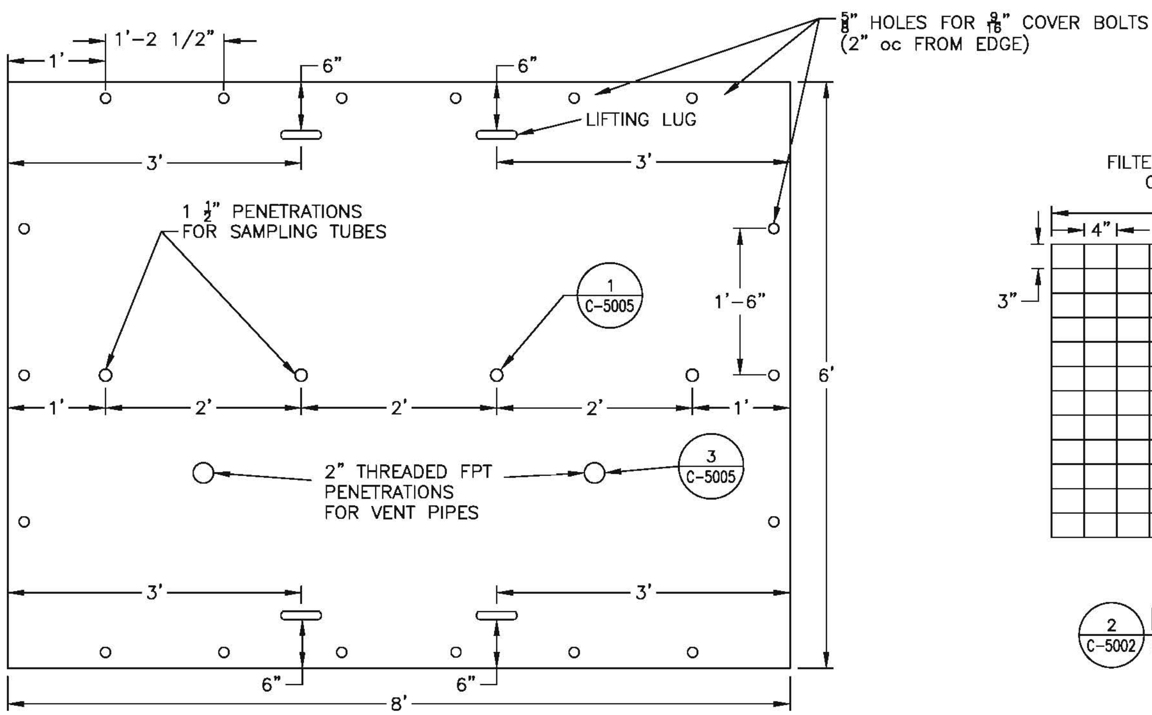
CORRECTIVE MEASURES IMPLEMENTATION CONSOLIDATED UNIT 16-021(c)-99	DRAWN	E. CARPIO
	DESIGN	J. PIETZ
PRB REACTION CELL DETAIL	CHECKED	C. GIVENS
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16	DATE	04/30/07
SUBMITTED JOHN PIETZ	APPROVED FOR RELEASE PROJECT TEAM LEADER	
Los Alamos NATIONAL LABORATORY PO Box 1663 Los Alamos, New Mexico 87545	SHEET C-5002	12 OF 18
CLASSIFICATION CLASSIFICATION	REVIEWER REVIEWER	DATE
PROJECT ID 5409	DRAWING NO 5409-C-5002-R0	REV



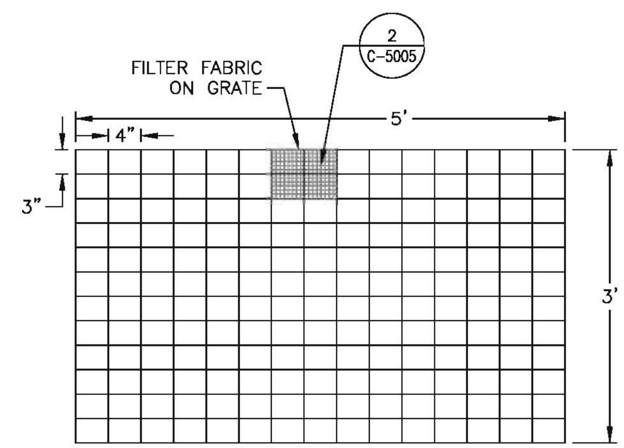
A / C-4001 SECTION GROUNDWATER DIVERSION WALL
SCALE: NONE



B / C-4001 SECTION STREAM CHANNEL CROSSING OF DIVERSION WALL
SCALE: NONE



1 / C-5002 DETAIL FRP REACTION CELL COVER
SCALE: NONE



2 / C-5002 DETAIL SCREEN RACK
SCALE: NONE

GENERAL NOTES

1. APPROXIMATE MEASUREMENTS AND DESIGNATORS TO BE VERIFIED IN THE FIELD.
2. KEY IN DIVERSION WALL 1' INTO TUFF AND GROUT VISIBLE FRACTURES.
3. KEY IN PRB REACTION CELL 6" INTO TUFF, LEVEL, AND GROUT IN PLACE.
4. INSTALL RIPRAP AROUND ABOVE-GRADE PORTIONS OF THE CELL FOLLOWING INSTALLATION.
5. INSTALL 24 MIL HDPE LINER SEAL PRIOR TO INSTALLING FRP LID.
6. SCREEN RACK CONSISTS OF 3/16" STEEL RODS ON 4" AND 3" CENTERS, WELDED, AND HOT DIP GALVANIZED. ASSEMBLY TO FIT INTO SCREEN RACK FLANGE.
7. INSTALL EROSION CONTROL BLANKET (SEE SPECIFICATION 32-7200) ON GROUND SURFACE OF DIVERSION WALL, EXCEPT AT STREAM CROSSING.
8. CONSTRUCT SAMPLING TUBES OF 1"Ø SCH 40 PVC, WITH 4' OF SLOTTED PIPE ON LOWER END.
9. IF OVERLAPPING OF GEOTEXTILE FABRIC IS REQUIRED, UPSTREAM SECTION SHALL OVERLAP DOWNSTREAM SECTION BY 2' MINIMUM. BOTH PIECES STAPLED ALONG OVERLAPPING EDGES.
10. GEOTEXTILE FABRIC (TERRATEX EP™ OR SIMILAR).
11. UPSTREAM TOE OF GEOTEXTILE FABRIC SHALL BE BURIED INTO EXISTING GRADE FOR FIRST 2' TO 4'.
12. STABILIZE RIPRAP WITH CONCRETE FOR UPSTREAM 16' SECTION (MIN.).

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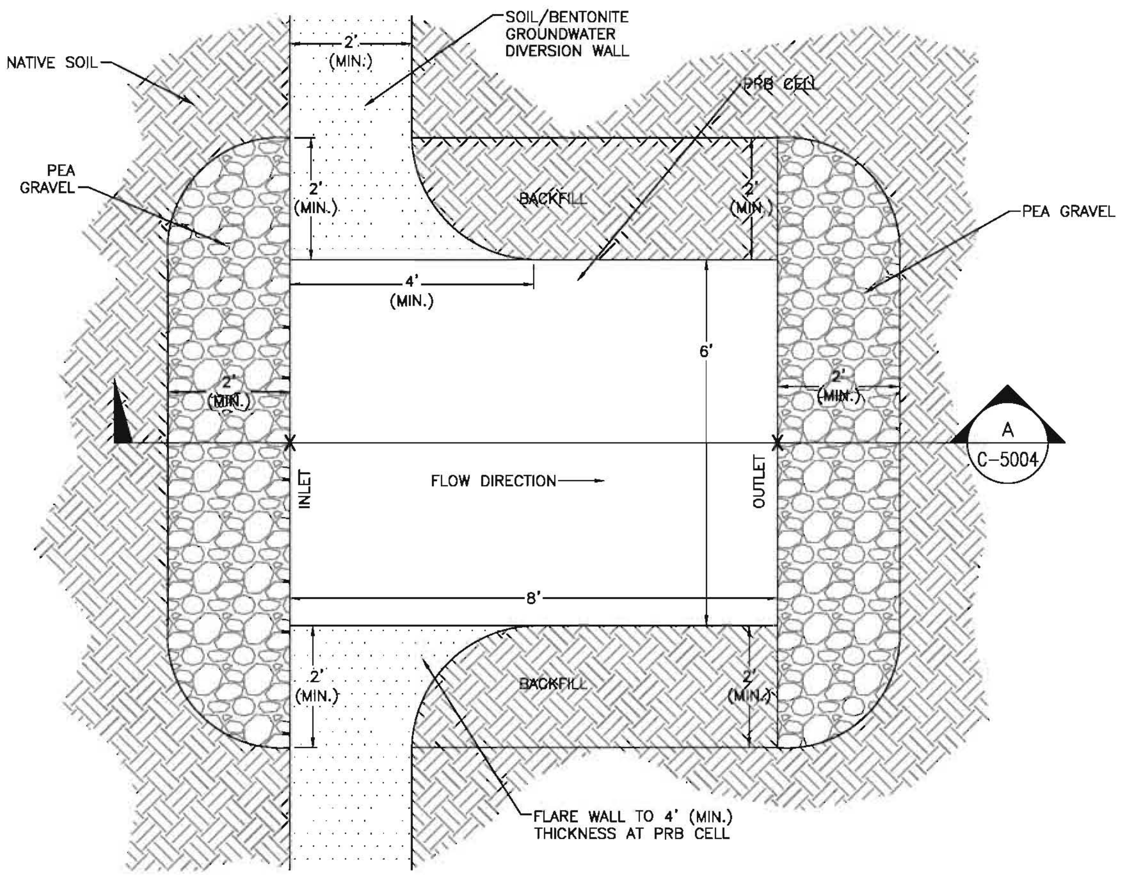
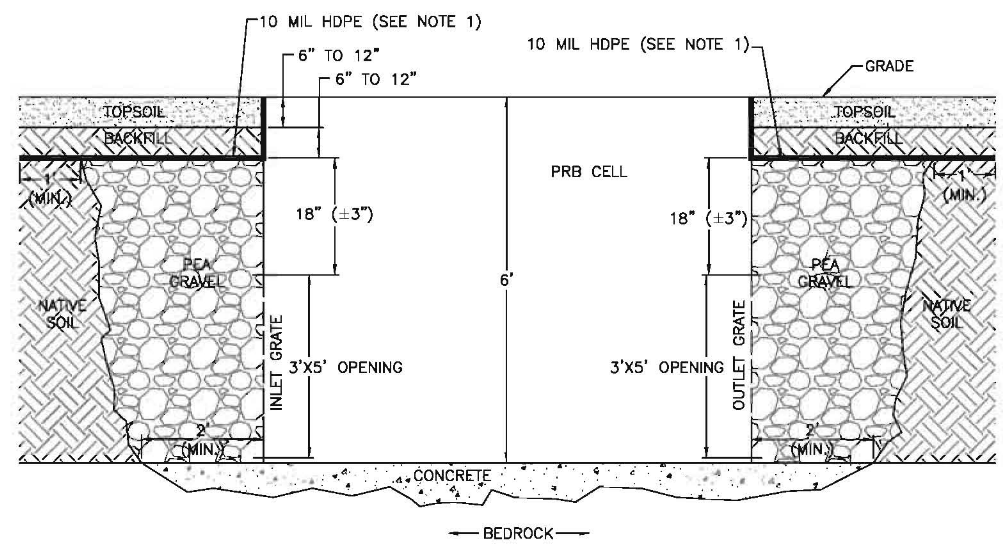
CORRECTIVE MEASURES IMPLEMENTATION CONSOLIDATED UNIT 16-021(c)-99	DRAWN	E. CARPIO
PILOT PRB DETAILS I	DESIGN	J. PIETZ
	CHECKED	C. GIVENS
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16	DATE	04/27/07
SUBMITTED: JOHN PIETZ	APPROVED FOR RELEASE: PROJECT TEAM LEADER	
Los Alamos NATIONAL LABORATORY, PO Box 1663, Los Alamos, New Mexico 87545	SHEET	C-5003
		13 OF 18
CLASSIFICATION: CLASSIFICATION	REVIEWER: REVIEWER	DATE
PROJECT ID: 5409	DRAWING NO: 5409-C-5003-R0	REV



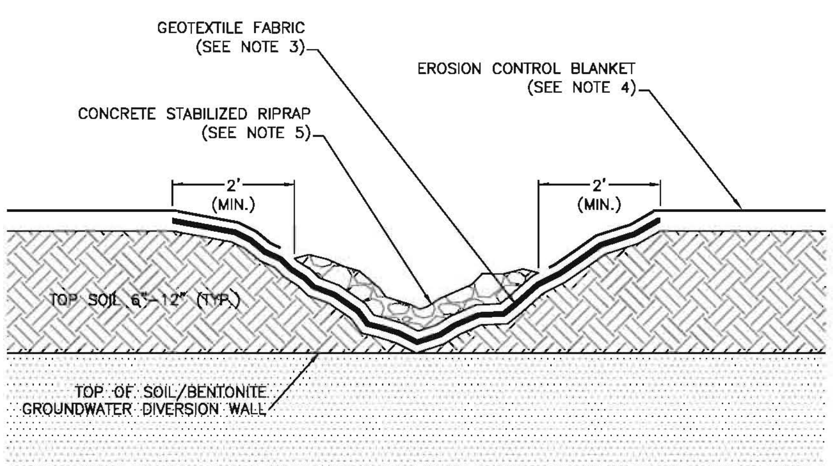
2 C-4001 DETAIL PRB REACTION CELL BACKFILL

SCALE: NONE



A C-5004 SECTION PRB REACTION CELL BACKFILL

SCALE: NONE



C C-4001 SECTION STREAM CHANNEL AT DIVERSION WALL

SCALE: NONE

GENERAL NOTES

1. PLACE 10 MIL HDPE SHEETING OVER TOP OF PEA GRAVEL TO LIMIT SURFACE INFILTRATION. EXTEND HDPE 1' (MIN.) PAST EDGE OF THE PEA GRAVEL BACKFILL IN ALL DIRECTIONS. WRAP HDPE UP SIDE OF PRB CELL TO TOP OF PRB CELL.
2. DO NOT MECHANICALLY COMPACT PEA GRAVEL.
3. GEOTEXTILE FABRIC (TERRATEX™ EP OR SIMILAR).
4. EROSION CONTROL BLANKET OVERLAPPING GEOTEXTILE FABRIC BY 18" (MIN.)
5. RIPRAP (STABILIZED WITH CONCRETE) EXTENDING TO EDGE OF EROSION CONTROL BLANKET (MIN.).

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CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99
PILOT PRB DETAILS II
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN: E. CARPIO
DESIGN: J. PIETZ
CHECKED: C. GIVENS
DATE: 04/27/07

SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

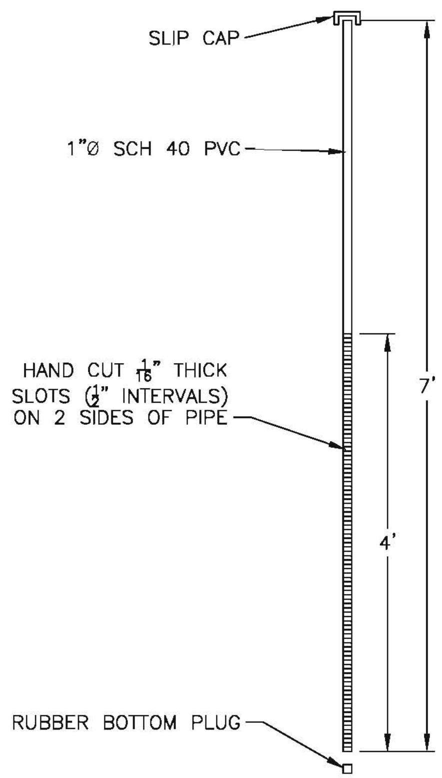
SHEET: C-5004
14 OF 18

CLASSIFICATION CLASSIFICATION
REVIEWER REVIEWER
DATE

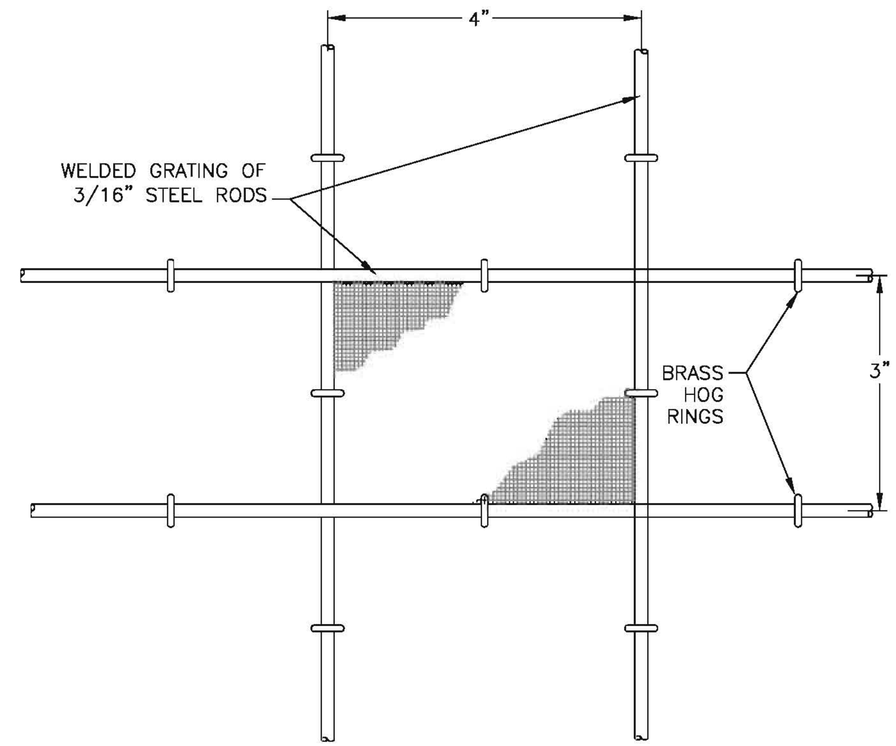
PROJECT ID: 5409
DRAWING NO: 5409-C-5004-R0
REV

GENERAL NOTES

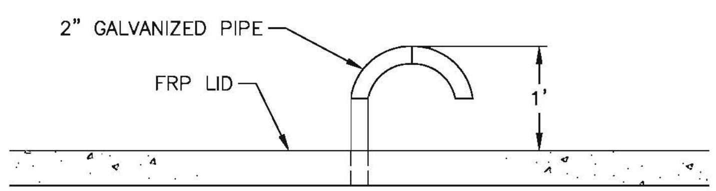
1. ATTACH WOVEN GEOTEXTILE FABRIC (APPARENT OPENING SIEVE SIZE = 70) TO GRATES USING BRASS HOG RINGS.
2. INSTALL GALVANIZED "U" TUBES INTO THREADED PENETRATIONS IN PRB CELL COVER.
3. INSTALL 4 SAMPLE TUBES INTO CELL COVER.
4. INSTALL 10" X 6" THICK CONCRETE COLLAR ON PRB REACTION CELL. ALLOW 1" SPINE BETWEEN REACTION CELL LIP AND PAD FOR BOLT CLEARANCE.



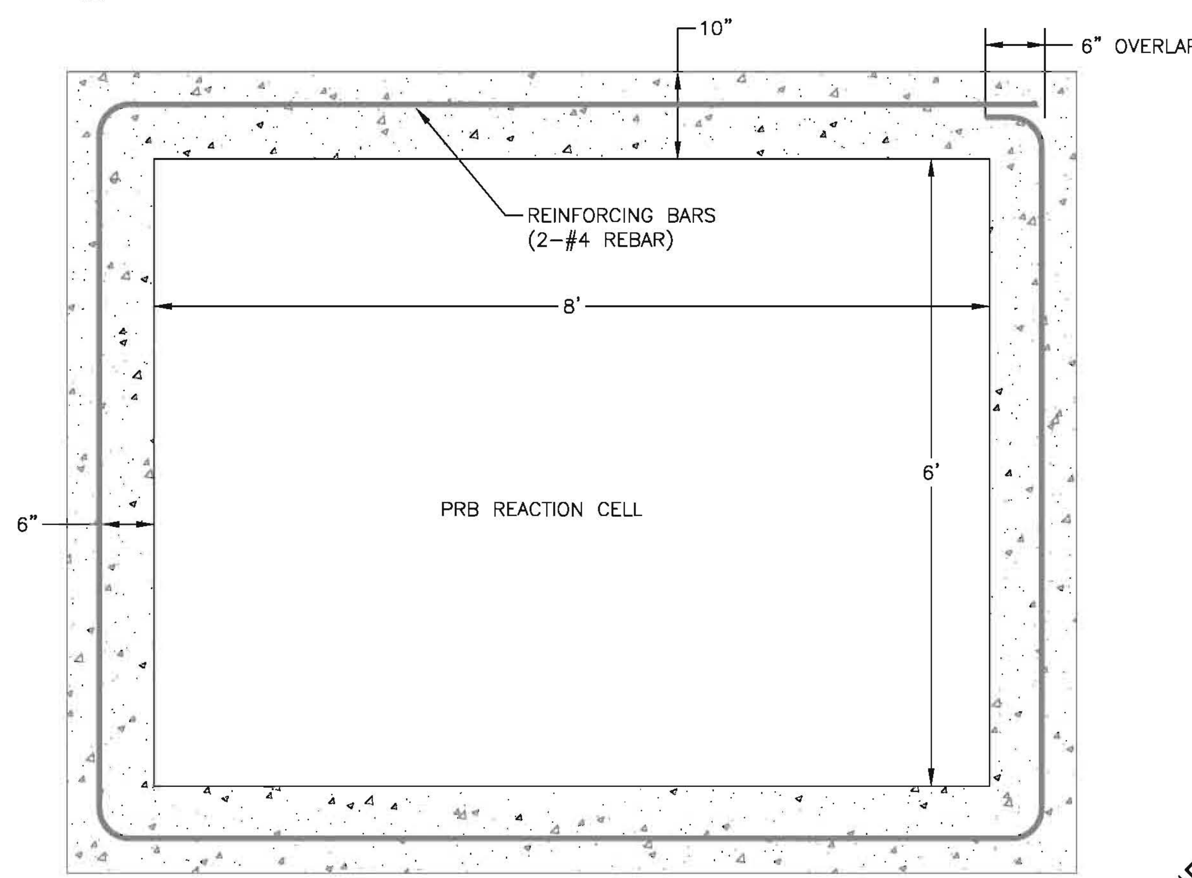
1 C-5003 DETAIL SAMPLE TUBE (TYP.)
SCALE: NONE



2 C-5003 DETAIL FILTER FABRIC AND SCREEN RACK
SCALE: NONE



3 C-5003 DETAIL VENT PIPE (TYP.)
SCALE: NONE



4 C-4001 DETAIL PRB CONCRETE PAD
SCALE: NONE

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CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99
PILOT PRB DETAILS III
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN	E. CARPIO
DESIGN	J. PIETZ
CHECKED	C. GIVENS
DATE	04/30/07

SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

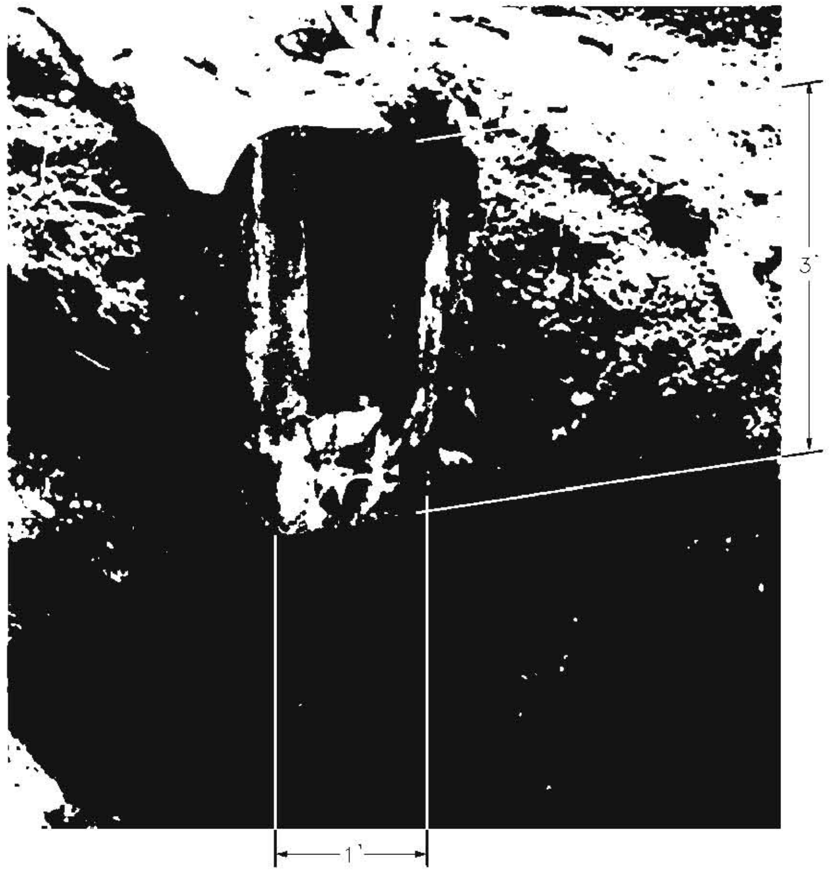
SHEET C-5005
15 OF 18

CLASSIFICATION: CLASSIFICATION
REVIEWER: REVIEWER
DATE

PROJECT ID: 5409
DRAWING NO: 5409-C-5005-R0
REV

GENERAL NOTES

1. DEMOLISH AND REMOVE CONCRETE TROUGH USING NON-PERCUSSIVE EQUIPMENT
2. CONDUCT LIMITED SOIL REMOVAL AT LOCATION 16-6404 USING MANUAL EXCAVATION.



(A / C-1003) SECTION CONCRETE TROUGH
SCALE: NONE

(1 / C-1003) DETAIL LOCATION 16-06404
SCALE: NONE

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CORRECTIVE MEASURES IMPLEMENTATION
CONSOLIDATED UNIT 16-021(c)-99
260 OUTFALL DRAINAGE CHANNEL DETAILS
CAÑON DE VALLE/MARTIN SPRING CANYON TA-16

DRAWN	E. CARPIO
DESIGN	J. PIETZ
CHECKED	C. GIVENS
DATE	04/27/07

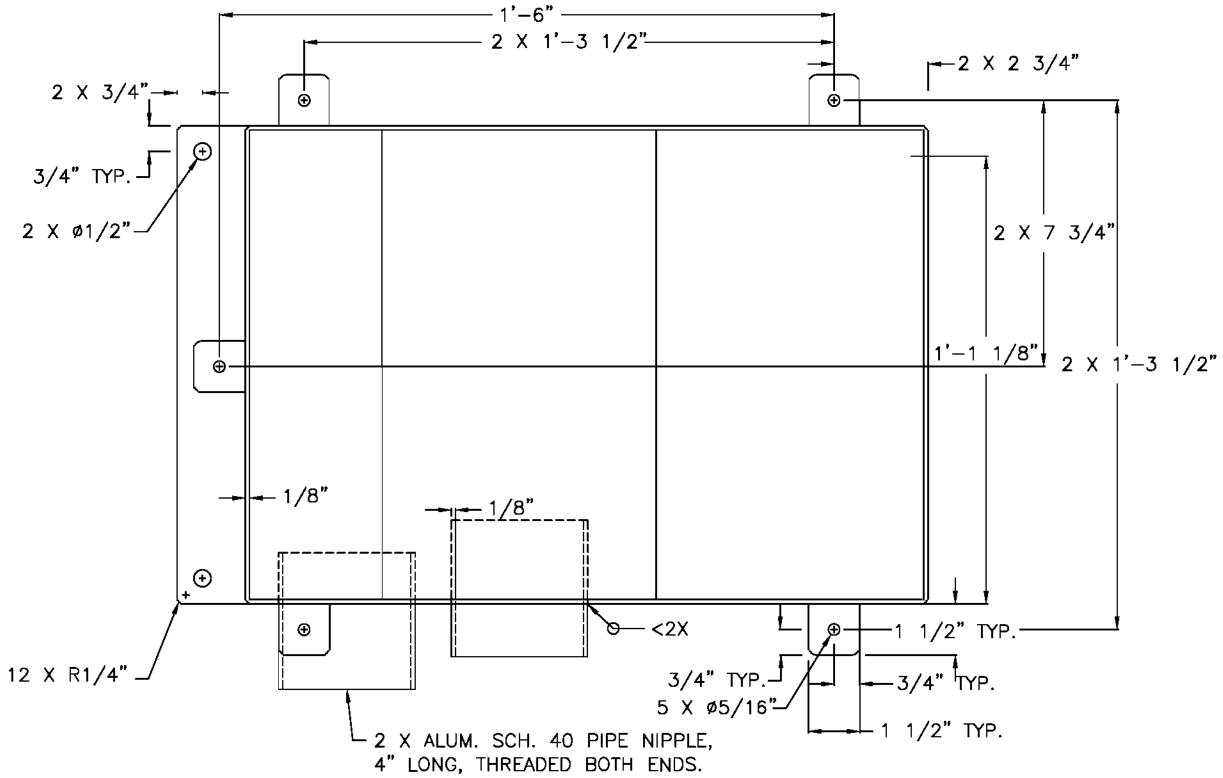
SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY — PO Box 1663 Los Alamos, New Mexico 87545

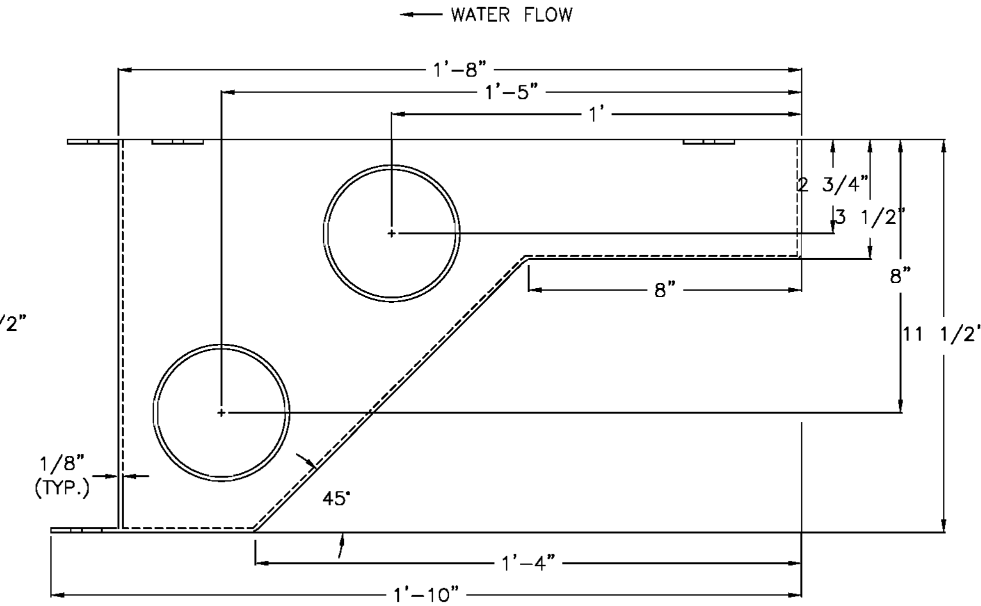
SHEET C-5006
16 OF 18

CLASSIFICATION: CLASSIFICATION
REVIEWER: REVIEWER
DATE

PROJECT ID: 5409
DRAWING NO: 5409-C-5006-R0
REV: 0



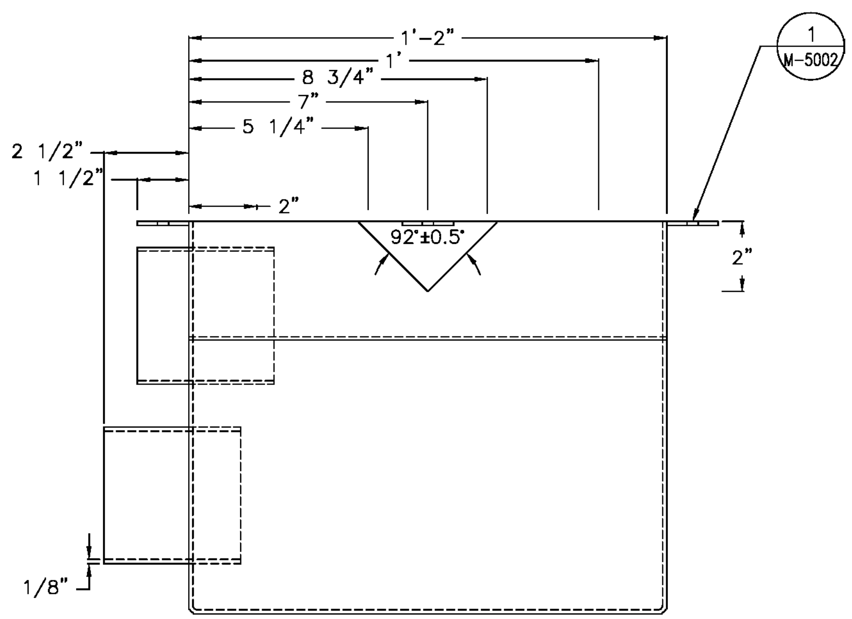
1 M-5001 WEIR BOX – PLAN VIEW
SCALE: NONE



2 M-5001 WEIR BOX – SIDE VIEW
SCALE: NONE

GENERAL NOTES

1. MATERIAL: ALUMINUM 5052–H32, .125" THICK.
2. TOLERANCE: ±.030 ALL DIMENSIONS.
3. FINISH: ALODINE.
4. OTHER FABRICATION DETAILS PER METAL FABRICATION SPECIFICATION.
5. "V" NOTCH TO BE INSTALLED ON UPSTREAM SIDE.
6. INSTALL WEIR BOX TO CAPTURE SPRING WATER BY HAND EXCAVATING PLACEMENT WITHIN SPRING CHANNEL. WATER TO FLOW THROUGH "V" NOTCH INTO WEIR.
7. CONNECT LOWER 2" THREADED NIPPLE TO 2" PIPING TO CARBON FILTER.
8. UPPER 2" PENETRATION TO REMAIN OPEN FOR OVERFLOW.
9. BACKFILL WEIR BOX, LEAVING OVERFLOW PIPE EXPOSED.



3 M-5001 WEIR BOX – END (UPSTREAM) VIEW
SCALE: NONE

1 C-4001 DETAIL WEIR BOX
SCALE: NONE

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CORRECTIVE MEASURES IMPLEMENTATION CONSOLIDATED UNIT 16–021(C)–99

WEIR BOX DETAIL

CAÑON DE VALLE/MARTIN SPRING CANYON TA–16

DRAWN	E. CARPIO
DESIGN	J. PIETZ
CHECKED	C. GIVENS
DATE	04/25/07

SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

SHEET M–5001
17 OF 18

CLASSIFICATION: CLASSIFICATION
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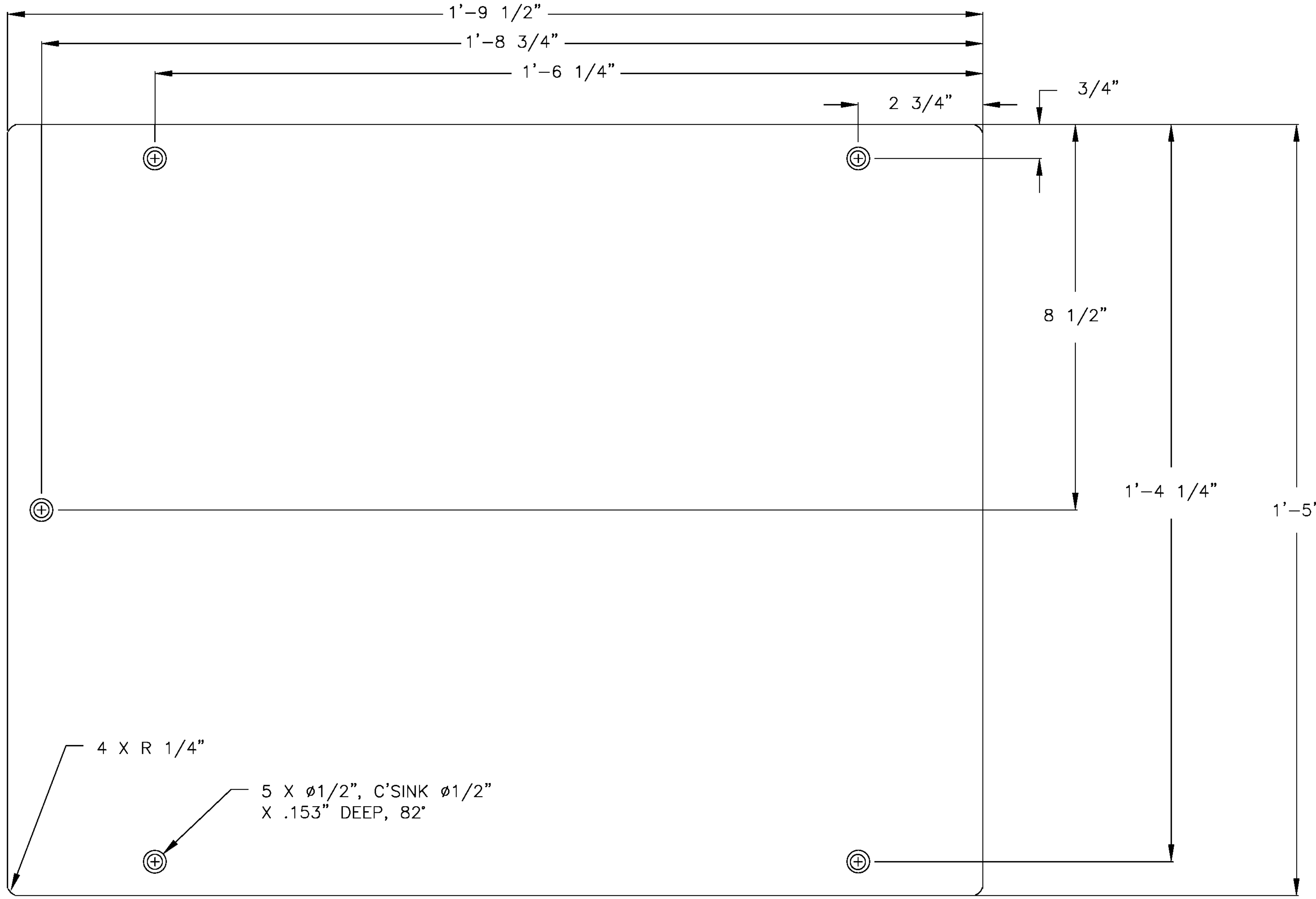
DATE

PROJECT ID: 5409
DRAWING NO: 5409–M–5001–R0
REV: 0



1 M-5001 DETAIL WEIR BOX COVER
SCALE: NONE

GENERAL NOTES

1. MATERIAL: ALUMINUM 6061-T6 DIAMOND TREAD PLATE, .125" THICK.
2. TOLERANCE: ±.030 ALL DIMENSIONS.
3. FINISH: ALODINE.

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CORRECTIVE MEASURES IMPLEMENTATION CONSOLIDATED UNIT 16-021(C)-99

WEIR BOX COVER DETAIL

CAÑON DE VALLE TA-16

DRAWN	E. CARPIO
DESIGN	J. PIETZ
CHECKED	C. GIVENS
DATE	04/27/07

SUBMITTED: JOHN PIETZ
APPROVED FOR RELEASE: PROJECT TEAM LEADER

Los Alamos NATIONAL LABORATORY
PO Box 1663
Los Alamos, New Mexico 87545

SHEET M-5002
18 OF 18

CLASSIFICATION CLASSIFICATION | REVIEWER REVIEWER | DATE

PROJECT ID: 5409
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REV: 0

Appendix E

Construction Quality Control Plan, Rev. 0, Corrective Measures Implementation Plan for Consolidated Unit 16-021(c)-99

E-1.0 INTRODUCTION

This draft Construction Quality Control Plan (CQCP) describes quality-control (QC) methods and procedures for performing the following tasks in support of the corrective measures implementation plan for Consolidated Unit 16-021(c)-99 (the CMI plan) at Los Alamos National Laboratory (LANL) in Los Alamos, New Mexico. The tasks include

- Construction/installation of a pilot-scale permeable reactive barrier (PRB), consisting of a groundwater diversion wall and a reactive cell, at the Cañon de Valle site location
- Excavation of high explosives (HE) contaminated soils from several "hotspots" located in the former settling pond adjacent to the 260 Outfall and the drainage channel down gradient from the settling pond.
- Backfilling and replacement of the low permeability cap over the hotspot excavations in the former setting pond.
- Injection pressure grouting of a contaminated surge bed within tuff beneath the former settling pond.
- Removal of the remaining portion of the concrete outfall trough from the former settling pond to the outfall and backfilling with clean fill.
- Installation of spring diversion weir boxes and carbon filter systems for the treatment of spring water at Burning Ground Spring (in Cañon de Valle) and Martin Spring (in Martin Spring Canyon).

This CQCP is provided as part of the CMI Plan and is to be used, and modified as necessary, by the construction contractor. The construction contractor will be responsible for updating and finalizing this CQCP and submitting the final CQCP to LANL for review and approval prior to performing any construction activities.

E-1.1 Quality Control Plan Objective

The goal of this CQCP is to establish the necessary levels of management and control to ensure that all construction activities performed in support of the CMI Plan will be completed as defined in the design drawings and specifications and will meet the quality assurance (QA) requirements of the Quality Management Plan and applicable quality procedures (QPs) and standard operating procedures (SOPs) for the Environmental Programs Directorate at LANL (or current applicable environmental management organization at LANL). The construction contractor shall meet the LANL QMP requirements either through the implementation of a QA/QC program and procedures that has been approved by LANL or by adopting the LANL QMP, QPs, and SOPs. In the process of performing construction QC, documentation shall be prepared and maintained during and after the completion of the CMI plan activities so that it can be demonstrated that all work has been completed and all applicable performance requirements of the design have been met.

This CQCP identifies the definable features of work for the project and defines the methodology and practices to control the quality of work features performed during the construction activities in support of the CMI plan. At a minimum, this CQCP addresses the following subjects:

- The organization, responsibilities, qualifications, and authority for personnel performing QC-related functions
- The definable features of work

- Scheduling and managing submittals
- Inspections and tests
- Sampling and analyses (chemical and geotechnical)
- Identifying and tracking nonconformances and corrective actions
- Subcontractor control
- Document control/records management
- Change control
- Audits and surveillance
- Project completion turnover/closeout

The Contractor Quality Control Manager (QCM) or designee shall be responsible for implementation and control of the QC program during the project duration from site preparation through excavation, debris and waste removal, equipment installation, site closure, operations and maintenance, and any other work affected by the QC program.

Work outside the definable features of work identified here shall not be performed without a comprehensive review of this plan and, as necessary, a LANL-accepted revision or variance to this CQCP outlining quality planning and execution for the additional work.

Revisions to this plan require the same level of approval, control, and distribution as the original.

E-1.2 Site Background

The Cañon de Valle site is located at Technical Area (TA) 16 of LANL in Los Alamos, New Mexico. Several remediation actions and systems are planned for Consolidated Unit 16-021(c)-99. The remediation actions and systems are detailed in this CMI plan. A list of the definable features of work is provided in section E-3.0.

E-2.0 QUALITY CONTROL ORGANIZATION

The contractor shall interface with LANL on all matters directly associated with this project. LANL will interface with other agencies, as necessary.

E-2.1 Quality Control Organization

The following sections describe the roles, responsibilities, and authorities of key project personnel positions performing activities that affect project quality.

The contractor will modify and expand these sections, as necessary, and submit a final CQCP to LANL for review and approval. Names, classification, and qualifications of each member of the contractor's quality control team must be included, together with assigned individual duties, responsibilities, and authorities. An organizational chart of the contractor's quality control team shall be included.

E-2.1.1 Contractor Project Manager

The Contractor Project Manager (PM) shall interface directly with LANL regarding project execution and accountability and be the primary point of contact for the contract. The PM controls the budget and schedule, ensuring that contract requirements are met. The PM shall be responsible for managing construction activities, including subcontractors, and for ensuring overall conformance of the work to project and contract requirements and specifications including technical, cost, and schedule requirements. The PM shall organize the assigned project and QC staff and initiate project planning and implementation activities.

E-2.1.2 Contractor Construction Site Manager

The Contractor Construction Site Manager (CCSM) shall be responsible for the on-site management and execution of all field project activities in accordance with the work plan and federal, state, and local laws and regulations. The CCSM shall function as the primary point of contact for on-site LANL, field, and subcontractor personnel. The CCSM shall advise the Contractor PM of technical progress, expenditures, project needs, potential problems, and recommended solutions.

E-2.1.3 Contractor Quality Control Manager

The Contractor QCM will support the Contractor PM on all day-to-day operations within the scope of the project QC program. The QCM will have the requisite authority, including stop-work authority, to ensure that all project site activities comply with applicable specifications of this CQCP, the approved project documents, and the contract. This authority applies equally to all project activities, whether performed by the Contractor or its subcontractors and suppliers.

The QCM shall be responsible for the overall management of the QC program on- and off-site, including field installation activities and consulting engineering activities for the project.

Duties of the Contractor QCM include, but are not limited to, the following:

- Implementing the project Contractor QCP
- Initiating or recommending corrective actions
- Verifying the implementation of corrective actions
- Continuously evaluating the effectiveness of the project Contractor QCP
- Notifying the Contractor PM of conditions adverse to quality that cannot be resolved at the project level
- Monitoring operation activities for compliance with contract requirements
- Monitoring laboratory testing activities
- Identifying and reporting nonconforming items, conditions, or activities
- Monitoring on-site subcontractors
- Preparing daily QC reports if required by the contract
- Performing and documenting installation inspection activities
- Performing or monitoring sampling activities
- Inspecting equipment and materials when received

E-2.1.4 Subcontractors

When other companies and/or subcontractors are involved in performing activities governed by the requirements of the Contractor QCP, the responsibility and authority of such organizations shall be clearly established and documented. Although the contractor may delegate the work of establishing and executing certain portions of the Contractor QCP, the contractor shall retain responsibility for fulfilling the QC program.

E-2.1.5 Site-Specific QA/QC Control Training

The Contractor QCM (or designee) shall be responsible for providing basic training of all project personnel performing quality-related activities. The training shall include a review of the project CQCP work plans, regulatory requirements, and other project-specific documents necessary for personnel to perform project work activities properly.

E-2.1.6 Changes of QA/QC Personnel

The Contractor shall strive to maintain continuity of QA/QC personnel on the project. In the event that personnel changes become necessary, LANL shall be notified and shall approve any proposed change.

E-3.0 DEFINEABLE FEATURES OF WORK AND SUBMITTAL MANAGEMENT

E-3.1 Definable Features of Work

Table E-3.1-1 lists the definable features of work governed by this CQCP.

The Contractor shall review this list of definable features of work and identify features to be removed or added to the list. The Contractor shall provide a revised table that identifies the feature, the scheduled activity number, the work document reference number, and the assigned responsible organization for each feature of work to LANL as part of the final CQCP for review and approval.

E-3.2 Submittal Management

Submittal management will be a primary responsibility of project management and QC staff. Submittal control is required to regulate the timely flow of materials and work, to facilitate problem prevention, and to demonstrate that materials and work comply with applicable specifications. Project submittal procedures shall be implemented as prescribed in Specification 01 3300, Submittal Procedures and in accordance with contract delivery requirements.

E-3.2.1 Submittal Schedule

The Contractor PM will be responsible for overall management and control of project submittals, including submittal scheduling and tracking. The QCM shall be responsible for ensuring, through detailed review, that submittals, as well as the materials and work these represent, are in full compliance with applicable contract specifications.

Submittals will be listed and tracked using a submittal schedule, identifying the individual submittals and the required dates for submitting and approval by LANL. A preliminary list of submittals anticipated for this project is provided in Specification 01 3300, Submittal Procedures. The Contractor shall review this preliminary list and identify items to be removed or added to the list. The QCM shall then provide a revised submittal schedule to LANL for review and approval.

Procurement documents for subcontracted services and materials shall list the required subcontractor submittals. The QCM is to review the list to ensure its completeness and may expand general category listings to show individual entries for each item. Submittals received from subcontractors are to be reviewed by the Contractor QCM before they are submitted to LANL. Subcontractors should not provide submittals directly to LANL. Changes in submittal progress and QC activities related to submittals are to be summarized in the daily QC report.

The Contractor PM shall maintain a project submittal delivery schedule that reflects submittal dates and status. Submittal activities are to be incorporated into the project schedule so that the submittal progress can be tracked in conjunction with overall progress. Submittal schedules shall allow for evaluation, approval, procurement, and delivery before the preparatory phase and before the deliverable is needed for work. Interrelated submittals shall be scheduled and submitted concurrently. Adequate time shall be allotted for required reviews and approvals.

E-3.2.2 Hold Points

Hold points are points during construction activities where mandatory inspections and approvals by the on-site Contractor QCM and LANL QA representative are required. Construction shall not progress past a hold point (identified in the construction drawings and specifications) without written approval from the LANL QA representative. Hold points are intended to allow verification of activities or constructed items before these items or evidence of these activities is covered by further construction activities. A list of hold points is provided in Table 1.8 of Specification 01 3300, Submittal Procedures.

E-4.0 QC INSPECTIONS

QC inspections shall be conducted to ensure that project tasks are performed in accordance with the Contract Documents. A final inspection shall be formally scheduled and completed for the entire project. Each type of anticipated inspection is discussed in the following sections. Completed inspection forms and a log will be maintained in the site QC files and will be available for review at any time.

E-4.1 Preparatory Inspections

Preparatory meetings/inspections shall be performed before the execution of each definable feature of work (identified in Table E-3.1-1). The preparatory inspection meeting will be attended by the CCSM, the Contractor Site Safety and Health Officer (SSHO), Contractor QCM, and subcontractors. The LANL QA representative shall be notified of/invited to the preparatory inspection meeting at least 48 hr before the meeting. The preparatory/inspection meeting shall include:

- Reviewing contract plans and pertinent contract specifications and drawings;
- Reviewing materials and equipment documentation for required tests, submittals, and approvals;
- Reviewing required control inspections and test requirements;
- Establishing that the preliminary work required to begin the task is complete and conforms to approved drawings and submittal data;
- Establishing that the required materials and equipment for commencement of the work are on hand or available for use on the task;

- Confirming that materials and equipment conform to the specifications and that all equipment is properly calibrated and in proper working condition;
- Discussing procedures for performing the work; and
- Reviewing the appropriate activity hazard analysis.

Personnel performing work activities affected by a preparatory inspection shall be instructed as to how to complete the task so that their workmanship is in compliance with QC requirements.

E-4.2 Initial and Follow-Up Inspections

Additional inspections shall be conducted at the start of the project and on a continuous basis to ensure continuing compliance with contract requirements. The frequency of the inspections shall depend on the extent of work being performed. The inspection shall be conducted to evaluate the following criteria:

- Verification of preliminary work
- Compliance with the specifications, plans, drawings, submittals, and other contract requirements
- Compliance with the site-specific health and safety plan (SSHASP)
- Verification of acceptable quality of workmanship
- Resolution of any differences

E-4.3 Equipment Inspections

Equipment shall be inspected and calibrated according to the manufacturers' requirements before field use. Inspection of heavy installation equipment shall be recorded daily. These forms will be attached to daily logs and submitted to the LANL QA representative on a daily basis. All equipment inspections and calibrations shall be conducted by personnel with specific training and experience in the operation of that equipment.

E-4.4 Installation Contingency Procedures

Changes to the Contract Document and/or specifications may be required during the project to address unforeseen situations encountered in the field. In the event that a modification to the approved plans, drawings, or specifications is necessary, the Contractor shall stop work and notify LANL of the change. Upon approval of the modification by LANL, construction activities will continue.

In the event that an emergency condition such as a fire or earthwork failure arises, notifications shall be completed via TA-16 emergency procedures detailed in the health and safety plan to be prepared by LANL and the contractor before the commencement of site work.

E-4.5 Substantially Complete and Final Inspections

The Contractor shall conduct substantially complete and final inspections to verify that the work performed meets the requirements of plans, specifications, quality, workmanship, and completeness. The substantially complete and final inspection shall be attended by representatives of LANL.

A substantially complete inspection shall be conducted at the conclusion of work activities to verify that all work complies with the contract plans and requirements. During the substantially complete inspection, a punch list of items not conforming to the specified requirements, including incomplete project items, shall be developed, if required.

Upon completion/correction of the punch-list items, a final inspection shall be conducted to verify that the completed work conforms to the contract requirements. The notice of a final inspection shall include assurance that all punch-list items previously identified will be completed by the date scheduled for the final inspection.

E-4.6 Safety Inspections

The Contractor SSHO shall perform daily safety inspections and conduct daily safety meetings throughout the project. The inspections and meetings will be reported on daily logs. The inspection and meeting attendance form shall be maintained in the project files.

E-4.7 Field Inspections

Field inspections are primarily visual examinations but may include measurements of materials and equipment being used, techniques employed, and the final products. These inspections shall confirm that a specific guideline, specification, or procedure for the activity has been successfully completed. These inspections shall be performed as prescribed in the specifications for each applicable definable feature of work (see section E-3.1).

The results shall be documented on daily logs. Photography should be used but must be approved by LANL. All photographic equipment is restricted at TA-16.

E-4.8 Field Tests

Field tests are tests or analyses made in connection with site activities. Field tests shall be performed as prescribed in the specifications for each applicable definable feature of work (see section E-3.1).

The results of the field tests shall be documented daily on forms. The Contractor shall submit the test forms to LANL on a daily basis for review and approval.

E-4.9 Laboratory Tests

Geotechnical laboratory permeability and moisture-density compaction testing will be conducted on the test soil-bentonite mixtures prepared from soil collected from the three test pits (see Specifications 02 3000, Subsurface Investigations and 31 2333, Trenching and Backfilling) and soil-bentonite mixtures to be used for cap material over excavations in the former settling pond (see Specification 31 3526.13, Soil/Bentonite Containment Cap). Per the specifications, the subcontracted geotechnical laboratory shall be approved by LANL.

Sieve analyses will be performed by an approved laboratory on the PRB cell reactive materials (see Specification 06 8200, Glass-Fiber Reinforced Plastic).

Concrete strength testing (7- and 28-day samples) and/or field slump testing may be required from a Contractor-provided, LANL-approved testing laboratory for the miscellaneous cast-in-place concrete placed around the spring filter boxes, the PRB cell, and the monitoring well pads. Determination of testing will be made by the LANL QA representative on-site.

Laboratory chemical analysis will be performed/provided by LANL. Soil and/or water samples will be collected by the Contractor and provided to LANL, along with proper chain-of-custody documentation, for analysis.

E-4.10 Surveys

Several civil surveys will be required during the performance of this project. These surveys are detailed in Specification 02 2113, Site Surveys, along with methods and required precision. These surveys shall be performed by a professional surveyor licensed in the State of New Mexico. In all surveys the requirements of LANL SOP-03.11, Coordinating and Evaluating Geodetic Surveys, shall be incorporated. A summary of the surveys follows.

E-4.10.1 Site Topographical Survey of the PRB Construction Area

Before the PRB is constructed, a local topographic survey will be performed. The survey will include establishing a horizontal and/or vertical grade control for PRB installation and an elevation benchmark and conducting reference/location surveys for structures and topography, as appropriate. The Contractor QCM will review the topographic survey. It is likely that the survey cannot be completed using a global positioning system (GPS) because of the difficulty in accessing satellites in Cañon de Valle.

E-4.10.2 Civil Survey of All Soil Sample Locations

A civil survey of all soil sampling locations, including samples collected for field and laboratory analysis, shall be conducted. Either GPS or traditional techniques may be used, as available and applicable to the site conditions. Samples collected in the excavations in the settling pond and drainage channel hot spots and field and confirmation sampling along the 260 Outfall trough removal shall be surveyed and recorded.

E-4.10.3 Civil Survey of the Completed PRB Components

A civil survey of the completed PRB components shall be conducted using either GPS or traditional techniques. Traditional techniques may be required because of the inaccessibility of GPS satellites in Cañon de Valle. Surveyed points (horizontal and vertical) shall include

- Four corner points of PRB cell at surface (top of cell)
- End points of PRB diversion wall identifying lateral extent of wall and width of wall at wall top
- Each side of PRB diversion wall at top of wall where stream bed crosses wall (center of stream)

E-4.10.4 Civil Survey of PRB Monitoring Wells

A civil survey of the three newly installed PRB monitoring wells shall be conducted using either GPS or traditional techniques (see Section 33 2413, Groundwater Monitoring Wells). Traditional survey techniques may be required because of the inaccessibility of GPS satellites in Cañon de Valle. Surveyed points (horizontal and vertical) shall include the location of the well and all appropriate elevations associated with the top-well equipment. The point on the well casing for which the elevation was determined shall be permanently marked on the casing.

E-4.11 Review of Manufacturers' Certificates of Compliance

Certificates of Compliance shall be obtained from suppliers for selected materials. The certificates shall be reviewed and approved by LANL before material delivery. Certificates shall include a statement that the material meets all the specification requirements and shall provide any supporting test results. This section will apply to the prefabricated PRB reaction cell, which is constructed of fiberglass reinforced plastic.

E-4.12 Inspection Checklists

Inspection checklists shall be required for all inspections of definable features of work and shall document inspection results. The checklists will be maintained by the Contractor QCM and be attached to the daily logs.

E-5.0 DOCUMENT CONTROL

This CQCP establishes the document control system that provides measures for controlling the issuance, distribution, storage, and maintenance of documents relating to quality, including those of subcontractors and other vendors.

E-5.1 Daily QC Reports

Daily QC reports shall be completed to document all project activities. These daily reports shall cover both conforming and nonconforming work and, where applicable, shall include a statement of certification that all materials, supplies, and work comply with the contract requirements. The daily reports shall include

- Location and type of work;
- Type and number of control activities;
- Results of inspections and tests;
- Types of defects/causes for rejection, if any;
- Corrective actions proposed/taken, if any;
- Trades/personnel working – type and number;
- Weather conditions;
- Delays and their causes, if any;
- Verbal instructions;
- Samples collected;
- Field analyses performed, including results;
- Calibration procedures and readings;
- Health and safety activities;
- Equipment used;
- Equipment daily checklist;

- Nonconformance reports (NCRs), deficiency reports, and records of statement of work clarifications;
- Remarks, and
- Certifications.

Additional documentation (e.g., test reports, daily logs, subcontractor daily reports, and other pertinent documentation) may be included as attachments to the daily QC report.

E-5.2 Project Records

QC records shall be prepared to furnish documented evidence that project activities, including CMI plan laboratory analyses, fulfill the scope of work and are in compliance with the requirements of the contract. Records shall be maintained and stored at the project site. Records shall be readily retrievable for review and audit purposes by LANL. The records shall be controlled to avoid the possibility of their loss or damage. The records shall be consistent with the applicable sections of the contract specifications and may include the following documents:

- Daily QC reports
- Inspection reports
- Monitoring and surveillance activities
- Personnel qualifications
- Corrective actions
- Training records
- Other specified documents

Examples of project and field forms (e.g., daily log forms, Daily QC Report forms, inspection forms, etc.) shall be included by the contractor as an attachment to the final CQCP.

E-5.3 Inspection Documentation

The Contractor is responsible for the maintenance of the inspection records. Inspection records shall be legible and will clearly provide all information necessary to verify that the items or activities inspected conform to the specified requirements. In the case of nonconforming conditions, inspection records shall provide evidence that the conditions were brought into conformance or otherwise accepted by LANL.

E-6.0 NOTIFICATION OF NONCONFORMANCE

This section describes the procedures for controlling items that do not conform to specified design requirements by tracking them from identification through acceptable corrective action. All personnel are responsible for identifying deficiencies and notifying the Contractor.

E-6.1 Identifying Deficiencies

The Contractor shall be notified of all deficiencies identified during the course of site activities to ensure that each deficiency is documented, reported, and tracked, that corrective actions are taken, and that follow-up verification is conducted.

The Contractor shall include the identified deficiencies in the daily log, noting the item found to be deficient, date, time, location, the person who identified the deficiency, and the status of the item to which the deficiency applies (installed, awaiting installation, deficiency identified upon receipt, item previously accepted but in storage, etc.). The Contractor shall also include an explanation of what action is being performed to correct the deficiency.

E-6.2 Punch Lists

Substantially complete inspections conducted by the Contractor typically result in the development of a punch list of items that do not conform to approved plans. During the course of each substantially complete inspection, the Contractor shall document nonconforming items in a punch list that will serve as input to the Contractor database for items requiring corrective action. The database will serve as the tracking system for the follow-up of open items and will identify when they are completed.

The Contractor shall monitor the punch list corrective action database daily until all corrective actions have been completed and the punch list is closed out. A printout of database open items shall be included with, and attached to, each day's daily log.

E-6.3 Notification

LANL will be notified of the identification and progress toward resolution of nonconforming items/conditions through the reporting requirements stated in the project procedures and/or plans or through attendance at coordination meetings.

E-7.0 TESTING

This section describes the controls to be implemented for the performance of tests required to verify the acceptability of the construction activities. The testing shall include on-site field tests and geotechnical and chemistry analytical laboratory tests. Details of identified testing are provided in the following subsections. Chemical analytical laboratory testing will be provided by a LANL supplied laboratory. The construction contractor will only be responsible for sample collection of chemistry analytical laboratory samples, not testing or reporting or results.

This section may be modified by the construction contractor based on the selected geotechnical laboratory and testing methods. Modifications will require review and approval from LANL.

E-7.1 Soil-Bentonite PRB Diversion Wall Mix

As part of the installation of three test pits at the PRB, a soil sample will be collected from each pit. Each sample will be mixed with a percentage of bentonite (see Specification 02 3000, Subsurface Investigations) and sent to a geotechnical laboratory for permeability testing per ASTM D-5084 and moisture-density compaction testing per ASTM D-698 or D-1557, as applicable (see Specification 02 3000, Subsurface Investigations) before further PRB construction activities. Geotechnical laboratory results shall be submitted to LANL through the submittal process (see Section E-3.2 and Specification 01 3300, Submittal Procedures).

During soil-bentonite PRB diversion wall installation, on-site field tests shall be conducted to verify that the materials (e.g., water) and soil-bentonite backfill mixture meet the requirements (e.g., moisture, compaction density). In-place density testing of compacted lifts will be performed as identified in Specification 31 2333, Trenching and Backfilling. The results shall be documented on forms (i.e., Daily

QC Reports). The soil-bentonite backfill shall be adjusted accordingly if the mixture does not meet the requirements.

E-7.2 Soil-Bentonite Low-Permeability Cap Mix

Soil samples will be collected from the former cap soil stockpile (see Section 02 6100, Removal and Disposal of Contaminated Soils) for moisture-density compaction testing per American Society for Testing and Materials (ASTM) D-698 or D-1557, as applicable, and for permeability testing per ASTM D-5084 (see Specification 31 3526.13, Soil/Bentonite Cap). Geotechnical laboratory results shall be submitted to LANL through the submittal process (see Section E-3.2 and Specification 01 3300, Submittal Procedures).

During soil-bentonite low-permeability cap installation, on-site field tests shall be conducted to verify that the materials (e.g., water) and soil-bentonite backfill mixture meet the requirements (e.g., moisture, compaction density). In-place density testing of compacted lifts will be performed as identified in Specification 31 3526.13, Soil/Bentonite Cap. The results shall be documented on forms (i.e., Daily QC Reports). The soil-bentonite cap material shall be adjusted accordingly if the mixture does not meet the requirements.

E-7.3 Injection Grouting

A field quality control program will be required as part of the injection grouting plan to ensure that the same grout approved of during the design phase is exactly what is injected. This may be evaluated with simple production-level tests such as Marsh funnel (ASTM D-6910) and mud balance. In addition, an in situ permeability test will be conducted to verify the completeness of grouting. See Specification 03 6400, Injection Grouting, for additional details.

E-7.4 Field Soil Testing

Field sampling and testing of potentially contaminated soil will be performed at the former settling pond and drainage channel hotspot excavation and under the 260 outfall trough after it is removed. Surface soil samples will be collected per SOP-01.07, Operational Guidelines for Taking Soil and Water Samples in Explosive Areas, and analyzed using field analytical methods for high explosives (see Specification 02 6100, Removal and Disposal of Contaminated Soils). Field results will be recorded and compared to the soil cleanup standards identified in the CMI plan. Results will be reported and submitted to LANL per Section E-3.2.

E-7.5 Concrete Testing

Concrete strength testing (7- and 28-day samples) and/or field slump testing may be required from a Contractor-provided, LANL-approved, testing laboratory for the miscellaneous cast-in-place concrete placed around the spring filter boxes, the PRB cell, and the monitoring well pads. Determination of testing will be made by the LANL QA representative on-site.

E-7.6 Air Monitoring

Air monitoring activities are not anticipated during construction activities.

E-8.0 FIELD QUALITY CONTROL

The field QC component of the CQCP includes:

- Procedures for documenting and justifying any field actions contrary to the CQCP;
- Documentation of all pre-field activities such as equipment checkout, calibrations, and manufacturer inspections;
- Documentation of field inspection activities during the project; and
- Documentation of field measurement QC data.

E-8.1 Field Changes to Quality Control Plan

Changes to the CQCP procedures, testing requirements, or personnel may be required to adjust for unforeseen circumstances. Modifications may be required in the event that the given procedures do not provide adequate control or may be proactively initiated by the Contractor to ensure that QA/QC objectives are met.

Should modifications to this CQCP become necessary or desirable, the contractor will notify LANL in writing. The notification will include a description of the proposed change, the reason(s) for requesting the change, and the date upon which the change needs to become effective, along with other pertinent information.

E-8.2 Pre-Field Activities

Prefield activities include calibrating equipment, performing preparation inspections, obtaining field permits, and obtaining a copy of the manufacturer inspection documents for materials to be incorporated into the project.

E-8.2.1 Field Equipment Calibrations and Inspections

Equipment shall be inspected and calibrated according to the manufacturers' requirements before field use. Inspection of heavy-installation equipment will be recorded daily. Calibration of field-testing equipment shall meet the requirements of QP-5.2, Control of Measuring and Test Equipment, and shall be recorded on equipment calibration forms. All equipment inspections and calibrations shall be conducted by personnel with specific training and experience in the operation of that equipment. These forms shall be attached to the daily QC report and submitted on a daily basis.

E-8.2.2 Field Permits

The Contractor will coordinate through LANL to obtain any required permits, before beginning construction activities. These permits include a wetlands disturbance permit (U.S. Army Corps of Engineers 401/404 permit), a construction stormwater pollution prevention plan, and a New Mexico Environment Department no-longer contained-in determination.

E-8.3 Field Measurement Quality Control

Field measurements will generate substantial quantities of data. Field measurement data results for the soil-bentonite backfill mixture shall be included on the Daily QC Reports. Copies of completed Daily QC Reports will be submitted to LANL within 24 hr.

E-8.4 Inspection of Field Activities

Field activities shall be inspected at least on a daily basis. The Contractor shall make daily inspections of all work in progress, recording all deficiencies in the Daily QC Report along with a notation of the corrective action taken. All other inspection activities shall also be reported on the Daily QC Report.

E-8.5 Subcontractor Direction

Activities of subcontractors shall be under the direction of the Contractor. Inspections of all subcontractor work, including inspections, shall be conducted by the Contractor QCM.

E-9.0 SUBCONTRACTOR CONTROL

All subcontractors performing work for the project are responsible for conformance to the quality requirements of their respective subcontract. Subcontractors include organizations supplying quality-related items or services to the project. The overall responsibility for conformance to the quality requirements for the subcontracted items and services is retained by the Contractor.

The requirements for personnel qualifications, technical performance levels, QC procedures, acceptability levels, and documentation shall be included as a part of the subcontract documents.

The Contractor is responsible for the implementation of inspections, document reviews, audits, and other QC activities used to monitor the subcontractor’s compliance with the contract. These activities shall be documented on checklists, Daily QC Reports, or other forms appropriate to the function performed.

For field operations, the Contractor shall provide QC checks before, during, and after the completion of the subcontractor's activities. The QC checks shall include preparatory, initial, follow-up, and final inspections to determine whether the subcontractor is in compliance with the QC measures set forth by the contract and the applicable subcontract responsibilities including:

- Meeting quality requirements;
- Generating, controlling, and maintaining required documentation;
- Performing and documenting required inspections and tests;
- Identifying, reporting, and correcting nonconforming conditions, and
- Submitting documentation to LANL.

E-9.1 Subcontractor QA/QC Responsibilities

Subcontractors performing work shall be monitored by the Contractor to verify conformance to the contract and subcontract quality requirements. The monitoring activities shall include inspections. All monitoring activities shall be documented on the appropriate form or included in the daily logs. Subcontractors shall be required to provide documentation consistent with project requirements.

E-9.2 Subcontractor Nonconformance

Work performed by subcontractors that does not comply with the specified requirements shall be identified, reported, corrected, and tracked in accordance with this CQCP.

E-9.2.1 Notification of Nonconformance

Notification of subcontractor noncompliance shall be accomplished via the NCR, with copies kept in the QC files.

E-9.2.2 Corrective Actions

Corrective actions by subcontractors will be monitored by the Contractor QCM or designee to verify that the subcontractor's performance meets the required specifications.

E-10.0 PROJECT COMPLETION TURNOVER/CLOSEOUT

Project completion and closeout shall follow the requirements presented in Specification 01 7700, Closeout Procedures, and any contractual requirements. Upon completion of the work the contractor shall certify that:

- Complete site restoration has been completed before final inspection.
- Waste and surplus materials, rubbish, and construction facilities have been removed from the project site.
- Contract documents have been reviewed;
- Work has been inspected for compliance with Contract Documents;
- Work has been completed in accordance with the Contract Documents;
- Equipment and systems have been tested as required, and are operational;
- All required operations and maintenance procedures/manuals have been turned over to LANL.
- Work is completed and ready for final inspection.

Should the work be found to be incomplete or defective, the Contractor shall correct the deficiencies promptly and notify LANL when the work is ready for reinspection. When the work is determined to be acceptable, the Contract Administrator will request Contractor to make the closeout submittals.

Table E-3.1-1
Definable Features of Work

1.0 Construction/installation of a pilot-scale PRB, consisting of a groundwater diversion wall and a reactive cell, at the Cañon de Valle site location
1.1. Excavation:
1.1.1. Install three test pits along the PRB route to confirm depth to bedrock, observe the rate of groundwater recharge into excavations, and observe the bedrock surface
1.1.2. Excavate location for PRB cell
1.1.3. Excavate trench for soil-bentonite diversion wall
1.2. Sample Collection: Collect soil samples for preparation of bentonite/soil test mixture
1.3. Geotechnical Testing: Perform Geotechnical Laboratory moisture/density and permeability testing of bentonite/soil mixture samples for the groundwater diversion wall
1.4. Excavation Plan: Prepare an excavation plan and final design drawings, including shop drawings
1.5. Grouting: Prepare/seal the bedrock surface/diversion wall interface
1.6. Survey: Perform Civil Survey of the site
1.7. Fabrication: Fabricate PRB reactive cell
1.8. Concrete:
1.8.1. Install concrete pad for PRB cell
1.8.2. Pour concrete collar around PRB cell
1.8.3. Stabilize riprap at stream crossing
1.8.4. Install monitoring well pads
1.9. Backfill:
1.9.1. Backfill soil-bentonite diversion wall
1.9.2. Backfill pea gravel and soil-bentonite around PRB cell
1.10. Site Restoration:
1.10.1. Construct stream bed erosion control crossing
1.10.2. Install erosion control blankets
1.10.3. Reseed disturbed areas
1.11. PRB Cell Operation: Load reactive materials into PRB cell.
1.12. Monitoring Wells: Install three monitoring wells
1.13. As-builts: Prepare a final construction report, including photographs and as-built drawings
2.0 Removal of potentially contaminated soil from hotspots in the former settling pond and drainage channel.
2.1. Excavation:
2.1.1. Excavate existing low permeability cap material
2.1.2. Remove potentially contaminated soil in identified "hotspots"
2.2. Sampling:
2.2.1. Conduct field characterization soil sampling and analysis
2.2.2. Collect confirmation samples for Laboratory analysis for Constituents of Concern
2.3. Backfill:
2.3.1. Emplace clean fill
2.3.2. Emplace soil-bentonite cap material

Table E-3.1-1 (continued)

3.0 Injection pressure grouting of a contaminated surge bed within tuff beneath the former settling pond.
3.1. Grouting Plan: Preparation, submittal, and approval of grouting plan
3.2. Drilling: Drilling of injection grouting holes
3.3. Grouting: Injection grouting of surge bed
4.0 Removal of the remaining portion of the 260 outfall concrete trough.
4.1. Excavation:
4.1.1. Remove concrete trough and dispose
4.1.2. Remove contaminated underlying soil
4.2. Sampling:
4.2.1. Conduct field characterization soil sampling and analysis
4.2.2. Collect confirmation samples for Laboratory analysis for Constituents of Concern
4.3. Backfill: Placement of clean fill
5.0 Installation of spring diversion weir boxes and carbon filter systems for the treatment of spring water at Burning Ground Spring (in Cañon de Valle) and Martin Spring (in Martin Spring Canyon).
5.1. Excavation:
5.1.1. Remove and stockpile topsoil
5.1.2. Excavate for weir boxes and filter systems
5.2. Fabrication: Fabricate aluminum weir box(es)
5.3. Plumbing: Install box(es) and filter systems and associated plumbing
5.4. Concrete: Pour concrete collar around filter systems
5.5. Backfill: Backfill around weir box(es) and filter systems
5.6. Filter installation: Install filter cartridges into filter systems and verify performance

Appendix F

Management Plan for Remediation Waste

F-1.0 INTRODUCTION

This appendix describes the management of waste generated during the performance of the corrective measure implementation (CMI) for the alluvial system in Cañon de Valle at Los Alamos National Laboratory (LANL or the Laboratory). These wastes consist of contaminated soil and concrete debris; contaminated personal protective equipment (PPE); sampling supplies and plastic; fluids from well development and the decontamination of PPE and sampling equipment; and all other waste that has potentially come into contact with contaminants. These wastes will be generated as a result of installing a permeable reactive barrier (PRB) and a carbon filter system in Cañon de Valle, the demolition of a concrete trough at the Technical Area 16 (TA-16) 260 Outfall, and the excavation of soils at the outfall and drainage channel.

To allow the efficient handling of excavated soil, the Laboratory will request that the New Mexico Environment Department (NMED) designate the PRB construction site and the 260 Outfall and channel as areas of concern (AOCs). An AOC designation was previously used for the interim measure (IM) at the 260 Outfall (NMED 2000, 070649). In addition, the Laboratory will request a "contained-in" determination from NMED for soil and particularly groundwater at the PRB site. Groundwater at the site may contain trace concentrations of F-listed solvents

F-2.0 CMI WASTES

All waste generated during the CMI activities will also be managed in accordance with applicable standard operating procedures (SOPs). These SOPs incorporate the requirements of all applicable U.S. Environmental Protection Agency (EPA) and NMED regulations, U.S. Department of Energy (DOE) orders, and Laboratory implementation requirements (LIRs). Two SOPs are applicable to the characterization and management of investigation-derived waste (IDW):

- SOP-01.06, Management of Environmental Restoration Project Waste, and
- SOP-01.10, Waste Characterization.

The CMI will be conducted in a manner that minimizes the generation of waste. Waste minimization will be accomplished by implementing the requirements of the Environmental Program (EP) Environment Remediation Support Services (ERSS) portion of the "Los Alamos National Laboratory Hazardous Waste Minimization Report" (LANL 2005, 091291). This report is updated annually to meet a requirement of Module VIII of the Laboratory's Hazardous Waste Facility Permit, which was issued by the EPA on May 23, 1990, and modified on May 19, 1994 (EPA 1990, 001585; Davis 1994, 044146).

The waste streams that will be generated and managed during the CMI are described in the following sections.

F-2.1 Drill Cuttings

The drill cuttings waste stream will consist of cuttings from the monitoring well adjacent to the former pond and from boreholes drilled into the former settling pond for the purpose of grouting the upper surge bed, as well as drill cuttings from the installation of three alluvial wells adjacent to the pilot PRB in Cañon de Valle. Drill cuttings will be collected and placed in containers at the point of generation (i.e., at the drill rig) and temporarily stored at the site. The drill cuttings waste stream will be characterized by direct sampling of the containerized cuttings. Chemicals of potential concern (COPCs) include high explosives (HE), inorganic chemicals, volatile organic compounds (VOCs), and semivolatile organic compounds (SVOCs).

Total concentrations of toxicity characteristic leaching procedure (TCLP) constituents will be compared with 20 times the TCLP regulatory level. If total concentrations are less than 20 times the regulatory level, the drill cuttings will be designated nonhazardous waste by characteristic. If the total concentrations exceed 20 times the regulatory level, the drill cuttings will be sampled and analyzed using the TCLP to determine whether they are hazardous waste by characteristic. If potential EPA-listed hazardous waste constituents are detected, the Laboratory will conduct a review of historical records and data to determine whether the source of each constituent was a listed hazardous waste at its point of generation. If the source is determined to be a listed hazardous waste, the cuttings will be managed as hazardous or mixed waste (depending on the levels of radioactivity). Based on the results of previous investigations, the Laboratory expects the majority of these drill cuttings to be designated as nonhazardous waste that will be either used for cover material at TA-54 or disposed of at an off-site disposal facility permitted for the disposal of solid waste.

F-2.2 Soil and Concrete Debris

During the CMI, soil will be generated from several sources: (1) the removal of the concrete trough at the 260 Outfall; (2) the excavation of residual soil at selected points within the former 260 Outfall settling pond and drainage channel; (3) the installation of the carbon filter at Burning Ground Spring; (4) the modification of the Martin Spring carbon filter; and (5) the installation of the pilot PRB in Cañon de Valle. In addition, concrete debris will be generated during the removal of the concrete trough at the 260 Outfall.

During installation of the PRB, excavation of the groundwater diversion walls will generate approximately 20 yd^3 of soil. Approximately 15 yd^3 of this soil will be reused for the groundwater diversion wall by mixing the soil with bentonite and backfilling into the excavation.

Soil not reused on site will be placed into containers appropriate to the waste volume generated (drums, supersacks, and/or rolloff containers), secured, and temporarily stored at the site. The COPCs include HE, inorganic chemicals, VOCs, and SVOCs. Total concentrations of TCLP constituents will be compared with 20 times the TCLP regulatory level. If total concentrations are less than 20 times the regulatory level, the soil will be designated nonhazardous by characteristic. If total concentrations exceed 20 times the regulatory level, the waste will be sampled and analyzed using the TCLP to determine whether it is hazardous by characteristic. If potential EPA-listed hazardous waste constituents are detected, the Laboratory will conduct a review of historical records and data to determine whether the source of each constituent was a listed hazardous waste at its point of generation. If the source is determined to be a listed hazardous waste, the soil will be managed as hazardous. Based on previous investigations conducted in these areas, neither hazardous wastes nor mixed waste is expected.

Concrete debris from the demolition of the concrete trough will be segregated and stockpiled on plastic. One composite sample will be collected consisting of concrete chips not greater than 1 in. thick. The above TCLP procedure will be used to analyze this concrete sample.

F-2.3 Spent PPE

The spent PPE waste stream will consist of PPE that has come into contact with contaminated environmental media (e.g., core and/or drill cuttings) and cannot be decontaminated. The bulk of this waste stream will consist of protective clothing such as gloves, shoe covers, and respirator cartridges (if required). Spent PPE will be collected in containers at personnel decontamination stations, secured, and temporarily stored at the site. Characterization of this waste stream will be performed through acceptable knowledge (AK) of the waste materials, the methods of generation, and the levels of contamination observed in the associated environmental media. The Laboratory expects spent PPE to be designated as nonhazardous waste that will be disposed of at an off-site disposal facility permitted for the disposal of solid waste.

F-2.4 Disposable Sampling Supplies

The disposable sampling supplies waste stream will consist of all equipment and materials necessary for sample collection that have come into direct contact with contaminated environmental media and cannot be decontaminated. This waste stream will also include residues associated with field test kits and wastes associated with dry decontamination activities. Field test kits will be segregated. Sampling wastes will consist primarily of paper and plastic items collected in bags at the sampling location and transferred to accumulation drums or other closable containers. Characterization of this waste stream will be performed through AK of the waste materials, the methods of generation, and the levels of contamination observed in the associated environmental media. The Laboratory expects disposable sampling supplies to be designated as nonhazardous waste, except for residues from some field test kits that will be designated hazardous. Nonhazardous wastes will be disposed of at an off-site facility permitted for the disposal of solid waste, and hazardous wastes will be sent to an off-site facility permitted for the treatment and/or disposal of hazardous waste.

F-2.5 Decontamination and Well Development Fluids

The decontamination and well development fluids waste stream will consist of liquid wastes from decontamination and development activities (e.g., decontamination solutions, purge waters, and rinse waters). Following waste-minimization practices, the Laboratory employs dry decontamination methods to the extent possible. If dry decontamination cannot be performed, liquid decontamination wastes will be collected in containers at the point of generation and transferred to accumulation drums; well-development fluids will be handled similarly. These drums will be temporarily stored at the site, and characterized using analytical results from direct sampling of the containerized waste. The Laboratory expects that the majority of decontamination fluids will be designated as nonhazardous liquid waste. Nonhazardous liquid wastes may be treated and disposed of at several on-site treatment facilities provided the waste meets the facility’s waste-acceptance criteria (WAC).

F-3.0 WASTE MANAGEMENT

All wastes will be managed in accordance with applicable federal, state, DOE, and Laboratory requirements. Waste streams, expected waste types, estimated waste volumes, and other data are listed in Table F-3.0-1.

All waste drums and containers (e.g., rolloff bins) will remain on-site until analytical results have been received and waste characterization has been completed.

Before the CMI activities begin, a waste characterization strategy form (WCSF) will be prepared and approved as required by the current version of SOP-01.10. The waste sampling procedures will be described in the WCSF.

Waste characterization will be achieved through existing data and/or documentation, direct sampling of the waste, or sampling of the media being investigated (e.g., surface soil, subsurface soil). If sampling is necessary, the procedures will be described in a sampling and analysis plan that will be developed in conjunction with the WCSF.

F-4.0 WASTE CONTAINERS AND TRANSPORTATION

The selection of waste containers will be based on both the appropriate U.S. Department of Transportation (DOT) requirements and the type and amount of waste that is anticipated to be generated. Immediately following containerization, each waste container will be individually labeled as to the waste classification, item identification number, and date of generation. Waste containers will be managed in clearly marked and appropriately constructed waste accumulation areas. Waste accumulation area postings, regulated storage duration, and inspection requirements will be based on waste type and classification. Container and storage requirements will be detailed in the WCSF, based on requirements outlined in the most recent versions of LIR 404-00-03, “Hazardous and Mixed Waste Requirements”; LIR 404-00-04, “Managing Solid Waste”; LIR 404-00-05, “Managing Radioactive Waste”; and LIR 405-10-01, “Packaging and Transportation.” Before waste is generated, the WCSF will be approved by the process detailed in SOP-01.10, “Waste Characterization.”

Transportation of waste will comply with appropriate DOT requirements. Transportation and disposal requirements will be detailed in the WCSF and approved prior to the generation of waste.

F-5.0 REFERENCES

The following list includes all documents cited in this appendix. Parenthetical information following each reference provides the author(s), publication date, and Environmental Remediation and Surveillance Program identification (ER ID) number. This information is also included in text citations. ER ID numbers are assigned by the Environmental Program–Environment and Remediation Support Services (EP-ERSS) Records Processing Facility (RPF) and are used to locate the document at the RPF and, where applicable, in the EP-ERSS Program master reference set.

Copies of the master reference set are maintained at the NMED Hazardous Waste Bureau; the U.S. Department of Energy–Los Alamos Site Office; EPA, Region 6; and the EP-ERSS Program. The set was developed to ensure that the administrative authority has all material needed to review this document, and it is updated with every document submitted to the administrative authority. Documents previously submitted to the administrative authority are not included.

Davis, A.M., April 19, 1994. “Transmittal of Hazardous Waste Permit for Los Alamos National Laboratory (NM0890010515),” U.S. Environmental Protection Agency Region VI letter to J.L. Bellows from A.M. Davis, Dallas, Texas. (Davis 1994, 044146)

EPA (U.S. Environmental Protection Agency), April 10, 1990. “Module VIII of RCRA Permit No. NM0890010515, issued to Los Alamos National Laboratory, Los Alamos, New Mexico,” EPA Region VI, Hazardous Waste Management Division, Dallas, Texas. (EPA 1990, 001585)

LANL (Los Alamos National Laboratory), November 2005. “Los Alamos National Laboratory Hazardous Waste Minimization Report,” Los Alamos National Laboratory document LA-UR-05-8650, Los Alamos, New Mexico. (LANL 2005, 091291)

NMED (New Mexico Environment Department), April 4, 2000. “Area of Contamination Approval 16-021(c)-99 Interim Measures Activities,” New Mexico Environment Department letter to J. Browne (Director/LANL), and T. Taylor (DOE) from J.E. Keiling (Acting Manager/RCRA Permits Management Program), Santa Fe, New Mexico. (NMED 2000, 070649)

Table F-3.0-1
Summary of Estimated CMI Waste Generation and Management

Waste Generating CMI Activity	Estimated Waste Type and Volume	Expected Waste Category	Principal Potential Contaminants	Potential Waste Disposal Facility
Removal of 260 Outfall concrete trough	Concrete debris, 20 yd^3	Nonhazardous	HE and barium	Construction debris landfill or Clean Harbors Deer Trail Colorado Facility or some other authorized off-site TSD* facility
Removal of contaminated soil beneath the 260 Outfall concrete trough	Soil, <10 yd^3	Nonhazardous	HE and barium	Clean Harbors Deer Trail Colorado Facility or some other authorized off-site TSD facility
Excavation of former 260 Outfall settling pond and drainage channel	Soil, <40 yd^3	Nonhazardous	HE and barium	Clean Harbors Deer Trail Colorado Facility or some other authorized off-site TSD facility
Installation of the Burning Ground Spring carbon filter	Soil, 1 yd^3	Nonhazardous	HE and barium	Clean Harbors Deer Trail Colorado Facility or some other authorized off-site TSD facility
Installation of the pilot PRB in Cañon de Valle	Soil, 20 yd^3 (including approximately 15 yd^3 to be reused on site)	Nonhazardous	HE and barium	Clean Harbors Deer Trail Colorado Facility or some other authorized off-site TSD facility
Installation of three alluvial wells in Cañon de Valle	Drill cuttings, 2 yd^3	Nonhazardous	HE and barium	Clean Harbors Deer Trail Colorado Facility or some other authorized off-site TSD facility or LANL TA-54
Decontamination water from installation of Cañon de Valle alluvial wells	Water, 100 gal.	Nonhazardous	HE and barium	LANL treatment facilities
Development water from installation of Cañon de Valle alluvial wells	Water, 200 gal.	Nonhazardous	HE and barium	LANL treatment facilities
PPE from above activities	2 yd^3	Nonhazardous	HE and barium	Off-site permitted landfill
Sampling supplies	<1 yd^3	Nonhazardous	HE and barium	Off-site permitted landfill
Sample kits	<1 ft^3	Hazardous	Metals, VOCs	Authorized off-site TSD facility

*TSD = Treatment, storage, or disposal (facility).

Appendix G

Field Methods

Table G-1
Exploratory Drilling Methods

Method	Applicable LANL SOP	Locations Used	Summary
Hollow-Stem Augering	SOP-04.01	Installation of permeable reactive barrier (PRB) monitoring wells	Hollow-stem augers (sections of seamless pipe with auger flights welded to the pipe) act as a screw conveyor to bring cuttings of sediment, soil, and/or rock to the surface. Auger sections are typically 5 ft in length and have outside diameters of 4.25 to 14 in. Drill rods, split-spoon core barrels, Shelby tubes, and other samplers can pass through the center of the hollow-stem auger sections for collection of discrete samples from desired depths. Hollow-stem augers are used as temporary casings when setting wells to prevent cave-ins of the borehole walls.
Direct Rotary Drilling	SOP-04.01	Installation of grouting boreholes	Air is used to lift the cuttings from the borehole. A large compressor is used to force air down the drill rods, where it passes through ports in the drill bit. As the bit cuts through the formation, cuttings are discharged to the surface and are collected in a dust-suppression system.
Drilling/Excavation Equipment Decontamination	SOP-01.08	Installation of PRB monitoring wells, grouting of boreholes, excavation	Dry decontamination is the preferred method to minimize the generating liquid waste. Dry decontamination may include the use of a wire brush or other tool to remove soil or other material adhering to the sampling equipment, followed by use of a commercial cleaning agent (nonacid, waxless cleaners) and paper wipes. Dry decontamination may be followed by wet decontamination if necessary. Wet decontamination may include washing with a nonphosphate detergent and water, followed by a water rinse and a second rinse with deionized water. Alternatively, steam cleaning may be used.

Table G-2
Well Construction and Development Methods

Method	Applicable LANL SOPs	Locations Used	Summary
Well Construction	SOP-05.01	Installation of PRB monitoring wells. Installation of a monitoring well in a settling-pond borehole	A properly constructed well allows access to formation fluids for collecting samples and for determining in situ characteristics. Single or multiple screens may be used to allow sampling of different water-bearing formations. Key components include filter sand pack, well screen, bentonite seals, and surface completions.
Well Development	SOP-05.02	Development of PRB monitoring wells	These procedures are performed to increase the porosity/permeability of the filter sand pack surrounding the well screen. Development procedures serve to remove foreign materials from the groundwater, well annulus, or well screen after well installation, and to facilitate hydraulic communication between the formation and the well screen. Bailing, scrubbing, purging and pumping are all methods to develop wells

Table G-3
Groundwater Sampling Methods

Method	Applicable LANL SOPs	Locations Used	Summary
Purging and Sampling of Wells	SOP-06.01 SOP-06.32 SOP-06.03	Sampling of PRB monitoring wells	Purging of the well is required to obtain a representative sample of formation groundwater. Generally several well volumes of water are removed from a well. These procedures prescribe monitoring groundwater characteristics such as turbidity and conductivity to ensure proper purging prior to sampling.
Field Analytical Measurements for Groundwater	SOP-06.02	Sampling of PRB monitoring wells	This procedure describes measurement procedures for temperature, specific conductance, alkalinity, pH, dissolved oxygen, and turbidity that closely represent water quality conditions in the aquifers.
Sample Control and Field Documentation	SOP-01.04	Sampling of PRB monitoring wells and sampling of spring water from the carbon filter	The collection, screening, and transport of samples are documented on standard forms generated by the Los Alamos National Laboratory's (the Laboratory's) Sample Management Office (SMO). These forms include sample-collection logs, chain-of-custody forms, sample container labels, and custody seals. Collection logs are completed at the time of sample collection and are signed by the sampler and a reviewer who verifies the logs for completeness and accuracy. Corresponding labels are initialed and applied to each sample container, and custody seals are placed around container lids or openings. Chain-of-custody forms are completed and assigned to verify that the samples are not left unattended.
Field Quality Control Sampling	SOP-01.05	Sampling of PRB monitoring wells, and collection of spring water samples from the carbon filter	Field quality-control samples are collected as directed in the March 1, 2005, Compliance Order on Consent (the Consent Order) as follows: *Field Duplicates*: at a frequency of 10%; collected at the same time as a regular sample and submitted for the same analyses. *Equipment Rinsate Blanks*: at a frequency of 10%; collected by rinsing sampling equipment with deionized water, which is collected in a sample container and submitted for laboratory analyses. *Trip Blanks*: required for all field events that include the collection of samples for volatile organic compound (VOC) analysis. Trip blank containers of certified clean sand are kept with the other sample containers during the sampling process and submitted for laboratory analyses.

Table G-4
Hydrologic Testing Methods

Method	Applicable LANL SOPs	Locations Used	Summary
Water-Level Measurements	SOP-07.02	Gauging of PRB monitoring wells	This procedure describes field methods used to determine groundwater levels in a well. Water-level measurements are generally used to determine groundwater flow direction, hydraulic gradients, impacts due to pumping or other aquifer stresses, as well as hydraulic conductivity and flow velocity.

Table G-5
Soil Sampling Methods

Method	Applicable LANL SOPs	Locations Used	Summary
Spade and Scoop Method for Collection of Soil Samples	SOP-06.09	Geotechnical sampling at PRB test pits, soil sampling at former settling pond and drainage channel locations, and soil sampling under concrete trough	This method is used for collecting shallow (i.e., 0–6 in.) soil or fill samples. The "spade-and-scoop" method involves digging a hole to the desired depth, as prescribed in the work plan, and collecting a discrete grab sample. The sample is typically homogenized and placed in a decontaminated stainless-steel bowl for transfer into appropriate sample containers.
Operational Guidelines for Taking Soil and Water Samples in Explosive Areas	SOP-01.07	Geotechnical sampling at PRB test pits, soil sampling at former settling pond and drainage channel locations, and soil sampling under concrete trough	This procedure describes the standard methods for collecting soil and water samples in potentially HE-contaminated areas such as Technical Area16.
High Explosives Spot Test	SOP-10.06	Soil sampling at former settling pond and drainage channel locations, and soil sampling under excavated outfall trough	This procedure describes the screening-level field analytical test for rapid determination of high explosives (HE) presence or absence with a 100 ppm detection limit.
Sample Control and Field Documentation	SOP-01.04	Soil sampling at former settling pond and drainage channel locations, and soil sampling under concrete trough	The collection, screening, and transport of samples are documented on standard forms generated by the Los Alamos National Laboratory's (the Laboratory's) Sample Management Office (SMO). These forms include sample-collection logs, chain-of-custody forms, sample container labels, and custody seals. Collection logs are completed at the time of sample collection and are signed by the sampler and a reviewer who verifies the logs for completeness and accuracy. Corresponding labels are initialed and applied to each sample container, and custody seals are placed around container lids or openings. Chain-of-custody forms are completed and assigned to verify that the samples are not left unattended.
Field Quality Control Sampling	SOP-01.05	Soil sampling at former settling pond and drainage channel locations, and soil sampling under concrete trough	Field quality control samples are collected as directed in the Consent Order as follows: *Field Duplicates*: at a frequency of 10%; collected at the same time as a regular sample and submitted for the same analyses. *Equipment Rinsate Blanks*: at a frequency of 10%; collected by rinsing sampling equipment with deionized water, which is collected in a sample container and submitted for laboratory analyses. *Trip Blanks*: required for all field events that include the collection of samples for VOC analysis. Trip blank containers of certified clean sand are kept with the other sample containers during the sampling process and submitted for laboratory analyses.

Table G-6
Investigation-Derived Waste Storage and Disposal Methods

Methods	Applicable LANL SOP	Summary
Management, Characterization and Storage of Investigation-Derived Waste	SOP-01.06	IDW will be managed, characterized, and stored in accordance with an approved waste characterization strategy form that documents site history, field activities, and the characterization approach for each waste stream managed. Waste characterization will comply with on-site or off-site waste acceptance criteria, as appropriate. All stored IDW will be marked with appropriate signage and labels. Drums containing IDW will be stored on pallets to prevent deterioration of containers. The means to store, control, and transport each potential waste type and classification will be determined before field operations begin. A waste storage area will be established before waste is generated. Each container of waste generated will be individually labeled with waste classification, item identification number, and radioactivity (if applicable), immediately following containerization. All waste will be segregated by classification and compatibility to prevent cross-contamination. (See Appendix F).