Final

Investigation and Remediation
Work Plan
Parcel 18, Eastern Landfill

Fort Wingate Depot Activity
McKinley County, New Mexico

February 6, 2013
Revision 1

Contract No. W9126G-11-D-0040
Task Order No. 0002

Prepared for:

US Army Corps
of Engineers ®

United States Army Corps of Engineers
Fort Worth District
P.O. Box 17300
Fort Worth, Texas 76102

Prepared by:

AMEC Environment & Infrastructure, Inc.
4600 E. Washington Street, Ste. 600
Phoenix, Arizona 85034
# Investigation and Remediation Work Plan

## Parcel 18, Eastern Landfill
Fort Wingate Depot Activity, McKinley County, New Mexico

## Revision 1

### Title and Subtitle

Final Investigation and Remediation Work Plan

### Dates Covered

December 2012 – January 2013

### Author(s)

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222

### Name of Responsible Person

Mark Patterson

### Telephone Number (Include area code)

330/358-7312

### Abstract

This Investigation and Remediation Work Plan describes activities planned for investigation and remediation activities at Parcel 18, Eastern Landfill, Fort Wingate Depot Activity, McKinley County, New Mexico. This Revision 1 incorporates changes based on comments by the New Mexico Environment Department.
Final

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Phoenix, Arizona 85034
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FEBRUARY 2013

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------------------------------------------
Mr. Steven W. Smith, P.E.
Fort Wingate Program Manager
This Resource Conservation and Recovery Act Investigation and Remediation Work Plan summarizes previous investigations and describes the field activities that will be conducted at the Parcel 18 Eastern Landfill at Fort Wingate Depot Activity (FWDA), New Mexico. This work plan addresses the requirements of the U.S. Army Corps of Engineers (USACE) Statement of Work (SOW) dated August 11, 2011.

This Work Plan was prepared by AMEC Environment & Infrastructure, Inc. in May 2012 and revised January 2013. Mr. Mark Patterson served as the FWDA Defense Base Realignment and Closure (BRAC) Environmental Director and Mr. Steve Smith served as the USACE Project Manager.

Julie Hamilton, PG  
Program Manager

Dan Kwiecinski, PE  
Project Engineer
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BIA-NR = Bureau of Indian Affairs – Navajo Representative  
BIA-Z = Bureau of Indian Affairs – Zuni Representative  
BRACD = U. S. Army Base Realignment and Closure Division.  
FWDA ARM = Fort Wingate Depot Activity Administrative Records Manager.  
FWDA BEC = Fort Wingate Depot Activity Base Realignment and Closure Environmental Coordinator.  
FWDA EIMS = Fort Wingate Depot Activity Environmental Information Management System.  
NN = Navajo Nation  
POZ = Pueblo of Zuni  
USACE SWF = U. S. Army Corps of Engineers – Fort Worth District.  
USAEC = U. S. Army Environmental Command.
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<td>1</td>
<td>µg/L micrograms per liter</td>
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<tr>
<td>2</td>
<td>°C degree centigrade</td>
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<tr>
<td>3</td>
<td>AMEC AMEC Environment &amp; Infrastructure, Inc.</td>
</tr>
<tr>
<td>4</td>
<td>ASTM American Society for Testing Materials</td>
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<tr>
<td>5</td>
<td>bgs below ground surface</td>
</tr>
<tr>
<td>6</td>
<td>BMPs Best Management Practices</td>
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<td>7</td>
<td>BRAC Base Realignment and Closure</td>
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<td>CFR U.S. Code of Federal Regulations</td>
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<td>10</td>
<td>COC chain of custody</td>
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<td>COPC contaminant of potential concern</td>
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<td>DOI Department of the Interior</td>
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<td>13</td>
<td>DRO diesel range organics</td>
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<td>mg/kg micrograms per liter</td>
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<td>picograms per liter</td>
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<td>photo-ionization detector</td>
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<td>Stormwater Pollution Prevention Plan</td>
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<td>White Sands Missile Range</td>
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EXECUTIVE SUMMARY

This Resource Conservation and Recovery Act (RCRA) Investigation and Remediation Work Plan summarizes previous investigations and describes planned investigation and remediation activities to be completed at the Eastern Landfill, also known as Solid Waste Management Unit (SWMU) 13, within Parcel 18 at Fort Wingate Depot Activity (FWDA), New Mexico.

This Investigation and Remediation Work Plan has been prepared for submission to the New Mexico Environment Department – Hazardous Waste Bureau (NMED-HWB), in accordance with the Interim Measure requirements of Section VII.G.5 of RCRA Permit NM 6213820974 for the FWDA, dated December 2005 (Revised June, 2011), in order to perform investigation and remediation activities at the Eastern Landfill.

This Work Plan has been revised to address review comments provided by NMED-HWB in a disapproval letter dated December 10, 2012. NMED comments and FWDA responses are provided in Appendix A.

Existing data have been evaluated to determine appropriate corrective measures required to reduce potential environmental impacts at Parcel 18. A brief summary of the recommended actions for Parcel 18 is provided below.

- Pre-mobilization activities including finalization of site-specific planning documents, utility clearance, filing of stormwater Notice of Intent, and coordination with FWDA, NMED, and the disposal facility;
- Pre-excavation grading to include haul road improvements, laydown area preparation, and protective measures ensuring protection of work area and compliance with Stormwater Pollution Prevention Plan (SWPPP) Best Management Practices (BMPs);
- Waste profile sampling;
- Monitoring, excavation, delineation, and segregation of surface debris and landfill contents;
- Disposal of wastes generated;
- Confirmation sampling;
- Backfill, compaction, and final grading;
- Monitoring well plugging and abandonment;
- Reclamation seeding; and
- Post-implementation reporting.
SECTION 1.0 INTRODUCTION

AMEC Environment & Infrastructure, Inc. (AMEC) was commissioned by the U.S. Army Corps of Engineers (USACE) Fort Worth District, to conduct investigation and remediation activities at the Eastern Landfill, also known as Solid Waste Management Unit (SWMU) 13 within Parcel 18 at Fort Wingate Depot Activity (FWDA), McKinley County, New Mexico. Figure 1-1 presents a Regional Map showing the location of FWDA. Figure 1-2 presents a Parcel Map showing the location of Parcel 18.

This Investigation and Remediation Work Plan has been prepared by AMEC for the USACE Fort Worth District, under Contract No. W9126G-11-D-0040, Task Order No. 0002 in accordance with USACE’s Statement of Work (SOW) dated August 11, 2011, and other guidance provided by the Fort Worth District.

As required by Permit Section VIII.B.1, on February 21, 2012 copies of this document were provided to designated representatives of the Navajo Nation and Pueblo of Zuni for their review and comment. The stakeholders were informed the comment deadline was April 23, 2012. At the same time, copies were provided to designated Bureau of Indian Affairs (BIA) representatives, for their review and comment. No comments were received by the requested date. This paragraph documents the consultation process, as required by Permit Section VIII.B.1.b.

This Work Plan has been revised to address review comments provided by NMED-HWB in a disapproval letter dated December 10, 2012. NMED comments and FWDA responses are provided in Appendix A.

1.1 Purpose and Scope

The purpose of the remediation and investigation activities is to define the limits of fill material and soil impacts, to remove all landfill debris, and to remove soil impacts to below New Mexico Environment Department (NMED) residential soil screening levels (SSLs). This Investigation and Remediation Work Plan has been prepared for submission to the NMED – Hazardous Waste Bureau (HWB), in accordance with the Interim Measure requirements of Section VII.G.5 of RCRA Permit NM 6213820974 for the FWDA Permit, dated December 2005 (Revised June, 2011). Project-specific planning documents which do not require approval by NMED will be completed prior to conducting field work and submitted to the USACE for approval.

The scope of activities includes the following:

- Pre-mobilization activities including finalization of site-specific planning documents, utility clearance, filing of stormwater Notice of Intent, and coordination with FWDA, NMED, and the disposal facility;
- Pre-excavation grading to include haul road improvements, lay down area preparation, and protective measures ensuring protection of work area and compliance with Stormwater Pollution Prevention Plan (SWPPP) Best Management Practices (BMPs);
- Confirmation sampling;
• Monitoring, excavation, delineation, and segregation of surface debris and landfill contents;
• Waste profile sampling;
• Disposal of wastes generated;
• Backfill, compaction, and final grading;
• Monitoring well plugging and abandonment;
• Reclamation seeding; and
• Post-implementation reporting.

1.2 Document Organization

The remainder of this Investigation and Remediation Work Plan is organized into the following sections:

Section 2 – Provides background information related to FWDA and specifically Parcel 18, including a summary of previous investigations.

Section 3 – Presents the investigative and remediation goals.

Section 4 – Provides operational details regarding planned site activities.

Section 5 – Provides general information regarding the methods that will be employed for various sampling activities to be completed during site activities.

Section 6 – Provides references for works cited within this Investigation and Remediation Work Plan.
SECTION 2.0 BACKGROUND INFORMATION

The following sections provide background information related to FWDA and Parcel 18 in particular.

2.1 FWDA Facility Description

FWDA is a closed U.S. Army depot that currently occupies approximately 24 square miles (approximately 15,277 acres) of land in northwestern New Mexico, in McKinley County. The FWDA installation was originally established by the U.S. Army in 1862 at the southern edge of the Navajo territory. In 1918, the mission of the FWDA changed from tribal issues to World War I related activities. Beginning in 1940, the FWDA’s mission was primarily to receive, store, maintain, and ship explosives and military munitions, as well as to disassemble and dispose of unserviceable or obsolete explosives and military munitions.

From 1975 to January 2008, the installation was under the administrative command of the Tooele Army Depot (TEAD), Utah. The active mission of FWDA ceased and the installation closed in January 1993, as a result of the Defense Authorization Amendments and Base Realignment and Closure (BRAC) Act of 1988. In 2002, the Army reassigned many functions at FWDA to the BRAC Division (BRACD), including property disposal, caretaker duties, management of caretaker staff, and performance of environmental restoration and compliance activities. TEAD retained command and control responsibilities, and continued to provide support services to FWDA until January 31, 2008. On January 31, 2008, command and control and support functions were transferred to White Sands Missile Range (WSMR).

Operations ended with the closure of FWDA in January 1993. Since then, FWDA has been undergoing environmental restoration prior to property transfer/reuse. As part of the planned property transfer to the Department of the Interior (DOI), the installation has been divided into reuse parcels (Figure 1-2). Parcels transferred to date consist of Parcels 1, 15, and 17. This Investigation and Remediation Work Plan only includes information related to the SWMU 13 located within Parcel 18.

The Eastern Landfill is located approximately one half-mile northeast of the water tower, as shown on Figure 2-1. The landfill is reported to have been used for the disposal of garbage, trash, and debris from the Administration Area and for the burning of other solid waste from FWDA. In 1968, the landfill was closed and covered with a layer of soil.

2.2 Site Conditions

2.2.1 Climate

Northwestern New Mexico is characterized by a semiarid continental climate. Most precipitation occurs from May through October. Most of the precipitation occurs as rain or hail in summer thunderstorms, and the remainder results from light winter snow accumulations (Metcalf & Eddy, Inc. [M&E], 1992).
The average seasonal temperatures for the area vary with elevation and topographic features. During winter, daily temperatures fluctuate as much as 50 to 70 degrees Fahrenheit (°F) in a 24 hour period. In summer, daily high temperatures are between 85°F and 95°F (M&E, 1992). Average temperatures in winter are about 27°F and in summer 70°F, while extreme temperatures are as low as -30°F in winter and as high as 100°F in summer. There are 100 to 150 frost-free days during the year from the middle of May to the middle of October (M&E, 1992).

Table 2-1 provides a summary of climate data for the area near FWDA, including the average monthly temperature highs and lows, and average monthly precipitation. Excavation operations may be conducted as to avoid the monsoon season, characterized by locally heavy thunderstorms, generally in August as indicated by average monthly precipitation values.

### 2.2.2 Topography

The elevation of the FWDA ranges from approximately 8,200 feet above mean sea level (MSL) in the south to 6,660 feet above MSL in the north (Figure 2-2). Topographically, the FWDA may be divided into three general areas: 1) the rugged north to south trending Hogback along the western and the southwestern boundaries; 2) the northern hilly slopes of the Zuni Mountains in the southern portion; and 3) the alluvial plains marked by bedrock remnants in the northern portion of the installation.

Main drainages, following the topography, generally flow from south to north and discharge to the South Fork of the Puerco River near the northern boundary of the FWDA. However, many tributaries follow the regional trend, flowing from southwest to northeast. During rainfall and snowmelt events, streams transport sediment to low-lying areas in the northern part of the installation, creating an extensive alluvial fan deposit among remnants of bedrock.

A preliminary survey was conducted on November 9 and 10, 2011, to establish a 1-foot contour topographic map of the existing surface (see Section 4.2). The surface contours illustrate that Parcel 18 has hills on the west and north of the parcel with contours leveling to the east. Surface runoff during rainfall/snowmelt events collects in drainages that flow across the parcel only during precipitation events and drains into a larger drainage to the east and the Rio Puerco to the north. Currently no surface water exists at Parcel 18.

### 2.2.3 Vegetation/Habitat

The vegetation cover for Parcel 18 includes moderate grasslands and sagebrush. Parcel 18 provides habitat for antelope, prairie dogs, rattlesnakes, field mice, various other insects and animals, and occasionally mountain lions, elk, and bear.

### 2.2.4 Soils

The soils found on the installation are similar to those occurring in cool plateau and mountain regions of New Mexico. The major soil types at the FWDA are variants/complexes of sands, loams, clays, gravel, and exposed bedrock units. These soils are relatively thin, and the parent bedrock is either at or near the surface in more than a quarter of the installation.
United States Department of Agriculture’s (USDA) Natural Resources Conservation Service (NRCS) soils mapping for Parcel 18 is shown in Figure 2-3. NRCS soil descriptions are included in Appendix B. As presented in Figure 2-3 and Appendix B, the two primary soil types at Parcel 18 are the Rehoboth Silty Clay Loam in the eastern half of the parcel (0.5 to 4 percent slopes) and the Bamac Extremely Gravelly Sand/Loam in the western half (4 to 14 percent slopes).

2.2.5 Geology

FWDA resides at the northwest end of the northwest-southeast trending Zuni uplift. North-trending Cretaceous hogbacks of the Nutria Monocline bound FWDA to the west; the Zuni Mountains lie to the southeast, and the South Fork of the Puerco River runs parallel and adjacent to Interstate 40 approximately one-quarter mile to the north. Alluvium filled washes, flowing north to the South Fork of the Puerco River, dissect outcrops of mudstones of the underlying Petrified Forest Formation of the Triassic Chinle Group.

The western portion of Parcel 18 lies on Triassic mudstones and the eastern portion on alluvium. A geologic map of Parcel 18 is presented in Figure 2-4.

2.2.6 Hydrogeology

Four monitoring wells were installed at Parcel 18 in July 2004 (see Section 2.3.6). Details from the installation report, including boring logs, are presented in Appendix D. The locations of the monitoring wells are illustrated in Figure 2-1. Two of the wells (EMW01 and EMW04) were drilled on the Triassic formations and two (EMW02 and EMW03) were drilled on the alluvium. Two of the wells did not contain water until some time after they were constructed. Wells may receive intermittent recharge or interflow from the adjacent drainage to the east or the Rio Puerco to the north. The wells are assumed to be completed in the Painted Desert Member in silt/claystone with extremely low hydraulic conductivity. Depth to groundwater has ranged from 25 up to 40 feet in wells EMW02 and EMW03 and from 70 to 80 feet in wells EMW01 and EMW04. Groundwater is not anticipated to be encountered during excavation activities.

Data regarding groundwater flow direction is summarized in the Groundwater Periodic Monitoring Reports. According to these reports, groundwater in the alluvial system flows from potentiometric highs in the east, north, and south to a potentiometric low in the Administration Area. From the Administration Area, groundwater flows to the west, until merging with the regional southwest flow. Bedrock groundwater flows west. Elevation readings within the monitoring wells installed within Parcel 18 have been inconsistent and could not be used to gauge groundwater flow direction. However, based on information from the Groundwater Periodic Monitoring Reports, groundwater flow within the alluvium in Parcel 18 is assumed to be to the southwest.

2.3 Previous Investigations

The following sections present summaries of previous investigations and reports regarding the Eastern Landfill.
2.3.1 Environmental Investigation Work Plan

The "Management and Resource Utilization Plan for Developing Environmental Investigation Work Plans and Environmental Investigation Work Plan for Areas Requiring Environmental Evaluation at Fort Wingate Depot Activity" (Metcalf & Eddy, Inc., 1992) indicates that a landfill (Old Landfill, originally designated as SWMU 12) was located north of the water storage tanks just off North Patrol Road. Additional studies listed below have since demonstrated the landfill was incorrectly located in the Environmental Investigation Work Plan (Metcalf & Eddy, Inc., 1992). According to the 1992 plan, the landfill reportedly accepted a variety of facility wastes, and was a suspected open burning area that was utilized until 1968.

2.3.2 Remedial Investigation/Feasibility Study

The Remedial Investigation (RI) conducted at FWDA by ERM Program Management Corporation (ERM) documented in the “Final Remedial Investigation/Feasibility Study Report & RCRA Corrective Action Program” document dated November 15, 1997 (ERM, 1997) references the Old Landfill reportedly located near the water tower area. The report indicates that prior to 1968, the Old Landfill was used for routine burial of garbage, trash, and debris generated at FWDA. Reportedly, solid waste was burned, and pesticide containers and asbestos containing material were disposed of at the Old Landfill. Furthermore, the report notes that in 1968, the Old Landfill was covered by a layer of soil.

The report indicates a geophysical survey (EM31 sweep and ground penetrating radar) was performed to determine whether an abandoned landfill was located adjacent to the water tower. The survey did not detect any anomalous data that would indicate that past landfilling activities may have occurred at the inferred landfill location near the water tower. Furthermore, according to the report, interviews with FWDA personnel in 1992 indicated that the Old Landfill was suspected to be located approximately 1 mile northeast of the water tower, contrary to the previously suspected location adjacent to the water tower. The report notes that aerial photographs from 1962 identified access roads and disturbed ground in this area. A visual inspection of the area also identified scrap metal, concrete rubble, and cinder piles on the ground surface. This area (1 mile northeast of the water tower) was reinterpreted as the site of the Old Landfill. Based on this data, the Old Landfill was reinterpreted to be approximately 1 mile northeast of the water tower and is now identified as SWMU 13, Eastern Landfill.

Additional investigations conducted during the RI at the Eastern Landfill included a geophysical survey, soil gas sampling, and subsurface soil sampling. The geophysical survey identified the approximate extent of the fill area. The soil gas survey demonstrated the presence of relatively low methane concentrations but no detectable hydrogen sulfide. The subsurface soil sampling consisted of three borings drilled in downgradient locations to the west, north, and east of the suspected landfill area. Borings were drilled to a depth of 20 feet with samples collected from depth intervals of 0 to 1 foot below ground surface (bgs), 8 to 10 feet bgs, and 18 to 20 feet bgs. No pesticides, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), or polychlorinated biphenyls (PCBs) were detected in the subsurface soil samples. Mercury, barium, lead, and manganese were detected in at least one sample at concentrations above background levels established during the RI. The highest detected levels are below current
NMED Residential Soil Screening Levels, as listed in Table A-1 of the “Technical Background Document for Development of Soil Screening Levels,” Revision 5.0 (NMED, 2009).

Section 7.5.2 from the RI report concerning the Old Landfill is included in its entirety as Appendix C, and includes maps of the geophysical survey and soil sampling, as well as summary tables regarding soil and soil gas sample results.

### 2.3.3 Surface Debris Removal

In October 1999, Safe Environment, Inc. removed surface debris in the area of the Eastern Landfill. The material removed consisted of metal ammunition lids, wire rope, I-beams, pipe, tires, wire fencing, concrete blocks, expended ammunition casings, scrap wood, and tree branches/trunks. Details of the surface debris removal are documented in the report entitled “Final Report for Debris Removal at Eastern Landfill, Debris Removal at Building 542” (Safe Environment, Inc., 1999). No soil or waste characterization sampling was conducted.

### 2.3.4 Landfill Delineation Release Assessment

In November 2000, Tetra Tech NUS, Inc. (TtNUS) performed a site investigation to locate areas of fill and define the lateral boundaries of the Eastern Landfill. The results are documented in the report entitled “Eastern Landfill Delineation Release Assessment Project” (TtNUS, 2000). The area was investigated using surface geophysical instruments including the EM-31, EM-61, and G-858. As anomalies were detected they were numbered and flagged for physical confirmation. The geophysical results identified 10 anomalies which required further investigation by visual or physical means. The 10 locations were excavated, and the results confirmed the presence of landfill material in four out of the ten anomalies.

The physical identification of the edge of the landfill by excavation was matched with geophysical anomalies, effectively delineating the Eastern Landfill cells along with other collections of burned material and debris. Based on the interpretation by TtNUS, the Eastern Landfill consists of three trenches that are oriented parallel to one another (designated A-8, A-9, and A-10) and three areas of surface debris (designated A-3, A-4, and A-5). These areas are shown in Figure 2-1.

Appendix D contains Section 4.0 of the Release Assessment report, which includes a summary tables and figures.

### 2.3.5 Summary Report for Eastern Landfill

The Summary Report for Eastern Landfill (FWDA, 2001) summarizes key information described above.

The report also indicates that in 2001 ERM compared the location of the Eastern Landfill with the landfill location reported in the 1997 RI. ERM concluded that the RI did not include a survey of the landfill site and its location on the FWDA maps was based upon aerial photographs, site features and topography. The past description as being located 1 mile northeast of the water tower was an approximate description of the landfill location. In order to determine if
investigations were performed at the same location, maps of anomalies identified in the RI were overlain by a map of the anomalies identified by TtNUS. The results corresponded well and ERM concluded that the two investigations were performed in the same area. Since a topographical survey was performed by TtNUS, the Eastern Landfill (formerly known as the Old Landfill) location reported 0.5 miles northeast of the water tower is considered accurate.

2.3.6 Groundwater Investigation

In July 2004, a groundwater investigation was performed by TtNUS (TtNUS, 2005) to determine if contaminants of concern (COCs) were present in the groundwater beneath the Eastern Landfill. The investigation included installation of four monitor wells, collection of groundwater samples from two of the monitor wells, and aquifer testing (slug tests) on two of the monitor wells. The locations of the monitor wells, designated EWM01 through EMW04, are identified in Figure 2-1. Groundwater sampling and aquifer testing were conducted on wells EMW02 and EMW03. Although wells EMW01 and EMW04 were completed as monitoring wells and have been sampled as part of the semi-annual groundwater monitoring, the wells were identified as being dry until after the original sampling and testing was completed.

Appendix E contains relevant excerpts from the groundwater investigation report, including Section 5.0 – Groundwater Investigation Results, and the boring logs from drilling of the four monitoring wells. Chemical analytical results are summarized in Table 5.2-1 of Appendix E, metals results are summarized in Table 5.2-2. Results were compared to U.S. Environmental Protection Agency (EPA) Region 6 Human Health Medium-Specific Screening Levels (HHMSSLs) for Tap Water (Version 6, November 2003). Additional sampling was recommended by TtNUS. The discussion of analytical results in this section is based on the conclusions in the groundwater investigation report (TtNUS, 2005). Although the investigation report compared analytical results to HHMSSLs, it is important to note that the HHMSSLs are not current permitted regulatory levels for FWDA.

Volatile Organic Compounds

Four volatile organics (acetone, toluene, xylene-total, and methyl ethyl ketone) were detected in a single well (EMW03) above the detection limit but below HHMSSLs.

Semi-Volatile Organic Compounds

Two semivolatile organics, including bis(2-ethylhexyl)phthalate and phenol were detected in EMW02 below the HHMSSLs. Six semivolatile organics—bis(2-ethylhexyl)phthalate, acetophenone, butylbenzene, 2-methylnaphthalene, naphthalene, and phenol—were detected in EMW03. Bis(2-ethylhexyl)phthalate was detected in the duplicate sample for EMW03 above the HHMSSL; all other constituents were detected below the HHMSSL.

Pesticides

Five pesticides (dieldrin, endosulfan II, endrin aldehyde, gamma-BHC, and heptachlor epoxide) were detected in the triplicate sample from EMW03. All levels were below HHMSSLs except for
dieldrin and heptachlor epoxide, at 0.0000139 and 0.0000587 milligrams per liter (mg/L), respectively.

**Polychlorinated Biphenyls**

One PCB congener (2-monochlorobiphenyl) was detected in EMW02 at 0.028 mg/L.

**Explosives**

Five explosives (RDX, nitrobenzene, 2,4,6-TNT, nitroglycerin, and DNX) were detected in EMW02. Levels of RDX exceeded HHMSSLs at 2.9 micrograms per liter. Three explosives (2,4,6-TNT, nitroglycerin, and DNX) were detected in EMW03, all below HHMSSLs.

**Metals**

Arsenic, chromium, and vanadium were detected at EMW03 above the HHMSSLs. Arsenic was detected at levels ranging from 0.00355 to 0.00725 mg/L, exceeding the HHMSSL of 0.000045. Chromium was detected in the duplicate sample for EMW03 at 0.117 mg/L, exceeding the HHMSSL of 0.11. Vanadium was detected in EMW03 at concentrations ranging from 0.081 to 0.0936, exceeding the HHMSSL of 0.037. Other metals were detected in both wells at concentrations below HHMSSLs.

### 2.3.7 Groundwater Monitoring

Semi-annual groundwater monitoring has been conducted at all four monitoring wells since April 2008. Groundwater monitoring results have been documented in Periodic Monitoring Reports (USACE, 2008, 2009, 2010a, 2010b, 2011a, and 2011b). Table 2-2 summarizes the detected analytical results from semi-annual monitoring for the last two years at the four Parcel 18 monitoring wells, and compares results to permitted regulatory levels. Bold values in the table indicate that regulatory levels were exceeded. Only total metals results which exceeded regulatory levels are shown; all other detected constituents are included in Table 2-2. Constituents which have exceeded regulatory levels during the past two years include arsenic and thallium in EMW01, manganese in EMW02, and nitrate, arsenic, chromium, manganese, and nickel in EMW04.

Some of the VOCs/SVOCS detected during the 2004 sampling—including acetone, methyl ethyl ketone, and bis(2-ethylhexyl)phthalate—have been detected in recent sampling; however, all detections have been below regulatory levels. Pesticides, PCBs, and explosives detected during the 2004 sampling have not been detected in recent sampling.

Dioxins/furans have been detected in wells EMW01 and EMW03; there are no regulatory levels for these constituents. 2,3,7,8-HPDCE was detected in EMW01 in October 2010 at 1.5 picograms per liter (pg/L) and EMW03 in April 2009 at 0.854 pg/L. Tetrachlorodibenzofuran was detected in well EMW01 at 1.06 pg/L and EMW03 in April 2010 at 7.1 pg/L. OCDF was detected in EMW03 in April 2010 at 1.01 pg/L and in October 2010 at 2.66 pg/L. All dioxin/furan results were J-flagged as estimated values. Analyses for dioxins and furans are no longer conducted as part of the groundwater monitoring program (NMED, 2011)
Although some constituents have been detected slightly above the regulatory levels, there do not appear to be any consistent analyte detections that would be indicative of groundwater impacts at the Eastern Landfill.

Table 2-3 provides a summary of the monitoring well purge records for the last two years. The purge records show extremely low recharge rates in all wells. The December 2008 monitoring report (USACE, 2008) noted poor well construction and slow recharge for all four wells, and recommended abandonment of EMW04 at a minimum. FWDA plans to plug and abandon the four monitoring wells as part of this IR effort. Details regarding planned plugging and abandonment activities are provided in Section 4.9.

2.3.8 Aerial Photography Summary

A historical aerial photograph collection and analysis was completed for FWDA by Environmental Research, Inc. (ERI) in 2006 (ERI, 2006). Aerial photographs from 1948 through 2005 are included in Appendix F. Evidence from the aerial photographs indicate that the landfill was originally constructed between 1948 and 1952. Surface disturbance is less visible after 1966, indicating that the landfill was most likely not used after this time.

2.3.9 Battelle Airborne Geophysics Study

A low-altitude vertical magnetic gradient helicopter geophysical survey was conducted by Battelle in 2009 over approximately 1,500 acres, including the area encompassing the Eastern Landfill (Battelle, 2009). The airborne system used for the magnetic data acquisition was the VG-22, developed and operated by Battelle. The Vertical Gradient Map and Analytic Signal Map from the Eastern Landfill area produced by the survey are included as Appendix G.

2.3.10 Summary of Previous Investigations

The previous investigations described in the sections above have provided positive identification of the location of the lateral extent of landfill trenches. In summary, an evaluation of all available data confirmed that older FWDA facility maps which portrayed the “Old Landfill” as being adjacent to the water tower were in error and the Old Landfill and the Eastern Landfill refer to the same site.
SECTION 3.0  CONTAMINANTS OF POTENTIAL CONCERN AND REMEDIATION

GOALS

The overall goal of the investigation and remediation efforts described in this Work Plan is to remove the contents of the Eastern Landfill and any associated impacted soils so that the site meets residential risk-based standards. The following sections discuss the contaminants of potential concern (COPCs) and constituent-specific remediation goals for site activities.

3.1 Contaminants of Potential Concern

Previous investigations have provided adequate information regarding the general nature and approximate lateral extent of landfill trenches and areas of surface debris. However, chemical characterization of surface and subsurface soils has been minimal and is not sufficient for waste characterization or evaluation of environmental impact. Therefore, a broad range of sample analyses will be conducted to determine proper waste profiling and to verify that the removal effort successfully mitigates potential impact from soil contamination. Samples collected for waste characterization and excavation confirmation will be analyzed using the following methods. All methods are from EPA publication SW-846. A full list of analytes and remediation goals is presented in Section 3.3.

- VOCs –8260B;
- SVOCs –8270C;
- Polynuclear aromatic hydrocarbons (PAHs) –8310;
- PCBs –8082A;
- Explosives –8330B;
- Pesticides –8081A;
- Perchlorates –6850;
- Dioxins/furans –8280A/8290;
- RCRA 8 Metals –6010B/7471A; and
- Asbestos—600/R-93/116

In addition, the following analyses will be performed for waste profile sampling only:

- Total Petroleum Hydrocarbons (TPH), Diesel Range Organics (DRO) –8015B;
- TPH, Gasoline Range Organics (GRO) –8260B; and
- Ignitability and Corrosivity (if deemed applicable) –1020B and 1110A, respectively.
3.2 Remediation Goals

The remediation goals for site COPCs are listed in Table 3-1. These remediation goals will be used to confirm the limits of excavation for the activities conducted as part of this Investigation and Remediation Work Plan. Consistent with the FWDA Permit, the remediation goals are based on a residential land use scenario. Remediation goals have been developed based on the cleanup criteria presented in Attachment 7 of the FWDA Permit, which include the following:

- For all contaminants for which NMED has specified a soil screening level in NMED’s *Technical Background Document for Development of Soil Screening Levels*, the cleanup level shall be the screening level specified in the most recent version of that document.

- If an NMED soil screening level has not been established for a hazardous waste or hazardous constituent the Permittee shall propose for NMED approval, a cleanup level based on the most recent version of the EPA Region 6 HHMSSL (based on a HI of one (1.0) for compounds designated as “n” (noncarcinogen effects), “max” (maximum concentration), and “sat” (soil saturation concentration), or ten times the EPA Region VI HHMSSL for compounds designated “c” (carcinogen effects) (i.e. a target excess cancer risk level of $10^{-5}$).

NMED has combined its remedial action guidance into a single document titled *Risk Assessment Guidance for Site Investigations and Remediation* (NMED, 2012). Accordingly, the remediation goals listed in Table 3-1 are primarily based on NMED’s SSLs for Residential Soil as listed in Table A-1 of the Risk Assessment Guidance dated February 2012 (updated June 2012). The EPA Region VI HHMSSLs were replaced in 2009 with Regional Screening Levels (RSL) for Chemical Contaminants at Superfund Sites, revised in 2011 (EPA, 2011). Therefore, if NMED SSLs were not available, the remediation goal is based on the EPA RSL Residential Soil Table dated June 2011. The remediation goals for PCBs will be based on the individual congeners, as approved in the Final Removal Work Plan, HWMU, Parcel 3, Revision 1, December 19, 2012, and will be evaluated based on NMED SSLs. The remediation goal for asbestos will be 1% asbestos content as determined by Polarized Light Microscopy.
SECTION 4.0 DESCRIPTION OF INVESTIGATION AND REMEDIATION ACTIVITIES

This section provides details regarding the planned field activities to be completed as part of this Investigation and Remediation Work Plan.

4.1 Site Safety and Awareness

All work will be accomplished in accordance with Army and Corporate safety measures. A project-specific Health and Safety Plan (HASP) will be developed prior to conducting site activities. The HASP defines the roles and responsibilities of site personnel, establishes proper levels of personal protective equipment (PPE), and describes emergency response and contingency procedures. The associated Activity Hazard Analyses define hazards associated with each type of work activity and how those hazards will be mitigated.

All work will be completed by a supervisor, operators, and technicians that have successfully completed 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training in accordance with 29 U.S. Code of Federal Regulations (CFR) 1910.120. A dedicated Site Safety Officer (SSO) will be on site during all site activities associated with this Work Plan. The SSO will be responsible for conducting site-specific training, including daily tailgate safety meetings, and conducting periodic safety inspections. All intrusive operations, including excavation and sampling, will be monitored using a Landfill Gas/Lower Explosive Limit (LEL) Monitor equipped with methane, carbon dioxide, hydrogen sulfide, oxygen, and carbon monoxide pods, as well as a photoionization detector (PID). In addition, due to suspected asbestos-containing materials within the landfill, intrusive operations will be monitored in compliance with the National Emissions Standards for Hazardous Air Pollutants (NESHAPS). NESHAPS monitoring requirements will be detailed in the HASP.

4.1.1 Munitions and Explosives of Concern

There is no history of munitions and explosives of concern (MEC) being encountered at the Eastern Landfill. However, due to the operational history of FWDA, there is a potential for MEC to be encountered during excavation operations. Therefore, the Army will implement the procedures provided in USACE Publication EP 75-1-2 (USACE, 2004). This includes having an Unexploded Ordnance (UXO) Technician Level III and Technician Level II on site during any intrusive work. In the unlikely event that MEC items are found, work will stop and on site Army personnel will be notified immediately. Based on the determination by Army Ordnance and Explosive Safety Specialists, all further operations on the landfill may be ceased. The discovery of MEC at the landfill site may significantly delay any activities because Army safety plans will have to be prepared and approved. Landfill debris removal will be continued only when all appropriate MEC safety procedures are in effect.

4.1.2 Cultural Resources

In accordance with Section 106 of the National Historic Preservation Act, the USACE has consulted with the Pueblo of Zuni, the Navajo Nation, and the New Mexico State Historic Preservation Office. Documentation of correspondence is provided in Appendix H. The Pueblo of Zuni has determined that there are no cultural resources within the area that will be impacted.
by operations related to this Investigation and Remediation Work Plan (Tsabetsaye, D., 2011). No other comments were received. No cultural resources monitoring is planned during site operations. However, there are culturally sensitive sites within the immediate vicinity of Parcel 18. Site personnel will be briefed on tribal concerns and potential cultural resources that may be encountered. If culturally sensitive issues arise and/or suspect items are encountered, they will be addressed, on site Army personnel will be notified immediately, and the Army will act in accordance with the Programmatic Agreement.

4.2 Initial Site Survey

A preliminary survey was conducted on November 9 and 10, 2011, to establish a 1-foot contour topographic map of the existing surface. The existing surface topography is illustrated on Figures 4-1 and 4-2.

4.3 Pre-Excavation Trenching and Waste Profile Sampling

An initial mobilization will be conducted to conduct trenching and collect samples for waste profiling purposes. Trench excavation will be conducted to better define the limits of landfill trenches and allow a more accurate volume estimate to be developed. The landfill disposal facility requires profile samples for each 1,000 cubic yards of waste. Although the depth of debris in the landfill trenches is not known, it is anticipated that approximately 15,000 cubic yards of soil and debris will be excavated for landfill disposal. Therefore, a total of 15 waste profile samples are planned to be collected for analysis. Approximate trench locations are illustrated in Figure 4-3. After evaluating the limits of trench waste and developing a revised volume estimate, the number of composite samples collected for analysis may be adjusted. Material excavated for the trench explorations will be placed back into the trenches; no transportation and disposal operations will be conducted during this initial mobilization.

Waste profile samples from areas A-3, A-4, and A-5 will be collected as surface grab samples from 0 to 1 foot depth; approximate locations are illustrated in Figure 4-3. Trench excavation will be conducted within areas A-8, A-9, and A-10. Trench excavations will be extended to the total depth of the waste and into the native soil/rock to determine the depth of debris. Sample material will be collected directly from the backhoe bucket and then handled in accordance with the procedures in Section 5.0. Samples will be submitted for analysis of all COPCs listed in Section 3.2. Sample numbering will follow the protocol described in Section 5.4.

Sample analytical data will be evaluated and provided to the disposal facility and a waste profile will be established prior to mobilizing for excavation, transportation, and disposal operations.

4.4 Excavation, Transportation, and Disposal

Prior to performing excavation of the landfill contents, minor site grading will be performed to improve the access road, provide a turn-around area for haul trucks, and to provide a small laydown area for a site trailer and equipment storage. The excavation areas are located near the bottom of a slope with several small drainage features entering the site. In order to minimize potential run-on a small drainage swale will be constructed along the western edge of the
improved access road. Initial grading construction details are provided in Figures 4-1 and 4-2. All surface disturbance activities will be conducted so as to avoid any potential disturbance of nearby archaeological sites; this may entail field changes to the construction details provided in Figures 4-1 and 4-2.

The goal of the work under this plan is to remove all wastes and source area as well as impacted soils, effectively delineating and remedying the issues associated with the former landfill. This task includes all labor, materials and equipment required to excavate, remove, transport and recycle and/or dispose approximately 15,000 cubic yards of debris and soil of the Eastern Landfill and associated surface debris as well as localized impacted soil if present. The soil currently covering the landfill will also be removed and disposed. Excavation will be conducted utilizing a Cat 325 Excavator or equivalent. Large pieces of metal debris will be segregated and transported for recycle as scrap steel. Remaining landfill material will be loaded directly following excavation into end-dump haul trucks utilizing the excavator or a Cat 950 Loader (or equivalent). No waste will be stockpiled. Landfill material is anticipated to be transported and disposed as solid waste at Waste Management’s San Juan Regional Landfill in Aztec, New Mexico, following waste profile acceptance. If hazardous waste is identified during the initial waste profile sampling, the proposed approach for remediation will be re-evaluated and the Work Plan will be modified accordingly.

All excavations and traffic areas will be watered throughout the duration of the project to minimize dust generation. Additional anticipated equipment on site will include a 4,000-gallon water truck and two service trucks equipped with portable fuel tanks (100 gallons or less) and tools. An office trailer and portable toilet facilities will also be provided and maintained through the duration of the project.

All waste will be transported in properly labeled vehicles permitted by New Mexico Department of Transportation and disposed in accordance with all Federal, State and local regulations. Each manifest will be signed by an approved representative of the Army as the generator. Copies of waste manifests, landfill weigh tickets, and metal recycling documentation will be maintained by the Army to document recycling and disposal activities, and will be included in the final report.

A proposed excavation plan and cross sections are provided as Figure 4-4 and 4-5, respectively. The actual depth of excavation will be based initially on field observations and confirmed by discrete sampling. Excavation in surface debris areas (A-3, A-4, and A-5) is estimated at approximately 2 feet. Excavation in landfill trench areas (A-8, A-9, and A-10) is estimated at a maximum of 12 feet. Excavations will proceed until all debris has been removed, at which point confirmation sampling will be performed as described in Section 4.5. Excavation will continue until the remediation goals established in Section 3.3 have been met.

4.5 Confirmation Sampling

As described in Section 4.4, excavations will continue until visual observations indicate that all landfill debris has been removed. Following the removal of all debris, confirmation sampling will be conducted on the floor and sidewalls of each excavation.
Composite samples will be collected from at least every 100 feet of excavation sidewall. The total length of excavation sidewall will be measured and rounded up to the nearest 100 feet to determine the number of composite samples to be collected. The sample locations will be spaced equally along the sidewall. For example, an excavation with 347 feet of sidewall will have four composite samples collected, one from each 86 foot segment of sidewall. If there are any excavations that are deeper than 20 feet, one composite sample will be collected for every 10 feet of depth every 100 feet of sidewall. Each sample area will consist of one discrete soil sample for VOCs and one composite sample for all other analyses. Each composite sample will be comprised of nine subsamples randomly collected from within each sampling area.

For the floor of the excavation, discrete samples will be collected from approximately every 50 feet along the excavation floor as illustrated in Figure 4-6. Two confirmation samples will be collected at each sample location; one from the floor of the excavation and one at 3 feet below the floor of the excavation. Soil will be collected using the excavator bucket and sample aliquots will be collected directly from the bucket.

Sample numbering will follow the protocol described in Section 5.4. Sidewall and floor confirmation samples will be analyzed for all COPCs as listed in Section 3.1. Analytical data will be compared to the remediation goals established in Section 3.2. If all remediation goals have been met, the excavation will be complete. If remediation goals have not been met, additional excavation will be conducted to remove impacted soils and additional confirmation sampling will be conducted.

Confirmation sample analysis results will be compiled and emailed to NMED in a short letter report. Verbal concurrence from NMED that all remediation goals have been met will be obtained prior to initiating backfill operations.

4.6 Survey of Excavation Extent

Following completion of confirmation sampling and verification of excavation completion, the area of excavation will be surveyed. This survey compared with the survey of the initial site surface will be used to evaluate removal volumes.

4.7 Backfill, Compaction, and Final Grading

Following the completion of excavation operations as verified by confirmation sampling, the excavated areas will be backfilled to grade using imported fill material. The backfill material is anticipated to be obtained from a borrow area located on FWDA property southwest of the administration area, illustrated in Figure 4-7. Samples will be collected from the borrow area at a minimum rate of one sample per 5,000 cubic yards to be analyzed for all COPCs listed in Section 3.2 to ensure that material is free from environmental impacts. In addition, the following analyses will be conducted at a rate as determined by visual observation of changes in soil type:

- Gradation – ASTM C136
Fill material will be excavated at the borrow source using a Cat 325 Excavator or equivalent and loaded into end-dump haul trucks for transportation to Parcel 18. The haul road from the borrow area to the main road is illustrated in Figure 4-7, and will be placed so as to minimize surface disturbance. Water will be added during excavation and loading operations to reduce dust generation and to achieve optimum moisture content requirements. Following the completion of borrow material excavation, the borrow area will be graded to blend with the surrounding topography in order to promote proper drainage, minimize erosion, and prevent ponding of surface water.

In the event that off-site borrow material is obtained instead of, or in addition to, the on-site borrow area illustrated in Figure 4-7, samples will be collected of the off-site borrow material at the same rate as discussed above.

Fill material will be placed in the excavations in 12-inch loose lifts and compacted using a smooth drum vibratory roller. Field testing for density and moisture content will be performed on in-place compacted material using a Troxler (or equivalent) nuclear density gauge. Compaction testing will be conducted at the rate of one test per excavation area per lift, except in trench area A-8, where testing will be conducted at the rate of two tests per lift. Testing locations will be logged following the procedures in Section 5.2.7. All in-place material is required to meet 90% maximum density and ±2% optimum moisture as determined by Standard Proctor.

The final grade above each excavation area will be sloped to promote proper storm water drainage and to prevent ponding if minor settling occurs. Figures 4-8 and 4-9 present the final grading plan and grading cross sections, respectively.

4.8 Final As-Built Survey

A professional surveyor, licensed in the State of New Mexico, will be retained to survey the site upon completion of backfill operations. The survey will be included in the final report described in Section 4.10.

4.9 Monitor Well Plugging and Abandonment

Groundwater monitoring is on-going. However, based on the details presented in Section 2.3.7, the Army is proposing under this Work Plan to plug the four monitoring wells at the Eastern Landfill. This proposal is based on the assumption that all landfill material will be removed under this work plan and the confirmation sample concentrations will be less than the Permit SSLs. A final round of groundwater monitoring will be conducted using the current groundwater monitoring program analyte list (NMED, 2011). Results will be forwarded to NMED for approval of monitoring well abandonment. Upon approval by NMED, the Army will proceed with well abandonment following the procedures presented in this section.

Details regarding borehole abandonment will be submitted to the New Mexico Office of the State Engineer (OSE) in a Well Plugging Plan of Operations. The Well Plugging Plan of Operations will be submitted to the OSE for review and approval prior to conducting any
abandonment activities. All plugging and abandonment activities will be completed by a New Mexico Licensed Well Driller; the well driller’s license number will be included in the submittal to OSE. In general, the following activities will be conducted.

Notification to OSE personnel will be made at least three days in advance, by a person-to-person telephone call, before any plugging and abandonment work is to take place, in order to allow OSE to observe plugging operations if desired.

All surface material, including well pads, bollards, and surface casing will be removed and the well casing will be cut approximately 2 feet below the ground surface. The monitor wells will be abandoned using a tremie pipe to place a high-density bentonite grout from the bottom of each well to within 10 feet of the ground surface. The tremie pipe will be removed as grout is placed in the wells. A Portland cement plug will be placed from 10 feet to 2 feet below ground surface. The Portland cement plug will be allowed to dry for at least 48 hours, after which time surface grading will be conducted to match surrounding topography.

The grout mix used at the site will be detailed in the Well Plugging Plan of Operations submitted and approved by the OSE. The driller will not deviate from the approved grout mix without prior written approval from the OSE. The grout mixture and plugging procedures will be documented by the field engineer in the field log book. The Licensed Well Driller will complete a Plugging Record (OSE Form WD-11) for each monitoring well plugged. The completed plugging records will be submitted to OSE within 30 days of plugging and abandonment. Records will also be included as an appendix to the RFI Report.

4.10 Reclamation Seeding

Following the completion of final grading, all previously disturbed areas within Parcel 18 and at the borrow area will be reseeded using a mix of native plants and grasses. Seeding will be conducted following site preparation and when no further disturbances are planned. Dormant seeding will be implemented for late fall or winter seeding schedules. Broadcast seeding will be applied at a rate above 100 Pure Live Seed per square foot of seeded area. Seed will be applied immediately after site preparation while the soil is loose and moist. Following seed application, soil seed contact will be enhanced by mechanical methods such as chaining.

4.11 Project Schedule

A summary of the expected schedule for conducting the IR activities at Parcel 18 is presented below. Days listed are days following NMED approval of this Work Plan.

- 10 Days – Provide 30-day notice to NMED.
- 40 Days – Initial mobilization to conduct trenching and profile sampling.
- 85 Days – Mobilization to conduct initial site grading, excavation, disposal, confirmation sampling, backfill, and site restoration.
- 150 Days – Completion of field work.
4. 345 Days – Submittal of Final Report to NMED.

4.12 Post-Implementation Reporting

All activities conducted as part of this Investigation and Remediation Work Plan will be documented in a final report. The final report will contain at a minimum a detailed schedule of completed activities, summaries of all analytical data, disposal documentation, and the final as-built survey.
SECTION 5.0 SAMPLING AND ANALYSIS

This section provides general information regarding the methods that will be employed for various sampling activities to be completed during site activities. Sampling will be conducted for waste characterization and excavation confirmation purposes. A summary of analytical methods, sample containers, preservatives, and holding times is provided in Table 5-1. Details regarding waste characterization sampling are provided in Section 4.3; details regarding excavation confirmation sampling are provided in Section 4.5.

The following subsections provide details regarding sample collection and management, quality assurance (QA) and quality control (QC), surveying of sample locations, decontamination of non-disposable sampling equipment, and investigation-derived waste (IDW) management. All soil samples will be collected as discrete samples directly from working surfaces or by using a backhoe bucket to collect soil and retrieving sample aliquots from the soil within the bucket.

5.1 Collection of Soil Samples for VOC Analysis

Samples for VOC analysis will be collected using NMED approved methods including EnCore or equivalent samplers using methanol extraction immediately after sample retrieval and before any other constituent group or field screening to prevent VOC loss due to volatilization. Sample containers will be prepared by the laboratory and shipped to the field location. The sampling containers will be filled with the appropriate amount and type of preservative by the laboratory. Just prior to sampling, a decontaminated stainless steel spoon or disposable trowel will be used to expose a fresh sampling surface. The syringe will be inserted into the freshly exposed surface, a sufficient quantity of soil will be removed from the sample, the aliquot “injected” into the pre-preserved sampling container, and the sampling container tightly sealed. Immediately upon collection, the sample container will be placed into a cooler with ice and cooled to 4 degrees centigrade (ºC).

5.2 Collection of Samples for Other Analyses

Samples for all other analyses will be placed using either a stainless steel spoon/trowel or a disposable scoop directly in laboratory supplied clean containers with a moisture-tight lid. The sample containers will then be placed into a cooler with ice and cooled to 4 ºC. Lids will be sealed by labels or custody seals to prevent tampering.

5.3 Quality Control

In order to attain data of sufficient quality to support project objectives, specific procedures are required to allow evaluation of data quality. These procedures and requirements for their evaluation are described in this section.
5.3.1 Field and Laboratory Quality Control Samples

Evaluation of field sampling procedures and laboratory equipment accuracy and precision requires the collection and evaluation of field and laboratory QC samples. Table 5-2 summarizes the planned QC samples for this project. A description of each QC sample type is provided in the following sections.

5.3.1.1 Quality Control Analyses/Parameters Originated by the Laboratory

Method Blank

Method blanks are used to monitor each preparation or analytical batch for interference and/or contamination from glassware, reagents, and other potential sources within the laboratory. A method blank is a contaminant-free matrix [laboratory reagent water for aqueous samples or Ottawa sand, sodium sulfate, or glass beads (metals) for soil samples] to which all reagents are added in the same amount or proportions as are added to the samples. It is processed through the entire sample preparation and analytical procedures along with the samples in the batch.

There will be at least one method blank per preparation or analytical batch. If a target constituent is found at a concentration that exceeds one half the reporting limit, corrective action must be performed in an attempt to identify and, if possible, eliminate the contamination source. If sufficient sample volume remains in the sample container, samples associated with the blank contamination should be re-prepared and re-analyzed after the contamination source has been eliminated.

Laboratory Control Sample

The Laboratory Control Sample (LCS) will consist of an contaminant-free matrix such as laboratory reagent water for aqueous samples or Ottawa sand, sodium sulfate, or glass beads (metals) for soil samples spiked with known amounts of constituents that come from a source different than that used for calibration standards. Target constituents will be spiked into the LCS. The spike levels will be less than or equal to the midpoint of the calibration range. If LCS results are outside the specified control limits, corrective action must be taken, including sample re-preparation and re-analysis, if appropriate. If more than one LCS is analyzed in a preparation or analytical batch, the results for each LCS must be reported. Any LCS recovery outside QC limits affects the accuracy for the entire batch and requires corrective action.

Matrix Spike/Matrix Spike Duplicate

A sample matrix fortified with known quantities of specific compounds is called a matrix spike (MS). It is subjected to the same preparation and analytical procedures as the native sample. For this project, all target constituents will be spiked into the matrix spike sample. Sample matrix spike recoveries are used to evaluate the effect of the sample matrix on the recovery of the analytes of interest. A matrix spike duplicate (MSD) is a second aliquot of the matrix spike sample, fortified at the same concentration as the MS. The Relative Percent Difference (RPD) between the results of the duplicate matrix spikes measures the precision of sample results.
Project-specific samples will be used by the laboratory for the MS/MSD samples, which will be designated on the chain of custody (COC) form. The spike levels will be less than or equal to the midpoint of the calibration range. MS/MSD pairs will be collected at a frequency of five percent. MS/MSDs are required in every analytical batch regardless of the rate of collection and how samples are received at the laboratory.

5.3.1.2 Quality Control Analyses Originated by the Field Team

Field QC samples will be collected to determine the accuracy and precision of the analytical results. The QC sample frequencies are stated in the following subsections.

**Equipment Blank**

Equipment blanks will be collected to monitor the cleanliness of sampling equipment and the effectiveness of decontamination procedures. Contamination from the sampling equipment can bias the analytical results high or lead to false positive results being reported. Equipment blanks will be prepared by filling sample containers with laboratory-grade contaminant free water that has been passed through a decontaminated or unused disposable sampling device. The required QC limits for equipment blank concentrations are to be less than the method’s reporting limit. Equipment blanks will be collected at a frequency of approximately five percent based on the professional judgment of the field team leader and conditions as presented in the field. Samples associated with equipment blanks that have detected target constituents will be assessed during the data validation process. The usability of the associated analytical data will be documented and affected data will be appropriately qualified. Field corrective action to improve equipment decontamination procedures may also be implemented by the field team leader at the request of the project chemist.

**Field Duplicate**

Field duplicates are collected in the field from a single aliquot of the sample to determine the precision and accuracy of the field team’s sampling procedures. Field duplicates will be collected and analyzed at a frequency of 10 percent.

**Trip Blank**

Trip blanks are used to monitor for contamination during sample shipping and handling, and for cross-contamination through volatile component migration among the collected samples. They are prepared in the laboratory by pouring organic-free water into a volatile organic analysis (VOA) sample container. They are then sealed, transported to the field, and transported back to the laboratory in the same cooler as the volatile component samples. One trip blank sample set (two VOAs) will accompany each volatile component sample cooler.

5.3.2 Data Precision, Accuracy, Representativeness, Comparability and Completeness

Field QA/QC samples and laboratory internal QA/QC samples are collected and analyzed to assess the data’s quality and usability. The following subsections discuss the parameters that are used to assess the data quality.
**Precision**

The precision of laboratory analysis will be assessed by comparing the analytical results between MS/MSD and laboratory duplicate samples. The precision of the field sampling procedures will be assessed by reviewing field duplicate sample results. The RPD will be calculated for the duplicate samples using the equation:

\[
\%\text{RPD} = \left( \frac{S - D}{\left(\frac{S + D}{2}\right)} \right) \times 100
\]

where:
- \(S\) = first sample value (original value)
- \(D\) = second sample value (duplicate value)

The precision criteria for the duplicate samples will be \(\pm 50\) percent in soil samples.

**Accuracy**

Accuracy of laboratory results will be assessed for compliance with the established QC criteria using the analytical results of method blanks, reagent/preparation blanks, LCS and MS/MSD samples and surrogate results, where applicable. Laboratory accuracy will be assessed for compliance with the established QC criteria described in Table B1 and the analytical SOPs. The percent recovery (\(\%R\)) of laboratory control samples will be calculated using the equation

\[
\%R = \left( \frac{A}{B} \right) \times 100
\]

where:
- \(A\) = the analyte concentration determined experimentally from the laboratory control sample
- \(B\) = the known amount of concentration in the sample

**Completeness**

The data completeness of laboratory analyses results will be assessed for compliance with the amount of data required for decision making. Complete data are data that are not rejected. Data with qualifiers such as “J” or “UJ” are deemed acceptable and can be used to make project decisions as qualified. The completeness of the analytical data is calculated using the equation

\[
\%\text{Completeness} = \left( \frac{\text{complete data obtained}}{\text{total data planned}} \right) \times 100
\]

The percent completeness goal for this sampling event is 90 percent.

**Representativeness**

Representativeness is the degree to which sampling data accurately and precisely represent site conditions, and is dependent on sampling and analytical variability and the variability of environmental media at the site. Representativeness is a qualitative “measure” of data quality.

Achieving representative data in the field starts with a properly designed and executed sampling program that carefully considers the project’s overall objectives. Proper location controls and sample handling are critical to obtaining representative samples.
The goal of achieving representative data in the laboratory is measured by assessing accuracy and precision. The laboratory will provide representative data when the analytical systems are in control. Therefore, representativeness is a redundant objective for laboratory systems if sample chain of custody and sample preservation are properly documented, analytical procedures are followed and holding times are met.

Comparability

Comparability is the degree of confidence to which one data set can be compared to another. Comparability is a qualitative “measure” of data quality.

Achieving comparable data in the field starts with a properly designed and executed sampling program that carefully considers the project’s overall objectives. Proper location controls and sample handling are critical to obtaining comparable samples.

The goal of achieving comparable data in the laboratory is measured by assessing accuracy and precision. The laboratory will provide comparable data when analytical systems are in control. Therefore, comparability is a redundant QC objective for laboratory systems if proper analytical procedures are followed and holding times are met.

Sensitivity

Sensitivity is the ability of the method or instrument to detect the contaminant of concern and other target compounds at the level of interest. Appropriate sampling and analytical methods were selected that have QC acceptance limits that support the achievement of established performance criteria. Assessment of analytical sensitivity will require thorough data validation.

5.3.3 Data Verification and Data Review Procedures

Personnel involved in data validation will be independent of any data generation effort. The project chemist will be responsible for the oversight of data verification, review, and validation. Data verification and review will be performed when the data packages are received from the laboratory. Verification will be performed on an analytical-batch basis using the summary results of calibration and laboratory QC, as well as those of the associated field samples. 100% of the data packages will undergo data verification and data review. The following items will be addressed in the data verification and data review:

- A review of the data set narrative to identify any issues that the lab reported in the data deliverable.
- A check of sample integrity (sample collection, preservation, and holding times).
- An evaluation of basic QC measurements used to assess the accuracy, precision and representativeness of data, including QC blanks, LCSs, MS/MSDS, surrogate recovery when applicable, and field or laboratory duplicate results.
• A review of sample results, target compound lists, and detection limits to verify that project analytical requirements are met.

• Initiation of corrective actions, as necessary, based on the data review findings.

• Qualification of the data using appropriate qualifier flags, as necessary, to reflect data usability limitations.

• Qualifier flags, if required, will be applied to the electronic sample results. If multiple flags are required for a result, the most severe flag will be applied to the electronic result. The hierarchy of flags from the most severe to the least severe will be as follows: R, NJ, UJ, U, and J. The qualifier flags are defined in Table 5-3.

• Any significant data quality problems will be brought to the attention of the project chemist.

5.3.4 Data Assessment

Limitations on data usability will be assigned, if appropriate, as a result of the validation process described earlier. The results of the data validation will be discussed in a separate report so that overall data quality can be verified through the precision, accuracy, representativeness, comparability, and completeness of sample results.

5.4 Sample Identification

Each sample identification (ID) will consist of a combination of the Parcel number, SWMU number, additional site identifier, source of sample, increment number, type of sample, and depth of sample collection in accordance with the latest version of the FWDA Environmental Information Management Plan (USACE, 2007). Following are example sample numbers and a description of the sample identifiers to be used during implementation of this work plan.

Example Waste Profile Sample ID:

1813A-8WP01-0405-G-SO

Parcel: 18
SWMU: 13
Additional Site Identifier: A-8 (landfill area, in this case Trench A-8)
Purpose of Sample: WP (Waste Profile)
Increment Number: Samples collected within each excavation area will be assigned sequential 2-digit numbers (in this case 01)
Sample Depth: Depth of samples will be designated with a 4-digit number, the first 2 digits starting depth, second 2 digits bottom depth (in this case 4 to 5 feet)
Sample Type: G (grab)
Sample Matrix: SO (soil)
Example Excavation Confirmation Sample ID:

1813A-9EC01-0001-C-SO

Parcel: 18
SWMU: 13
Additional Site Identifier: A-9 (landfill area, in this case trench A-9)
Purpose of Sample: EC (Excavation Confirmation)
Increment Number: Samples collected within each excavation area will be assigned sequential 2-digit numbers (in this case 01)
Sample Depth: Depth of samples will be designated with a 4-digit number, the first 2 digits starting depth, second 2 digits bottom depth (in this case 0 to 1 foot)
Sample Type: C (composite)
Sample Matrix: SO (soil)

For QA/QC samples, the sample matrix portion of the ID will be changed. Acceptable QA/QC sample matrices are TB for trip blank, EB for equipment blank/rinsate, DUP for duplicate samples, and MSMSD for MS/MSD. The sample ID may also be shortened if it is not associated with a specific soil sample (e.g., trip blanks). Examples are provided below.

Example Duplicate of Excavation Confirmation Sample:

1813A-9EC01-0001-C-DUP

Example Trip Blank Sample ID:

1813-01-TB

5.5 Chain-of-Custody

COC forms will be completed and will accompany each sample at all times. Data on the COC will include the sample ID (as described in Section 5.4), depth interval, date sampled, time sampled, project name, project number, and signatures of those in possession of the sample. COC forms will accompany those samples shipped to the designated laboratory so that sample possession information can be maintained. The field team will retain a separate copy of the COC at the field office. Additionally, the sample ID, date and time collected, collection location, and analysis requested will be documented in the field log book as discussed in Section 5.7.

5.6 Packaging and Shipping Procedures

All samples will be shipped by overnight air freight to the laboratory or hand-delivered. Unless otherwise indicated, samples will be treated as environmental samples, shipped in heavy duty coolers, packed in materials to prevent breakage, and preserved with ice in sealed plastic bags.
Each shipment will include the appropriate field QC samples (i.e., trip blanks, duplicates, and rinsates).

Corresponding COC forms will be placed in waterproof bags and taped to the inside of the cooler lids. Each cooler shipped from the laboratory containing aqueous sample bottles for VOC analyses will contain a trip blank. The trip blank will stay with the cooler until the cooler is returned to the analytical laboratory. All coolers will be taped shut and a custody seal will be placed over the tape to prevent tampering.

**5.7 Sample Documentation**

Sample control and tracking information will be recorded in bound dedicated field logbooks and will include the following information: sample number and location, date, sampler's name, method of sampling, sample depth, soil sample physical description, ambient weather conditions, and miscellaneous observations. At the conclusion of each day in the field, the sampling team leader will review each page of the logbook for errors and omissions. He or she will then date and sign each reviewed page.

**5.8 Field Instrument Calibration**

All field instruments will be calibrated following manufacturer recommended calibration procedures and frequencies. Field instrument calibrations will be recorded in a designated portion of the field logbook at the time of the calibration. Adverse trends in instrument calibration behavior will be corrected.

**5.9 Survey of Sample Locations**

The location of each sample collected, including waste profile and confirmation samples, will be surveyed using appropriate instrumentation and procedures to obtain horizontal accuracy of less than 0.1 feet. A Trimble Total Station Global Positioning System (GPS), Trimble Static GPS, or equivalent, will be utilized to collect the soil sample locations. A North American Datum (NAD) 1983 Northing and Easting in U.S. Survey Feet will be established for all surveyed points and recorded in the field notebook. Survey data will be supplied in the Final Report in NM State Plane and UTM coordinates.

**5.10 Decontamination Procedures**

Decontamination of reusable sampling equipment and personnel will be performed to ensure chemical analyses reflect actual concentrations at sampling locations by maintaining the quality of samples and preventing cross-contamination. The standard equipment decontamination procedures to be used during completion of soil sampling activities are as follows:

- Hand augers and reusable drive samplers are not expected to come into direct contact with soil samples recovered for laboratory analysis. However, the equipment will be decontaminated between boreholes.
A simple decontamination wash pad shall be constructed using plastic sheeting which is rolled up at the ends (typically with lumber) to contain water. The pad shall be large enough to hold multiple 5-gallon buckets and equipment that requires decontamination and to provide ample working area within the pad (roughly 8 feet by 8 feet).

Sampling equipment will be washed using a bristle brush in potable water to which alconox or liquinox laboratory detergent has been added. All items will then be thoroughly rinsed with potable water and allowed to air dry.

Decontamination should be performed on the plastic sheeting of the temporary decontamination pad. Accumulated wash and rinse water will be left within the decontamination pad and allowed to evaporate.

Once all decontamination water is evaporated, the plastic sheeting and associated pad materials shall be disposed of at an approved facility.

After field cleaning, equipment will be handled only by personnel wearing clean gloves to prevent re-contamination. The equipment will be moved away from the cleaning area to prevent re-contamination. If the equipment is not to be immediately reused it will be covered with plastic sheeting or wrapped in aluminum foil to prevent re-contamination. The area where the equipment is stored prior to re-use must be free of contaminants.

5.11 Investigation-Derived Waste Characterization and Disposal

Investigation-derived waste (IDW) anticipated to be generated during sampling activities may include disposable sampling equipment and PPE. Used IDW will be placed in polyethylene trash bags, which will be placed in transport containers along with excavated waste destined for landfill disposal.
SECTION 6.0 REFERENCES


10 Tsabetsaye, D., 2011, Written Communication to Mr. Mark Patterson of BRAC, Fort Wingate Army Depot, Fort Wingate, New Mexico, August 2011.


### Table 2-1. Summary of Weather Data for Fort Wingate, New Mexico

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<td>63.5</td>
<td>30.7</td>
<td>47.1</td>
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## Table 2-2. Summary of Monitor Well Analytical Data

<table>
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<th>Well ID</th>
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<th>April 2009</th>
<th>October 2009</th>
<th>April 2010</th>
<th>October 2010</th>
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<td>Flag</td>
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<tr>
<td></td>
<td>Perchlorate</td>
<td>µg/L</td>
<td>0.52</td>
<td>3.5</td>
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<td>ND</td>
<td>6</td>
<td>Permit³</td>
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<td>EMW01</td>
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<td>µg/L</td>
<td>17</td>
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<td>Benzene</td>
<td>µg/L</td>
<td>0.16</td>
<td>J⁵</td>
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<td>ND</td>
<td>5</td>
<td>MCL⁶</td>
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<tr>
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<td>Chloromethane</td>
<td>µg/L</td>
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<td>J</td>
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<td>Phenol</td>
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<td>ND</td>
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<td>J</td>
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<td>October 2009</td>
<td>April 2010</td>
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<td>Standard Used</td>
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<td>7.10</td>
<td>J</td>
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<td>J</td>
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<td>Chloroform</td>
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<td>J</td>
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<td>ND</td>
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<td></td>
<td>0.1</td>
<td>J</td>
<td>ND</td>
<td>ND</td>
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<td>35</td>
<td>9.13</td>
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<td>ND</td>
<td>ND</td>
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<td>0.416</td>
<td>1.17</td>
<td>0.2</td>
<td>WQCC Yes</td>
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</table>

1 µg/L = micrograms per liter
2 ND = Not Detected
3 Permit = RCRA Permit NM 6213820974, Attachment 7
4 NC = US EPA Regional Screening Levels for non-carcinogens (December 2009)
5 J = value estimated
6 MCL = US EPA Maximum Contaminant Level
7 CA = US EPA Regional Screening Levels for carcinogens (December 2009)
8 WQCC = New Mexico Water Quality Control Commission standard
9 pg/L = picograms per liter
10 N/A = No applicable standard available
11 mg/L = milligrams per liter
12 NS = Not specified (metals results only reported if standard exceeded)
Table 2-3. Summary of Monitor Well Purge Data

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Date</th>
<th>Purge Volume</th>
<th>Units</th>
<th>Notes</th>
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<tbody>
<tr>
<td>EMW01</td>
<td>24-Apr-09</td>
<td>17</td>
<td>G</td>
<td>Pumped dry</td>
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<td>15-Oct-09</td>
<td>NR</td>
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<td></td>
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<td></td>
<td>10-Apr-10</td>
<td>14.18</td>
<td>L</td>
<td>Low flow</td>
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<tr>
<td></td>
<td>12-Oct-10</td>
<td>2.59</td>
<td>L</td>
<td>Pumped dry</td>
</tr>
<tr>
<td>EMW02</td>
<td>24-Oct-08</td>
<td>17</td>
<td>G</td>
<td>Pumped dry</td>
</tr>
<tr>
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<td>15-Oct-09</td>
<td>NR</td>
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<td></td>
</tr>
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<td></td>
<td>5-Oct-10</td>
<td>9.0</td>
<td>L</td>
<td>Pumped dry</td>
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<td>EMW03</td>
<td>24-Oct-08</td>
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<td>17-Apr-10</td>
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<td>9-Oct-10</td>
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<td>EMW04</td>
<td>16-Apr-09</td>
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<td>Grundfos pump, pumped dry</td>
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<td>14-Oct-09</td>
<td>8.0</td>
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<td>Bennett pump, pumped dry</td>
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<td>12-Apr-10</td>
<td>2.5</td>
<td>G</td>
<td>Bennett pump, pumped dry</td>
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<td>9-Oct-10</td>
<td>6</td>
<td>G</td>
<td>Bennett pump</td>
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G = Gallons  
L = Liters  
NR = Not Recorded
### Table 3-1. Summary of Soil Remediation Goals

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<tr>
<th>Chemical</th>
<th>SSL for Residential (mg/kg)&lt;sup&gt;1&lt;/sup&gt;</th>
<th>EPA Residential RSLs (mg/kg)&lt;sup&gt;2&lt;/sup&gt;</th>
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<tr>
<td><strong>Volatile Organic Compounds</strong>&lt;sup&gt;3&lt;/sup&gt;</td>
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<tr>
<td>Acetone</td>
<td>6.66E+04</td>
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</tr>
<tr>
<td>Benzene</td>
<td>1.54E+01</td>
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</tr>
<tr>
<td>Bromodichloromethane</td>
<td>5.41E+00</td>
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</tr>
<tr>
<td>Bromomethane</td>
<td>1.65E+01</td>
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<td>2-Butanone (Methyl ethyl ketone, MEK)</td>
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<td>tert-Butyl methyl ether (MTBE)</td>
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<td>Carbon disulfide</td>
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<tr>
<td>Carbon tetrachloride</td>
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<td>Chlorobenzene</td>
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<tr>
<td>Chloroform</td>
<td>5.86E+00</td>
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<td>Chloromethane</td>
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<td>1,2-Dibromo-3-chloropropane</td>
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<td>1,4-Dichlorobenzene</td>
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## Volatile Organic Compounds (continued)

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<th>EPA Residential RSLs (mg/kg)</th>
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<td>Trichlorofluoromethane</td>
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<tr>
<td>1,2,3-Trichloropropane</td>
<td>4.97E-02</td>
<td>-----</td>
</tr>
<tr>
<td>Vinyl chloride</td>
<td>7.28E-01</td>
<td>-----</td>
</tr>
<tr>
<td>Xylenes</td>
<td>8.14E+02</td>
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</tr>
</tbody>
</table>

## Semi-Volatile Organic Compounds

<table>
<thead>
<tr>
<th>Chemical</th>
<th>SSL for Residential (mg/kg)</th>
<th>EPA Residential RSLs (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benzyl alcohol</td>
<td>NS</td>
<td>6.1E+03</td>
</tr>
<tr>
<td>bis(2-Chloroethoxy)methane</td>
<td>NS</td>
<td>1.8E+02</td>
</tr>
<tr>
<td>bis(2-Chloroethyl)ether</td>
<td>2.68E+00</td>
<td>-----</td>
</tr>
<tr>
<td>bis(2-Chloroisopropyl) ether</td>
<td>9.15E+01</td>
<td>-----</td>
</tr>
<tr>
<td>bis(2-Ethylhexyl)phthalate</td>
<td>3.47E+02</td>
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<tr>
<td>Butyl benzyl phthalate</td>
<td>NS</td>
<td>1.2E+04</td>
</tr>
<tr>
<td>2-Chloronaphthalene (b-Chloronaphthalene)</td>
<td>6.26E+03</td>
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</tr>
<tr>
<td>2-Chlorophenol</td>
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</tr>
<tr>
<td>Dibenzofuran</td>
<td>NS</td>
<td>7.80.E+01</td>
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<tr>
<td>Dibutyl phthalate (Di-n-butyl phthalate)</td>
<td>6.11E+03</td>
<td>-----</td>
</tr>
<tr>
<td>2,4-Dichlorophenol</td>
<td>1.83E+02</td>
<td>-----</td>
</tr>
<tr>
<td>Diethyl phthalate</td>
<td>4.89E+04</td>
<td>-----</td>
</tr>
<tr>
<td>Dimethyl phthalate</td>
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<tr>
<td>2,4-Dimethylphenol</td>
<td>1.22E+03</td>
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</tr>
<tr>
<td>4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol)</td>
<td>4.89E+00</td>
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</tr>
<tr>
<td>2,4-Dinitrophenol</td>
<td>1.22E+02</td>
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<tr>
<td>Chemical</td>
<td>SSL for Residential (mg/kg)</td>
<td>EPA Residential RSLs (mg/kg)</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
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<tr>
<td><strong>Semi-Volatile Organic Compounds (continued)</strong></td>
<td></td>
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<tr>
<td>2,4-Dinitrotoluene</td>
<td>1.57E+01</td>
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<tr>
<td>2,6-Dinitrotoluene</td>
<td>6.11E+01</td>
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<tr>
<td>Hexachlorobenzene</td>
<td>3.04E+00</td>
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<td>Hexachloroethane</td>
<td>4.28E+01</td>
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<tr>
<td>Isophorone</td>
<td>5.12E+03</td>
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<tr>
<td>3- and 4-Methylphenol (o- and m-Cresol)</td>
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<td>2-Methylphenol (p-Cresol)</td>
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<td>3.10E+02</td>
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<tr>
<td>2-Nitroaniline</td>
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<td>4-Nitroaniline</td>
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<td>2.40E+02</td>
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<td>Nitrobenzene</td>
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<td>N-Nitrosodimethylamine</td>
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<td>N-Nitroso-di-N-propylamine</td>
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<td>Phenol</td>
<td>1.83E+04</td>
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<td>2,4,5-Trichlorophenol</td>
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<td>2,4,6-Trichlorophenol</td>
<td>6.11E+01</td>
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<td><strong>Polynuclear Aromatic Hydrocarbons</strong></td>
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</tr>
<tr>
<td>Acenaphthene</td>
<td>3.44E+03</td>
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</tr>
<tr>
<td>Anthracene</td>
<td>1.72E+04</td>
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<tr>
<td>Benzo(a)anthracene</td>
<td>1.48E+00</td>
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<tr>
<td>Benzo(a)pyrene</td>
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<tr>
<td>Benzo(b)fluoranthene</td>
<td>1.48E+00</td>
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<tr>
<td>Benzo(k)fluoranthene</td>
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<td>Chrysene</td>
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<tr>
<td>Dibenz(a,h)anthracene</td>
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<td>Fluoranthene</td>
<td>2.29E+03</td>
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<tr>
<td>Fluorene</td>
<td>2.29E+03</td>
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<td>Indeno(1,2,3-c,d)pyrene</td>
<td>1.48E+00</td>
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<td>Naphthalene</td>
<td>4.30E+01</td>
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<td>EPA Residential RSLs (mg/kg)</td>
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<td><strong>Polynuclear Aromatic Hydrocarbons (continued)</strong></td>
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</tr>
<tr>
<td>Phenanthrene</td>
<td>1.83E+03</td>
<td>------</td>
</tr>
<tr>
<td>Pyrene</td>
<td>1.72E+03</td>
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<td><strong>Polychlorinated Biphenyls</strong></td>
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<tr>
<td>Aroclor 1016</td>
<td>3.93E+00</td>
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</tr>
<tr>
<td>Aroclor 1221</td>
<td>1.49E+00</td>
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<tr>
<td>Aroclor 1232</td>
<td>1.49E+00</td>
<td>------</td>
</tr>
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<td>Aroclor 1242</td>
<td>2.22E+00</td>
<td>------</td>
</tr>
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<td>Aroclor 1248</td>
<td>2.22E+00</td>
<td>------</td>
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<td>Aroclor 1254</td>
<td>1.12E+00</td>
<td>------</td>
</tr>
<tr>
<td>Aroclor 1260</td>
<td>2.22E+00</td>
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<tr>
<td><strong>Explosives</strong></td>
<td></td>
<td></td>
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<tr>
<td>2-Amino-4,6-Dinitrotoluene</td>
<td>NS</td>
<td>1.5E+02</td>
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<tr>
<td>4-Amino-2,6-Dinitrotoluene</td>
<td>NS</td>
<td>1.5E+02</td>
</tr>
<tr>
<td>1,3-Dinitrobenzene</td>
<td>NS</td>
<td>6.1E+00</td>
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<tr>
<td>2,4-Dinitrotoluene</td>
<td>1.57E+01</td>
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<tr>
<td>HMX</td>
<td>3.91E+03</td>
<td>------</td>
</tr>
<tr>
<td>Nitrobenzene</td>
<td>5.35E+01</td>
<td>------</td>
</tr>
<tr>
<td>m-Nitrotoluene</td>
<td>7.82E+00</td>
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<tr>
<td>o-Nitrotoluene</td>
<td>2.91E+01</td>
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<tr>
<td>p-Nitrotoluene</td>
<td>2.44E+02</td>
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<td>RDX</td>
<td>5.82E+01</td>
<td>------</td>
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<tr>
<td>1,3,5-Trinitrobenzene</td>
<td>NS</td>
<td>2.2E+03</td>
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<tr>
<td>Tetryl (Trinitrophenylmethylnitramine)</td>
<td>2.44E+02</td>
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<td>2,4,6-Trinitrotoluene</td>
<td>3.91E+01</td>
<td>------</td>
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<tr>
<td><strong>Chlorinated Pesticides</strong></td>
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<tr>
<td>4,4'-DDD</td>
<td>2.03E+01</td>
<td>------</td>
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<tr>
<td>4,4'-DDE</td>
<td>1.43E+01</td>
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<tr>
<td>4,4'-DDT</td>
<td>1.72E+01</td>
<td>------</td>
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<tr>
<td>Aldrin</td>
<td>2.84E-01</td>
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</tr>
<tr>
<td>Alpha-BHC</td>
<td>7.72E-01</td>
<td>------</td>
</tr>
<tr>
<td>Chemical</td>
<td>SSL for Residential (mg/kg)</td>
<td>EPA Residential RSLs (mg/kg)</td>
</tr>
<tr>
<td>-------------------------------------</td>
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<td><strong>Chlorinated Pesticides (cont’d)</strong></td>
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</tr>
<tr>
<td>Beta-BHC</td>
<td>2.70E+00</td>
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<tr>
<td>Gamma-BHC (Lindane)</td>
<td>5.17E+00</td>
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<tr>
<td>Chlordane</td>
<td>1.62E+01</td>
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<td>Dieldrin</td>
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<tr>
<td>Endosulfan</td>
<td>3.67E+02</td>
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<tr>
<td>Endrin</td>
<td>1.83E+01</td>
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<tr>
<td>Heptachlor</td>
<td>1.08E+00</td>
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</tr>
<tr>
<td>Heptachlor Epoxide</td>
<td>NS</td>
<td>7.9E-01</td>
</tr>
<tr>
<td>Methoxychlor</td>
<td>NS</td>
<td>3.1E+02</td>
</tr>
<tr>
<td>Toxaphene</td>
<td>4.42E+00</td>
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<tr>
<td><strong>Organophosphorus Pesticides</strong></td>
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<tr>
<td>Chlorpyrifos</td>
<td>NS</td>
<td>6.1E+01</td>
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<tr>
<td>Demeton, Total</td>
<td>NS</td>
<td>2.4E+00</td>
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<tr>
<td>Diazinon</td>
<td>NS</td>
<td>4.3E+01</td>
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<tr>
<td>Disulfoton</td>
<td>NS</td>
<td>2.4E+02</td>
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<td>Ethion</td>
<td>NS</td>
<td>3.1E+01</td>
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<td>Malathion</td>
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<td>1.2E+03</td>
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<td>Methyl Parathion</td>
<td>NS</td>
<td>1.5E+01</td>
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<td>Parathion</td>
<td>NS</td>
<td>3.7E+02</td>
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<td><strong>Herbicides</strong></td>
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<td>2,4-D</td>
<td>NS</td>
<td>6.9E+02</td>
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<td>2,4-DB</td>
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<td>4.9E+02</td>
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<td>2,4,5-T</td>
<td>NS</td>
<td>6.1E+02</td>
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<td>2,4,5-TP (Silvex)</td>
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<td>Dicamba</td>
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<td>1.8E+03</td>
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<tr>
<td>Dichloroprop</td>
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<td>Dinoseb</td>
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<td>6.1E+01</td>
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<td><strong>Metals</strong></td>
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<tr>
<td>Arsenic</td>
<td>3.90E+00</td>
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</tr>
<tr>
<td>Barium</td>
<td>1.56E+04</td>
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</tr>
<tr>
<td>Cadmium</td>
<td>7.03E+01</td>
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### Chemicals

<table>
<thead>
<tr>
<th>Chemical</th>
<th>SSL for Residential (mg/kg)&lt;sup&gt;1&lt;/sup&gt;</th>
<th>EPA Residential RSLs (mg/kg)&lt;sup&gt;2&lt;/sup&gt;</th>
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</thead>
<tbody>
<tr>
<td>Chromium III</td>
<td>1.17E+05</td>
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<tr>
<td>Chromium VI</td>
<td>2.97E+00</td>
<td>-----</td>
</tr>
<tr>
<td>Lead</td>
<td>4.00E+02</td>
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</tr>
<tr>
<td>Mercury (elemental)</td>
<td>1.56E+01</td>
<td>-----</td>
</tr>
<tr>
<td>Selenium</td>
<td>3.91E+02</td>
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</tr>
<tr>
<td>Silver</td>
<td>3.91E+02</td>
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</tbody>
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### Notes:

1. Soil Screening Levels from NMED 2012: Risk Assessment Guidance for Site Investigations and Remediation, February 2012 (Updated June 2012)
2. EPA RSL http://www.epa.gov/superfund/health/conmedia/soil/index.htm
3. VOC EPA Method 8260B (except 1,2-Dibromoethane (EDB) using EPA Method 504.1)
4. SVOC EPA Method 8270C
5. PAHs EPA Method 8310
6. PCBs EPA Method 8082A
7. Explosives EPA Method 8330B
8. Chlorinated Pesticides EPA Method 8081
9. Organophosphorus Pesticides EPA Method 8141
10. Herbicides EPA Method 8151
11. Metals EPA Method 6010C/7471B
12. EPA = US Environmental Protection Agency
13. mg/kg = milligrams per kilogram
14. NS = Not Specified
15. NMED = New Mexico Environment Department
<table>
<thead>
<tr>
<th>Target Analytes</th>
<th>Matrix</th>
<th>Analytical Method (EPA SW846)</th>
<th>Sample Volume/Container</th>
<th>Preservative</th>
<th>Holding Time</th>
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<tbody>
<tr>
<td>Volatile Organic Compounds</td>
<td>Soil</td>
<td>8260B with methanol extraction</td>
<td>40-ml VOA Vial</td>
<td>Cool to 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Semi-Volatile Organic Compounds</td>
<td>Soil</td>
<td>8270C</td>
<td>4-oz Glass Jar</td>
<td>Cool to 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Polynuclear Aromatic Hydrocarbons</td>
<td>Soil</td>
<td>8310</td>
<td>4-oz Glass Jar</td>
<td>Cool to 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Polychlorinated biphenyls</td>
<td>Soil</td>
<td>8082</td>
<td>8-oz Glass Jar</td>
<td>Cool to 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Explosives</td>
<td>Soil</td>
<td>8330B</td>
<td>8-oz Glass Jar</td>
<td>Cool to 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Chlorinated Pesticides</td>
<td>Soil</td>
<td>8081</td>
<td>8-oz Glass Jar</td>
<td>Cool to 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Organophosphorus Pesticides</td>
<td>Soil</td>
<td>8141</td>
<td>8-oz Glass Jar</td>
<td>Cool to 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Herbicides</td>
<td>Soil</td>
<td>8151</td>
<td>8-oz Glass Jar</td>
<td>Cool to 4°C</td>
<td>14 days</td>
</tr>
<tr>
<td>Perchlorates</td>
<td>Soil</td>
<td>6850</td>
<td>8-oz Glass Jar</td>
<td>Cool to 4°C</td>
<td>28 days</td>
</tr>
<tr>
<td>Dioxins/Furans</td>
<td>Soil</td>
<td>8280A/8290</td>
<td>8-oz Amber Glass Jar</td>
<td>Cool to 4°C</td>
<td>30 days</td>
</tr>
<tr>
<td>RCRA 8 Metals</td>
<td>Soil</td>
<td>6010C/7471B</td>
<td>4-oz Glass Jar</td>
<td>Cool to 4°C</td>
<td>6 months (28 days for Hg)</td>
</tr>
<tr>
<td>Total Petroleum Hydrocarbons –</td>
<td>Soil</td>
<td>8015 modified, with methanol extraction</td>
<td>40-ml VOA Vial</td>
<td>Cool to 4°C</td>
<td>14 days</td>
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<td>Gasoline Range Organics</td>
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<tr>
<td>Total Petroleum Hydrocarbons –</td>
<td>Soil</td>
<td>8015 modified, with methanol extraction</td>
<td>40-ml VOA Vial</td>
<td>Cool to 4°C</td>
<td>14 days</td>
</tr>
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<td>Diesel Range Organics</td>
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Notes:
3 EPA = U.S. Environmental Protection Agency
4 Hg = mercury
5 ml = milliliter
6 oz = ounce
7 RCRA = Resource Conservation and Recovery Act
Table 5-2. Quality Control Samples for Precision and Accuracy

<table>
<thead>
<tr>
<th>Quality Control Type</th>
<th>Precision</th>
<th>Accuracy</th>
<th>Minimum Frequency</th>
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<tbody>
<tr>
<td>Field</td>
<td>Field Relative Percent Difference (RPD) Goal of ≤ 20%</td>
<td>Duplicate Sample Laboratory Analysis</td>
<td>One every 10 samples (10%)</td>
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<tr>
<td></td>
<td></td>
<td>Equipment Blank</td>
<td>One per day for reusable equipment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Trip Blank</td>
<td>One per each cooler containing VOC samples</td>
</tr>
<tr>
<td>Laboratory</td>
<td>Laboratory Matrix Spike Duplicate (RPD goal of ≤ 20%)</td>
<td>Method Blank</td>
<td>One per batch, at least one every 20 samples (rounded up) (5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Laboratory Control Sample or Blank Spike</td>
<td>One per batch, at least one every 20 samples (rounded up) (5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Matrix Spike Percent Recovery</td>
<td>One every 20 samples (rounded up) (5%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(Percent Recovery Goal of 80% to 120%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Surrogate Sample (for organics only)</td>
<td>One every 20 samples (rounded up) (5%)</td>
</tr>
</tbody>
</table>

Notes:
- VOC = volatile organic compound
### Table 5-3. Data Validation Flags

<table>
<thead>
<tr>
<th>Flag</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>R</td>
<td>The sample results are rejected because of serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the constituent cannot be verified.</td>
</tr>
<tr>
<td>NJ</td>
<td>The analysis indicates the presence of a constituent that has been tentatively identified and the associated numerical value represents its approximate concentration.</td>
</tr>
<tr>
<td>UJ</td>
<td>The constituent was not detected above the reported sample quantification limit. However, the reported quantification limit is approximate and may or may not represent the actual limit of quantification necessary to accurately and precisely measure the constituent in the sample.</td>
</tr>
<tr>
<td>U</td>
<td>The constituent was analyzed for but was not detected above the reported sample quantification limit.</td>
</tr>
<tr>
<td>J</td>
<td>The constituent was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.</td>
</tr>
</tbody>
</table>

Note: Flags are listed in order of severity, from most severe (R) to least severe (J).
FIGURES

1
2
1. The limits and depths of cover fill shown are estimated. Surface disturbances will be minimized to the extent possible and limited to preventing runoff to excavation areas.

2. Swale location is approximate and will be located to avoid any potential disturbance of nearby archaeological sites.

**Legend**
- **Existing Surface**
- **Proposed Surface**
- **Fill Area**

**Diversion Channel Cross Section**
- Scale 1" = 20'
1. BACKFILL MATERIAL TO BE OBTAINED FROM ON-SITE BORROW AREA, SEE FIGURE 4-7.

2. EXCAVATION AREAS AND DEPTHS ARE ESTIMATED BASED ON AVAILABLE INFORMATION. ACTUAL EXCAVATION EXTENT WILL BE BASED ON VISUAL OBSERVATION AND CONFIRMATION SAMPLING RESULTS.

3. BACKFILL MATERIAL SHALL BE PLACED IN MAXIMUM 12-INCH THICK LOOSELY PACKED LIFTS. EACH LIFT WILL BE COMPACTED AND COMPRESSED TO OPTIMUM MOISTURE (12%) AND EQUAL TO OR GREATER THAN 95% OF THE MAXIMUM DRY DENSITY AS DETERMINED BY THE MODIFIED PROCTOR TEST (ASTM D1557), UNLESS OTHERWISE SPECIFIED.

4. BACKFILL MATERIAL SHALL BE FREE OF DEBRIS, FROZEN MATERIALS, ANGLAR ROCKS, ROOTS, AND ORGANICS.

5. VEGETATIVE LAYER SHALL BE PLACED OVER THE ENTIRE COVER, THE TOPSOIL LAYER SHALL BE PLACED IN A SINGLE LIFT OF 8 TO 12 INCHES THICK AND UNIFORMLY COMPACTED TO A MINIMUM THICKNESS OF 6 INCHES. THE TOPSOIL WILL BE SEED TO GENERATE A STAND OF NATIVE GRASS.

[Diagram of parcel showing boundaries and sections]

NOTE:

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC Environment & Infrastructure

FOUR WINGATE DEPOT ACTIVITY
PARCEL 18, EASTERN LANDFILL

BACKFILL AND FINAL GRADING PLAN

4-8
1. Final surfaces will be graded to prevent ponding and promote proper stormwater drainage.

2. Excavation area and depth are estimated based on available information. Actual excavation extent will be based on visual observations and confirmative sampling results.

3. Backfill material shall be placed in maximum 18-inch thick loosely packed lifts, each lift will be conditioned and compacted to optimum moisture (12%) and equal to or greater than 90% of the maximum dry density as determined by the Modified Proctor test (ASTM D1557), unless otherwise specified.

4. Backfill material shall be free of debris, frozen materials, angular rocks, roots, and organics.

5. Vegetative layer shall be placed over the entire cover. The topsoil layer shall be placed in a single lift of 6-10 inches thick and uniformly compacted to a minimum thickness of 6 inches. The topsoil will be seeded to generate a stand of native grass.

Legend:
- EXISTING SURFACE (POST-EXCAVATION)
- PROPOSED SURFACE
- FILL AREA
- SURFACE DEBRIS/TRENCH AREA DESIGNATION

A-3
APPENDIX A

RESPONSE TO NMED NOTICE OF DISAPPROVAL COMMENTS,
DATED DEC. 10, 2012, INVESTIGATION & REMEDIATION WORK PLAN
PARCEL 18, SUBMITTED MAY 10, 2012
<table>
<thead>
<tr>
<th>Comment Number</th>
<th>Comment</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>New Mexico Environment Department</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NMED Comment 1</td>
<td>The Permittee must separate all tables and figures from the text and include the tables and figures as separate sections or appendices to the Work Plan. In the revised Work Plan and future work plans and reports, include the tables and figures and separate sections.</td>
<td>The revised Work Plan includes tables and figures in separate sections following the main text.</td>
</tr>
<tr>
<td>NMED Comment 2</td>
<td>In Section 2.3.6 (Groundwater Investigation), page 2-6, lines 6-11, the Permittee states, &quot;[o]ne SVOC [bis(2-ethylhexyl)phthalate], two pesticides (dieldrin and heptachlor epoxide), one explosive [Royal Demolition Explosive (RDX)], and three metals (arsenic, chromium, and vanadium) were reportedly detected in at least one sample from at least one well above the U.S. Environmental Protection Agency (EPA) Region 6 Human Health Medium-Specific Screening Levels (HHMSSLs) for Tap Water (Version 6, November 2003).&quot; Revise the Work Plan to describe which groundwater wells and samples contained the constituents listed. Although below standards, groundwater samples also contained VOCs, SVOCs, pesticides, explosives, PCBs and metals; revise the Work Plan to discuss the presence of these constituents. In general, discuss groundwater conditions and quality in more detail.</td>
<td>Additional details regarding groundwater conditions and quality have been added to Section 2.3.6.</td>
</tr>
<tr>
<td>NMED Comment 3</td>
<td>In Section 2.3.7 (Groundwater Monitoring), page 2-6, lines 18-24, the Permittee states, &quot;Table 2-2 summarizes the detected analytical results from semi-annual monitoring for the last two years at the four Parcel 18 monitoring wells, and compares results to permitted regulatory levels. Bold values in the table indicate that regulatory levels were exceeded. Only total metals results which exceeded regulatory levels are shown. Although some constituents have been detected slightly above regulatory levels, there do not appear to be any consistent analyte detections that would be indicative of groundwater impacts at the Eastern Landfill.&quot; Discuss the groundwater monitoring results in more detail. Include all constituent exceedences in addition to metals. Discuss the presence or absence of constituents found in the first</td>
<td>Site geology and hydrogeology are discussed in Section 2.2.5 and 2.2.6. Additional details regarding groundwater monitoring results have been added to Section 2.3.7.</td>
</tr>
<tr>
<td>Comment Number</td>
<td>Comment</td>
<td>Response</td>
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<td></td>
<td>round of sampling (e.g. SVOC, pesticides, RDX, and three metals mentioned in Comment 2). Also discuss constituents that have been found in the groundwater, but that are not above regulatory limits, such as: dioxins/furans, mercury, and perchlorate. In addition, revise the Work Plan to expand the discussion of site hydrology to include, but not be limited to groundwater flow direction at the site.</td>
<td></td>
</tr>
<tr>
<td>NMED Comment 4</td>
<td>Section 3.1 (Contaminants of Potential Concern), page 3-1, lines 7-10, states, &quot;[p]revious investigations have provided adequate information regarding the general nature and approximate lateral extent of landfill trenches and areas of surface debris. However, chemical characterization of surface and subsurface soils has been minimal and is not sufficient for waste characterization or evaluation of environmental impact.&quot; The section lists analytes and methods to be sampled for during the investigation and cleanup. Revise the Work Plan to propose soil sampling for dioxins/furans, since there is evidence of burning at the site, and perchlorate since it has been detected in groundwater (though below regulatory standards).</td>
<td>Dioxins/furans and perchlorates have been added to the analyte list.</td>
</tr>
<tr>
<td>NMED Comment 5</td>
<td>In Section 3.2 (Remediation Goals), page 3-2, the Permittee discusses the remediation goals based on NMED's Technical Background Document for Development of Soil Screening Levels and NMED's Position Paper Risk-Based Remediation of Polychlorinated Biphenyls at RCRA Corrective Action Sites (March 2000 as updated). Both of those documents have been combined into one document titled Risk Assessment Guidance for Site Investigations and Remediation which is available online at <a href="http://www.nmenv.state.nm.us/HWB/documents/NMED_RA_Guidance_for_SI_and_Remediation_6-14-2012.pdf">http://www.nmenv.state.nm.us/HWB/documents/NMED_RA_Guidance_for_SI_and_Remediation_6-14-2012.pdf</a>. Ensure that the remediation goals and Table 3-1 (Summary of Soil Remediation Goals) is up to date. Revise the Work Plan accordingly.</td>
<td>The Work Plan has been revised to reflect the most current NMED corrective action guidelines.</td>
</tr>
<tr>
<td>Comment Number</td>
<td>Comment</td>
<td>Response</td>
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<tr>
<td>NMED Comment 6</td>
<td>In Section 4.3 (Pre-Excavation Grading and Waste Profile Sampling), page 4-10, lines 31-34, the Permittee states, &quot;[a]dditional trench excavation may be conducted at this time to determine the depth of debris in each of the identified landfill trenches.&quot; Since the depth of the debris in the trenches is unknown, the Permittee must sample to at least native soil or rock. Revise the Work Plan to sample waste through the trenches and into the underlying native soil or rock. Also, revise the Work Plan to include discussion of the materials and methods to be used in the sample collection (e.g., trenching or boreholes, split barrel sampler, direct push, directly from backhoe bucket).</td>
<td>The trench excavations and sample collection intervals will be extended to the total depth of the waste and into the native soil/rock. The samples will be collected directly from the backhoe bucket and then handled in accordance with the procedures in Section 5.0. At least one composite sample of the waste material at each trench location will be submitted for analysis. Additional detail has been added to Section 4.3 to clarify waste profile sampling.</td>
</tr>
<tr>
<td>NMED Comment 7</td>
<td>In Section 4.4 (Excavation, Transportation, and Disposal) the Permittee discusses excavation of the landfill pits. It is not clear whether or not the Permittee will sample the material from the excavations to characterize for hazardous waste (other than the initial sampling discussed in Section 4.3) and whether or not samples collected from the waste stockpiles. Describe the sampling during excavation. Additionally, it is not clear where the waste will be sorted or where the stockpiles will be located. Describe how the waste will be segregated and where it will be stockpiled. Revise the Work Plan to describe sampling during the excavation and provide a more detailed description of the excavation plan.</td>
<td>The purpose of the initial sampling discussed in Section 4.3 is to create a waste profile so that once excavation is initiated, excavated waste can be placed directly into haul trucks for disposal. If this process is acceptable then there is no need to sample or stockpile waste after excavation. Additional detail has been added to Section 4.4 to clarify the excavation and disposal plan.</td>
</tr>
<tr>
<td>NMED Comment 8</td>
<td>In Section 4.4 (Excavation, Transportation, and Disposal), page 4-11, lines 3-4, the Permittee states, &quot;[o]verburden will be scraped from the surface of the landfill trenches and stockpiled for re-use during backfill operations.&quot; Because there was surface debris located around the trenches, there is potential for the overburden to be impacted. Revise the Work Plan to propose to collect samples from all material intended for use as backfill to determine whether or not the soils were impacted.</td>
<td>Due to the potential for impact to overburden, all overburden material will be included in the waste profile sampling described in Section 4.3 and will be excavated and disposed along with landfill trench waste. The Work Plan has been revised to remove any reference to stockpiling and/or reusing overburden.</td>
</tr>
<tr>
<td>Comment Number</td>
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</tr>
<tr>
<td>NMED Comment 9</td>
<td>In Section (Excavation, Transportation, and Disposal), page 4-11, lines 8-10, the Permittee states, &quot;[l]andfill material is anticipated to be transported and disposed as non-regulated solid waste at Waste Management's San Juan Regional Landfill in Aztec, New Mexico, following waste profile acceptance.&quot; Discuss the protocol for handling waste if any of it is found to be hazardous waste. Revise the Work Plan to discuss the potential need for the disposition of hazardous waste.</td>
<td>Based on current site knowledge and excavation of the similar Western Landfill at FWDA, no hazardous waste is anticipated. If hazardous waste is identified during the initial waste profile sampling, the proposed approach for remediation will be re-evaluated and the Work Plan will be modified accordingly.</td>
</tr>
<tr>
<td>NMED Comment 10</td>
<td>In Section 4.5 (Confirmation Sampling), page 4-11, lines 29-31, the Permittee states, &quot;[a]s described in Section 4.4, excavations will continue until visual observations indicate that all landfill debris has been removed. Following the removal of all debris, confirmation sampling will be conducted on the floor of the excavation.&quot; The Permittee must also propose to sample the excavation sidewalls. The Permittee must show that both the lateral and vertical extent of contamination has been removed by excavation. Revise the Work Plan to propose confirmation samples along the excavation sidewalls.</td>
<td>Based on discussions with NMED regarding confirmation sampling at other sites, this section has been revised. Composite samples will be collected from every 100 feet of excavation sidewall. If there are any excavations deeper than 20 feet, one composite sample will be collected for every 10 feet of depth every 100 feet of sidewall. Section 4.5 has been revised to denote the sampling area and logic as well as further describe how the samples will be collected.</td>
</tr>
<tr>
<td>NMED Comment 11</td>
<td>In Section 4.5 (Confirmation Sampling), page 4-11, lines 37-38, the Permittee states, &quot;[c]onfirmation samples will be analyzed for all COPCs as listed in Section 3.2. Analytical data will be compared to the remediation goals established in Section 3.3.&quot; Revise the Work Plan to reference the correct sections: Sections 3.1 and 3.2. Throughout the Work Plan, ensure that the correct sections are referenced.</td>
<td>Section references have been corrected.</td>
</tr>
<tr>
<td>Comment Number</td>
<td>Comment</td>
<td>Response</td>
</tr>
<tr>
<td>----------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>NMED Comment 12</td>
<td>In Section 4.9 (Monitoring Well Plugging and Abandonment), page 4-13, the Permittee states, &quot;[g]roundwater monitoring is ongoing. However, based on details presented in Section 2.3.7, the Army is proposing under this Work Plan to plug the four monitoring wells at the Eastern, Landfill. This proposal is based on the assumption that all landfill material will be removed under this work plan and the confirmation samples will be less than the Permit SSLs.&quot; The Permittee must not abandon the wells until after the excavation is completed in order to collect a final round of groundwater sampling to demonstrate that the groundwater cleanup standards have not been exceeded. If a groundwater monitoring well is damaged during excavation (e.g., EMW04 is close to proposed excavation area A-8), the Permittee may abandon the well as proposed. The results of the final round of sampling must be submitted with the Investigation Report.</td>
<td>A final round of groundwater monitoring will be conducted as recommended. Section 4.9 has been revised to reflect this change.</td>
</tr>
</tbody>
</table>
December 10, 2012

Mark Patterson
BRAC Coordinator
Ravenna Army Ammunition Plan
Building 1037
8451 State Route 5

Steve Smith
USACE
CESWF-PER-DD
819 Taylor Street, Room 3B06
PO Box 17300

Dear Messrs. Patterson and Smith:

The New Mexico Environment Department (NMED) received the Department of the Army’s (the Permittee) Investigation and Remediation Work Plan Parcel 18, Eastern Landfill, dated May 10, 2012 and submitted pursuant to Section VII.H of the Fort Wingate Hazardous Waste Facility Permit. NMED has reviewed the Work Plan and hereby issues this Disapproval. The Permittee must address the following comments in a revised Work Plan.

Comment 1
The Permittee must separate all tables and figures from the text and include the tables and figures as separate sections or appendices to the Work Plan. In the revised Work Plan and future work plans and reports, include the tables and figures and separate sections.

Comment 2
In Section 2.3.6 (Groundwater Investigation), page 2-6, lines 6-11, the Permittee states, “[o]ne SVOC [bis(2-ethylhexyl)phthalate], two pesticides (dieldrin and heptachlor epoxide), one
explosive [Royal Demolition Explosive (RDX)], and three metals (arsenic, chromium, and vanadium) were reportedly detected in at least one sample from at least one well above the U.S. Environmental Protection Agency (EPA) Region 6 Human Health Medium-Specific Screening Levels (HHMSSLs) for Tap Water (Version 6, November 2003).” Revise the Work Plan to describe which groundwater wells and samples contained the constituents listed. Although below standards, groundwater samples also contained VOCs, SVOCs, pesticides, explosives, PCBs and metals; revise the Work Plan to discuss the presence of these constituents. In general, discuss groundwater conditions and quality in more detail.

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Comment 12
In Section 4.9 (Monitoring Well Plugging and Abandonment), page 4-13, the Permittee states, “[g]roundwater monitoring is on-going. However, based on details presented in Section 2.3.7, the Army is proposing under this Work Plan to plug the four monitoring wells at the Eastern Landfill. This proposal is based on the assumption that all landfill material will be removed under this work plan and the confirmation samples will be less than the Permit SSLs.” The Permittee must not abandon the wells until after the excavation is completed in order to collect a final round of groundwater sampling to demonstrate that the groundwater cleanup standards have not been exceeded. If a groundwater monitoring well is damaged during excavation (e.g., EMW04 is close to proposed excavation area A-8), the Permittee may abandon the well as proposed. The results of the final round of sampling must be submitted with the Investigation Report.
The Permittee must address all comments contained in this letter and submit a revised Work Plan. The Permittee must include a cover page with the revised document; the cover page must indicate that the submittal is a revision prepared for NMED. The revised document must be accompanied with a response letter that details where all revisions have been made, cross-referencing NMED’s numbered comments. The Permittee must also submit an electronic copy of the revised document with all edits and modifications shown in redline-strikeout format. The revised Work Plan must be submitted to NMED no later than February 20, 2013.

If you have any questions regarding this letter, please contact Kristen Van Horn at (505)-476-6046.

Sincerely,

John E. Kieling
Chief
Hazardous Waste Bureau

cc: D. Cobrain, NMED HWB
    S. Duran, NMED HWB
    Christy Esler, USACE
    Laurie King, U.S EPA Region 6
    Chuck Hendrickson, U.S. EPA Region 6
    Tony Perry, Navajo Nation
    Franklin Jishie, Navajo Nation
    Jason John, Navajo Nation
    Eugenia Quintana, Navajo Nation
    Steve Beran, Zuni Pueblo
    Darrell Tsabetsaye, Zuni Pueblo
    Kirk Bemis, Zuni Pueblo
    Clayton Seoutewa, Southwest Region BIA
    Rose Duwyenie, Navajo BIA
    Judith Wilson, BIA
    Eldine Stevens, BIA
    Ben Burshia, BIA

File: FWDA 2012 & Reading File
     FWDA-12-003
APPENDIX B

NRCS SOIL SURVEY OF MCKINLEY COUNTY, NEW MEXICO
Soil Survey of McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Conservation Tree/Shrub Group: 10

Typical Profile:
A—0 to 3 inches; very fine sandy loam
Bt1—3 to 8 inches; clay loam
Bt2—8 to 19 inches; clay
Btk—19 to 24 inches; clay loam
2R—24 inches; sandstone bedrock

Minor Components
Atarque and similar soils
Composition: About 10 percent
Slope: 1 to 6 percent
Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Shallow Sandstone

Rock outcrop
Composition: About 5 percent
Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

40—Nuffel silt loam, 0 to 2 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,100 to 6,500 feet (1,859 to 1,981 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Average annual air temperature: 49 to 54 degrees F (9 to 12 degrees C)
Frost-free period: 120 to 140 days

Map Unit Composition
Nuffel and similar soils: 90 percent
Minor components: 10 percent

Component Descriptions

Nuffel soils
Geomorphic position: Flood plains on valley floors
Parent material: Alluvial material derived from siltstone and shale
Slope: 0 to 2 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Slowest permeability: About 0.20 in/hr (moderately slow)
Available water capacity: About 11.8 inches (high)
Shrink-swell potential: About 1.5 LEP (low)

Flooding hazard: Frequent
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Medium
Calcium carbonate maximum: About 10 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 5 SAR (slightly sodic)
Ecological site: Bottomland
Present native vegetation: alkali sacaton, western wheatgrass, fourwing saltbush, blue grama, galleta, spike muhly, mat muhly, sand dropseed, spineless horsebrush
Land capability (irrigated): 4w
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 8

42—Suwanee clay loam, 0 to 2 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,100 to 6,500 feet (1,859 to 1,981 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Average annual air temperature: 49 to 54 degrees F (9 to 12 degrees C)
Frost-free period: 120 to 140 days

Map Unit Composition
Suwanee and similar soils: 90 percent
Minor components: 10 percent

Component Descriptions

Suwanee soils
Geomorphic position: Flood plains on valley floors
Slope: 1 to 5 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Sandstone Upland

Huerfano and similar soils
Composition: About 3 percent
Slope: 1 to 5 percent
Depth to restrictive feature: 10 to 20 inches to bedrock (paralithic)
Drainage class: Well drained
Ecological site: Loamy Upland (sodic)

Kimnoli and similar soils
Composition: About 3 percent
Slope: 1 to 5 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Sandstone Upland

121—Badland

Map Unit Composition
Badland: 95 percent
Minor components: 5 percent

Component Descriptions
Badland
Badland is a miscellaneous area consisting of exposed areas of raw shale that is essentially denuded of vegetation. Seams and layers of coal and porcelainite are also included in some areas. These areas are highly dissected.

Geomorphic position: Ridges, hills, and escarpments
Parent material: Unweathered to slightly weathered shale
Slope: 1 to 50 percent
Depth to restrictive feature: 0 to 2 inches to bedrock (paralithic)
Drainage class: Somewhat excessively drained
Available water capacity: About 0.2 inches (very low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Very high
Calcium carbonate maximum: About 5 percent
Gypsum maximum: About 5 percent
Salinity maximum: About 4 mhos/cm (very slightly saline)

Sodicity maximum: About 10 SAR (slightly sodic)
Land capability (nonirrigated): 8

Minor Components
Rock outcrop
Composition: About 5 percent
Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

122—Rock outcrop-Farb complex, 2 to 8 percent slopes

Map Unit Setting
MLRA: 37
Elevation: 6,600 to 6,800 feet (2,012 to 2,073 meters)
Mean annual precipitation: 7 to 9 inches (178 to 229 millimeters)
Average annual air temperature: 50 to 55 degrees F (10 to 13 degrees C)
Frost-free period: 130 to 150 days

Map Unit Composition
Rock outcrop: 45 percent
Farb and similar soils: 45 percent
Minor components: 10 percent

Component Descriptions
Rock outcrop
Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

Farb soils
Geomorphic position: Escarpments on cuestas and mesas
Parent material: Eolian material over residuum derived from sandstone
Slope: 2 to 8 percent
Surface fragments: About 55 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Somewhat excessively drained
Slowest permeability: About 2.00 in/hr (moderately rapid)
Available water capacity: About 0.5 inches (very low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
212—Rehobeth silty clay loam, 0 to 1 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,600 to 6,800 feet (2,012 to 2,073 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Average annual air temperature: 46 to 49 degrees F (8 to 9 degrees C)
Frost-free period: 100 to 135 days

Map Unit Composition
Rehobeth and similar soils: 90 percent
Minor components: 10 percent
Urban land
In the City of Gallup, components of this map unit are covered by buildings, parking lots, roads, and sidewalks. The percentage of Urban land ranges from less than 10 percent on the city’s periphery to 60 percent in densely developed residential sections. There are also many areas that have been cut and filled with a variety of earthen materials or man-made soils.

Component Descriptions
Rehobeth soils
Geomorphic position: Flood plains and stream terraces on valley floors
Parent material: Stream alluvium derived from gypsiferous shale
Slope: 0 to 1 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Slowest permeability: About 0.06 in/hr (slow)
Available water capacity: About 8.5 inches (moderate)
Shrink-swell potential: About 7.5 LEP (high)
Flooding hazard: Occasional
Ponding hazard: Occasional
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Low
Calcium carbonate maximum: About 5 percent
Gypsum maximum: About 15 percent
Salinity maximum: About 8 mmhos/cm (slightly saline)
Sodicity maximum: About 13 SAR (moderately sodic)
Ecological site: Salty Bottomland
Present native vegetation: alkali sacaton, western wheatgrass, fourwing saltbush, black greasewood, blue grama, bottlebrush squirreltail, inland saltgrass, mat muhly, rabbitbrush

Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 10

Typical Profile:
A—0 to 2 inches; silty clay loam
Bw—2 to 5 inches; silty clay loam
Bss—5 to 12 inches; clay
Bssny1—12 to 18 inches; clay
Bssny2—18 to 32 inches; clay
Bssny3—32 to 80 inches; clay

Minor Components
Nuffel and similar soils
Composition: About 4 percent
Slope: 0 to 1 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Bottomland

Aquima and similar soils
Composition: About 3 percent
Slope: 0 to 1 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Loamy

Zia and similar soils
Composition: About 3 percent
Slope: 0 to 1 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Somewhat excessively drained
Ecological site: Sandy

215—Viuda-Penistaja-Rock outcrop complex, 1 to 5 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,700 to 7,000 feet (2,042 to 2,134 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Average annual air temperature: 49 to 54 degrees F (9 to 12 degrees C)
Frost-free period: 120 to 140 days

Map Unit Composition
Viuda and similar soils: 35 percent
Penistaja and similar soils: 30 percent
Rock outcrop: 25 percent
Minor components: 10 percent
Minor components: 15 percent

Component Descriptions

**Hagerwest soils**

*Geomorphic position:* Summits on hills and mesas and dipslopes on cuestas  
*Parent material:* Eolian material and slope alluvium derived from sandstone and shale  
*Slope:* 1 to 5 percent  
*Depth to restrictive feature:* 20 to 40 inches to bedrock (lithic)  
*Drainage class:* Well drained  
*Slowest permeability:* About 0.60 in/hr (moderate)  
*Available water capacity:* About 4.8 inches (low)  
*Shrink-swell potential:* About 1.5 LEP (low)  
*Flooding hazard:* None  
*Seasonal water table minimum depth:* Greater than 6 feet  
*Runoff class:* Medium  
*Calcium carbonate maximum:* About 10 percent  
*Gypsum maximum:* None  
*Salinity maximum:* About 2 mmhos/cm (nonsaline)  
*Sodicity maximum:* About 0 SAR (nonsodic)  
*Ecological site:* Loamy  
*Present native vegetation:* blue grama, western wheatgrass, Indian ricegrass, galleta, bottlebrush squirreltail, fourwing saltbush, winterfat, sand dropseed, oneseed juniper, spineless horsebrush, rabbitbrush  
*Land capability (nonirrigated):* 6c  
*Conservation Tree/Shrub Group:* 6D  

**Typical Profile:**  
A—0 to 2 inches; fine sandy loam  
Bt1—2 to 5 inches; fine sandy loam  
Bt2—5 to 14 inches; sandy clay loam  
2R—14 inches sandstone bedrock  

**Bond soils**

*Geomorphic position:* Summits on hills and mesas and dipslopes on cuestas  
*Parent material:* Eolian material and slope alluvium derived from sandstone  
*Slope:* 1 to 8 percent  
*Depth to restrictive feature:* 10 to 20 inches to bedrock (lithic)  
*Drainage class:* Well drained  
*Slowest permeability:* About 0.60 in/hr (moderate)  
*Available water capacity:* About 2.0 inches (very low)  
*Shrink-swell potential:* About 1.5 LEP (low)  
*Flooding hazard:* None  

**Minor Components**

**Rock outcrop**  
*Composition:* About 5 percent  
*Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.**

**Tintero and similar soils**  
*Composition:* About 5 percent  
*Slope:* 1 to 8 percent  
*Depth to restrictive feature:* None within 60 inches  
*Drainage class:* Somewhat excessively drained  
*Ecological site:* Sandy  

**Penistaja and similar soils**  
*Composition:* About 5 percent  
*Slope:* 1 to 8 percent  
*Depth to restrictive feature:* None within 60 inches  
*Drainage class:* Well drained  
*Ecological site:* Loamy  

**225—Aquima-Hawaikuh silt loams, 1 to 5 percent slopes**

**Map Unit Setting**

*MLRA:* 36  
*Elevation:* 6,000 to 6,800 feet (1,829 to 2,073 meters)  
*Mean annual precipitation:* 10 to 13 inches (254 to 330 millimeters)  
*Average annual air temperature:* 49 to 54 degrees F (9 to 12 degrees C)  
*Frost-free period:* 120 to 140 days
Map Unit Composition

Aquima and similar soils: 40 percent  
Hawaikuh and similar soils: 40 percent  
Minor components: 20 percent

Component Descriptions

Aquima soils

Geomorphic position: Stream terraces on valley floors and alluvial fans on valley sides  
Parent material: Fan and stream alluvium derived from siltstone, sandstone and shale  
Slope: 1 to 5 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Well drained  
Slowest permeability: About 0.20 in/hr (moderately slow)  
Available water capacity: About 10.1 inches (high)  
Shrink-swell potential: About 4.5 LEP (moderate)  
Flooding hazard: None  
Seasonal water table minimum depth: Greater than 6 feet  
Runoff class: Medium  
Calcium carbonate maximum: About 10 percent  
Gypsum maximum: None  
Salinity maximum: About 4 mmhos/cm (very slightly saline)  
Sodicity maximum: About 2 SAR (slightly sodic)  
Ecological site: Clayey  
Present native vegetation: alkali sacaton, western wheatgrass, galleta, Indian ricegrass, blue grama, bottlebrush squirreltail, broom snakeweed, fourwing saltbush, threeawn, winterfat, mat muhly, spike muhly  
Land capability (irrigated): 3e  
Land capability (nonirrigated): 6c  
Conservation Tree/Shrub Group: 4

Typical Profile:
A—0 to 3 inches; silt loam  
Btk1—3 to 12 inches; silty clay loam  
Btk2—12 to 29 inches; clay loam  
Bk1—29 to 39 inches; sandy clay loam  
Bk2—39 to 54 inches; sandy loam  
Bk3—54 to 65 inches; silty clay loam

Hawaikuh soils

Geomorphic position: Fan remnants on valley sides and stream terraces on valley floors  
Parent material: Fan and stream alluvium derived from sandstone and shale  
Slope: 1 to 5 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Well drained

Slowest permeability: About 0.20 in/hr (moderately slow)  
Available water capacity: About 10.1 inches (high)  
Shrink-swell potential: About 4.5 LEP (moderate)  
Flooding hazard: None  
Seasonal water table minimum depth: Greater than 6 feet  
Runoff class: Medium  
Calcium carbonate maximum: About 10 percent  
Gypsum maximum: None  
Salinity maximum: About 4 mmhos/cm (very slightly saline)  
Sodicity maximum: About 2 SAR (slightly sodic)  
Ecological site: Clayey  
Present native vegetation: alkali sacaton, western wheatgrass, galleta, Indian ricegrass, blue grama, bottlebrush squirreltail, broom snakeweed, fourwing saltbush, threeawn, winterfat, mat muhly, spike muhly  
Land capability (irrigated): 3e  
Land capability (nonirrigated): 6c  
Conservation Tree/Shrub Group: 4

Typical Profile:
A—0 to 3 inches; silt loam  
Btk1—3 to 12 inches; silty clay loam  
Btk2—12 to 29 inches; clay loam  
Bk1—29 to 39 inches; sandy clay loam  
Bk2—39 to 54 inches; sandy loam  
Bk3—54 to 65 inches; silty clay loam

Minor Components

Venadito and similar soils  
Composition: About 10 percent  
Slope: 0 to 1 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Well drained  
Ecological site: Clayey Bottomland

Tintero and similar soils  
Composition: About 6 percent  
Slope: 1 to 5 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Somewhat excessively drained  
Ecological site: Sandy

Mido and similar soils  
Composition: About 4 percent  
Slope: 1 to 5 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Excessively drained  
Ecological site: Deep Sand
230—Sparank-San Mateo-Zia complex, 0 to 3 percent slopes

Map Unit Setting

MLRA: 36
Elevation: 6,300 to 6,900 feet (1,920 to 2,090 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Average annual air temperature: 49 to 54 degrees F (9 to 12 degrees C)
Frost-free period: 120 to 140 days

Map Unit Composition
Sparank and similar soils: 40 percent
San Mateo and similar soils: 35 percent
Zia and similar soils: 20 percent
Minor components: 5 percent

Component Descriptions

Sparank soils

Geomorphic position: Flood plains on valley floors and alluvial fans on valley sides

Parent material: Fan and stream alluvium derived from sandstone and shale
Slope: 0 to 3 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Slowest permeability: About 0.03 in/hr (very slow)
Available water capacity: About 10.0 inches (high)
Shrink-swell potential: About 7.5 LEP (high)
Flooding hazard: Occasional
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: High
Calcium carbonate maximum: About 5 percent
Gypsum maximum: None
Salinity maximum: About 4 mmhos/cm (very slightly saline)
Sodicity maximum: About 5 SAR (slightly sodic)
Ecological site: Clayey Bottomland
Present native vegetation: western wheatgrass, alkali sacaton, fourwing saltbush, galleta, blue grama, spike muhly, mat muhly, broom snakeweed, rabbitbrush
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4CC
Barboncito and similar soils
Composition: About 2 percent
Slope: 2 to 5 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Loamy

260—Quarries and Pits

This unit consists of limestone quarries and gravel and borrow pits. This unit occurs throughout the county and on a wide variety of different soils. Included in this unit is the demolition area on Ft. Wingate. This unit is used for the excavation of construction materials. Recommendations on use, reclamation, and revegetation need to be made on a site-specific basis.

261—Coal Mine Land

This unit consists of all areas associated with coal mine activities. These areas include the actual mines, barren tailings, and reclaimed areas. This unit occurs in the northwest part of Mckinley county, from Gallup to near Window Rock, Arizona. Recommendations on use, revegetation, and reclamation need to be made on a site-specific basis.

265—Uranium Mined Lands

This unit consists of all areas associated with uranium mine activities. These areas include the actual mines, shafts, structures, borrow pits, barren tailings and waste rock piles, evaporation ponds, and contaminated waste yards. This unit occurs throughout the county and on a wide variety of different soils. These areas, unless reclaimed or revegetated, have no agricultural uses. Recommendations on use, revegetation and reclamation need to be made on a site-specific basis.

270—Alesna-Rock outcrop complex, 15 to 55 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,500 to 7,600 feet (1,981 to 2,316 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Average annual air temperature: 49 to 54 degrees F (9 to 12 degrees C)

Frost-free period: 120 to 140 days

Map Unit Composition
Alesna and similar soils: 70 percent
Rock outcrop: 20 percent
Minor components: 10 percent

Component Descriptions

Alesna soils

Geomorphic position: Volcanic cones and escarpments on lava plateaus
Parent material: Slope alluvium and colluvium derived from basalt, shale, and sandstone
Slope: 15 to 55 percent
Surface fragments: About 65 percent
Depth to restrictive feature: 40 to 60 inches to bedrock (paralithic)
Drainage class: Well drained
Slowest permeability: About 0.06 in/hr (slow)
Available water capacity: About 8.0 inches (moderate)
Shrink-swell potential: About 7.5 LEP (high)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Very high
Calcium carbonate maximum: About 40 percent
Gypsum maximum: None
Salinity maximum: About 4 mmhos/cm (very slightly saline)
Sodicity maximum: About 5 SAR (slightly sodic)
Ecological site: Foothills
Present native vegetation: blue grama, galleta, sideoats grama, alkali sacaton, black grama, bottlebrush squirreltail, fourwing saltbush, little bluestem, needleandthread, winterfat, common wolfstail, oneseed juniper, twoneedle pinyon, narrowleaf yucca
Land capability (nonirrigated): 7e
Conservation Tree/Shrub Group: 4K

Typical Profile:
A—0 to 1 inches; extremely cobbly loam
Bt—1 to 10 inches; gravelly clay loam
Btk1—10 to 20 inches; very gravelly clay
Btk2—20 to 26 inches; clay
Btk3—26 to 52 inches; clay loam
2Cr—52 inches; basalt bedrock

Rock outcrop

Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.
McKinley County Area, New Mexico

APPENDIX B

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Bt—2 to 31 inches; clay, clay loam
Btk1—31 to 45 inches; very gravelly sandy clay
Btk2—45 to 50 inches; clay loam
Btk3—50 to 60 inches; stratified very gravelly sandy clay loam
3BCk—60 to 80 inches; gravelly sandy loam

Minor Components

Tuces and similar soils
Composition: About 10 percent
Slope: 2 to 10 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (paralithic)
Drainage class: Well drained
Ecological site: Pinyon-Juniper Forest

Venzuni and similar soils
Composition: About 10 percent
Slope: 1 to 3 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Meadow

305—Celavar-Atarque complex, 1 to 8 percent slopes

Map Unit Setting

MLRA: 36
Elevation: 6,500 to 7,500 feet (1,981 to 2,286 meters)
Mean annual precipitation: 13 to 14 inches (330 to 356 millimeters)
Average annual air temperature: 49 to 53 degrees F (9 to 12 degrees C)
Frost-free period: 115 to 135 days

Map Unit Composition

Celavar and similar soils: 50 percent
Atarque and similar soils: 35 percent
Minor components: 15 percent

Component Descriptions

Celavar soils
Geomorphologic position: Dipslopes on cuestas and summits on mesas
Parent material: Eolian material and slope alluvium derived from sandstone and shale
Slope: 1 to 8 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)
Drainage class: Well drained
Slowest permeability: About 0.60 in/hr (moderate)
Available water capacity: About 4.7 inches (low)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Low
Calcareous carbonate maximum: About 10 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 1 SAR (slightly sodic)
Ecological site: Savannah
Present native vegetation: blue grama, western wheatgrass, Indian ricegrass, Mormon tea needleandthread, oneseed juniper, sand dropseed, twoneedle pinyon, muttongrass, rabbitbrush, winterfat, Bigelow's sagebrush, bottlebrush squirreltail, spineless horsebrush
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 6D

Typical Profile:
A—0 to 2 inches; loam
Bt1—2 to 24 inches; sandy clay loam
Bt2—24 to 31 inches; sandy clay loam
2R—31 inches; sandstone bedrock

Atarque soils
Geomorphologic position: Dipslopes on cuestas and summits on mesas
Parent material: Eolian material and slope alluvium derived from sandstone and shale
Slope: 1 to 8 percent
Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Slowest permeability: About 0.60 in/hr (moderate)
Available water capacity: About 2.0 inches (very low)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: High
Calcareous carbonate maximum: About 3 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 0 SAR (nonsodic)
Ecological site: Shallow Sandstone
Present native vegetation: Indian ricegrass, New Mexico feathergrass, blue grama, little bluestem, sideoats grama, Bigelow's sagebrush, fourwing saltbush, galleta, rabbitbrush, twoneedle pinyon, Mormon tea, oneseed juniper
Land capability (nonirrigated): 7s
Conservation Tree/Shrub Group: 10

Typical Profile:
A—0 to 3 inches; sandy loam
Bt—3 to 14 inches; sandy clay loam
2R—14 inches; sandstone bedrock

Minor Components
Rock outcrop
Composition: About 9 percent
Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

Flugle and similar soils
Composition: About 6 percent
Slope: 1 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Loamy

308—Fikel-Venzuni complex, 1 to 6 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 7,000 to 7,600 feet (2,134 to 2,316 meters)
Mean annual precipitation: 13 to 16 inches (330 to 406 millimeters)
Average annual air temperature: 49 to 53 degrees F (9 to 12 degrees C)
Frost-free period: 115 to 135 days

Map Unit Composition
Fikel and similar soils: 50 percent
Venzuni and similar soils: 40 percent
Minor components: 10 percent

Component Descriptions
Fikel soils
Geomorphic position: Fan remnants on valley sides
Parent material: Fan alluvium derived from sandstone and shale
Slope: 2 to 6 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Slowest permeability: About 0.06 in/hr (slow)
Available water capacity: About 9.0 inches (moderate)
Shrink-swell potential: About 4.5 LEP (moderate)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: High
Calcium carbonate maximum: About 10 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (very slightly saline)
Sodicity maximum: About 5 SAR (slightly sodic)
Ecological site: Clayey
Present native vegetation: alkali sacaton, western wheatgrass, galleta, Indian ricegrass, blue grama, bottlebrush squirreltail, broom snakeweed, fourwing saltbush, threeawn, winterfat, mat muhly, spike muhly
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4C

Venzuni soils
Geomorphic position: Stream terraces on valley floors
Parent material: Stream alluvium derived from sandstone and shale
Slope: 1 to 6 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Slowest permeability: About 0.01 in/hr (very slow)
Available water capacity: About 7.9 inches (moderate)
Shrink-swell potential: About 8.0 LEP (high)
Flooding hazard: Rare
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Very high
Calcium carbonate maximum: About 10 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 5 SAR (slightly sodic)
Ecological site: Clayey
Present native vegetation: alkali sacaton, western wheatgrass, galleta, Indian ricegrass, blue grama, bottlebrush squirreltail, broom snakeweed, fourwing saltbush, threeawn, winterfat, mat muhly, spike muhly
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4C

Typical Profile:
A—0 to 3 inches; clay loam
Bt—3 to 14 inches; clay
Btk1—14 to 32 inches; clay
Btk2—32 to 50 inches; sandy clay loam
Btk3—50 to 65 inches; clay
Btk4—65 to 70 inches; sandy clay loam


**Salinity maximum:** About 2 mmhos/cm (nonsaline)

**Sodicity maximum:** About 0 SAR (nonsodic)

**Ecological site:** Sandy Plains

**Present native vegetation:** blue grama, Indian ricegrass, big sagebrush, one-seed juniper, sand sagebrush, little bluestem, rabbitbrush, two-needle pinyon, antelope bitterbrush, cliffrose, spineless horsebrush

**Land capability (nonirrigated):** 6e

**Conservation Tree/Shrub Group:** 7

**Typical Profile:**
- A1—0 to 2 inches; loamy fine sand
- A2—2 to 6 inches; loamy fine sand
- C—6 to 65 inches; fine sand

**Minor Components**

- Parkelei and similar soils
  - **Composition:** About 10 percent
  - **Slope:** 1 to 5 percent
  - **Depth to restrictive feature:** None within 60 inches
  - **Drainage class:** Well drained
  - **Ecological site:** Loamy

- Fraguni and similar soils
  - **Composition:** About 5 percent
  - **Slope:** 1 to 10 percent
  - **Depth to restrictive feature:** None within 60 inches
  - **Drainage class:** Slowly drained
  - **Ecological site:** Sandy

- Plumasano and similar soils
  - **Composition:** About 5 percent
  - **Slope:** 5 to 15 percent
  - **Depth to restrictive feature:** None within 60 inches
  - **Drainage class:** Well drained
  - **Ecological site:** Sandy Slopes

**317—Highdye-Evpark-Bryway complex, 2 to 20 percent slopes**

**Map Unit Setting**

**MLRA:** 36

**Elevation:** 6,800 to 7,600 feet (2,073 to 2,316 meters)

**Mean annual precipitation:** 13 to 16 inches (330 to 406 millimeters)

**Average annual air temperature:** 46 to 49 degrees F (8 to 9 degrees C)

**Frost-free period:** 100 to 135 days

**Map Unit Composition**

- Highdye and similar soils: 35 percent
- Evpark and similar soils: 30 percent

Bryway and similar soils: 20 percent

Minor components: 15 percent

**Component Descriptions**

**Highdye soils**

**Geomorphologic position:** Sideslopes and summits on hills and ridges, dipslopes on cuestas, and summits on mesas

**Parent material:** Eolian material and slope alluvium over residuum derived from sandstone and shale

**Slope:** 2 to 20 percent

**Depth to restrictive feature:** 5 to 20 inches to bedrock (lithic)

**Drainage class:** Well drained

**Slowest permeability:** About 0.06 in/hr (slow)

**Available water capacity:** About 1.8 inches (very low)

**Shrink-swell potential:** About 7.5 LEP (high)

**Flooding hazard:** None

**Seasonal water table minimum depth:** Greater than 6 feet

**Runoff class:** High

**Calcium carbonate maximum:** None

**Gypsum maximum:** None

**Salinity maximum:** About 0 mmhos/cm (nonsaline)

**Sodicity maximum:** About 2 SAR (slightly sodic)

**Ecological site:** Pinyon-Juniper Forest

**Present native vegetation:** Gambel’s oak, antelope bitterbrush, banana yucca, big sagebrush, blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, cliffrose, fringed sagewort, muttongrass, one-seed juniper, pingue hymenoxys, prairie junegrass, threeawn, two-needle pinyon

**Land capability (nonirrigated):** 7s

**Conservation Tree/Shrub Group:** 10

**Typical Profile:**
- A—0 to 3 inches; fine sandy loam
- Bt1—3 to 5 inches; clay loam
- 2Bt2—5 to 12 inches; clay
- R—12 inches; sandstone bedrock

**Evpark soils**

**Geomorphologic position:** Sideslopes and summits on hills and ridges, dipslopes on cuestas, and summits on mesas

**Parent material:** Eolian material and slope alluvium derived from sandstone and shale

**Slope:** 2 to 8 percent

**Depth to restrictive feature:** 20 to 40 inches to bedrock (lithic)

**Drainage class:** Well drained

**Slowest permeability:** About 0.20 in/hr (moderately slow)
Available water capacity: About 3.9 inches (low)
Shrink-swell potential: About 4.5 LEP (moderate)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: High
Calcium carbonate maximum: About 10 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 0 SAR (slightly sodic)
Ecological site: Pinyon-Juniper Forest
Present native vegetation: Gambel’s oak, antelope bitterbrush, banana yucca, big sagebrush, blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, muttongrass, oneseed juniper, prairie junegrass, twoneedle pinyon, western wheatgrass
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4C

Typical Profile:
A—0 to 4 inches; sandy loam
Bt1—4 to 10 inches; clay
Bt2—10 to 23 inches; clay
2Cr—23 inches; shale

Minor Components
Vessilla and similar soils
Composition: About 5 percent
Slope: 2 to 4 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Shallow Sandstone

Galzuni and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Clayey

Parkelei and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Pinyon-Juniper Forest

320—Parkelei-Fraguni complex, 1 to 8 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,500 to 7,500 feet (1,981 to 2,286 meters)
Mean annual precipitation: 13 to 16 inches (330 to 406 millimeters)
Average annual air temperature: 46 to 49 degrees F (8 to 9 degrees C)
Frost-free period: 100 to 135 days

Map Unit Composition
Parkelei and similar soils: 45 percent
Fraguni and similar soils: 40 percent
Minor components: 15 percent

Component Descriptions
Parkelei soils
Geomorphic position: Dipslopes on cuestas, summits
Component Descriptions

Venzuni soils

**Geomorphic position:** Stream terraces on valley floors and alluvial fans on valley sides

**Parent material:** Fan and stream alluvium derived from shale

**Slope:** 1 to 3 percent

**Depth to restrictive feature:** None within 60 inches

**Drainage class:** Well drained

**Slowest permeability:** About 0.01 in/hr (very slow)

**Available water capacity:** About 9.0 inches (moderate)

**Shrink-swell potential:** About 7.5 LEP (high)

**Flooding hazard:** Rare

**Seasonal water table minimum depth:** Greater than 6 feet

**Runoff class:** Very high

**Calcium carbonate maximum:** About 5 percent

**Gypsum maximum:** None

**Salinity maximum:** About 2 mmhos/cm (nonsaline)

**Sodicity maximum:** About 5 SAR (slightly sodic)

**Ecological site:** Clayey

**Present native vegetation:** western wheatgrass, rush, sedge, slender wheatgrass, California brome, muttongrass, willow

**Land capability (irrigated):** 3s

**Land capability (nonirrigated):** 6c

**Conservation Tree/Shrub Group:** 4CC

**Typical Profile:**

- A—0 to 2 inches; silty clay
- BC—2 to 12 inches; silty clay
- Bss—12 to 46 inches; clay
- 2Bss—46 to 65 inches; clay

Minor Components

Nutreeah and similar soils

**Composition:** About 5 percent

**Slope:** 0 to 2 percent

**Depth to restrictive feature:** None within 60 inches

**Drainage class:** Moderately well drained

**Ecological site:** Meadow

Suwanee and similar soils

**Composition:** About 5 percent

**Slope:** 0 to 2 percent

**Depth to restrictive feature:** None within 60 inches

**Drainage class:** Well drained

**Ecological site:** Bottomland

332—Evpark-Arabrab complex, 2 to 6 percent slopes

Map Unit Setting

**MLRA:** 36

**Elevation:** 6,800 to 8,000 feet (2,073 to 2,438 meters)

**Mean annual precipitation:** 13 to 16 inches (330 to 406 millimeters)

**Average annual air temperature:** 46 to 49 degrees F (8 to 9 degrees C)

**Frost-free period:** 100 to 135 days

Map Unit Composition

Evpark and similar soils: 50 percent

Arabrab and similar soils: 40 percent

Minor components: 10 percent

Component Descriptions

Evpark soils

**Geomorphic position:** Dipslopes on cuestas and summits on mesas

**Parent material:** Eolian material and slope alluvium derived from sandstone and shale

**Slope:** 2 to 6 percent

**Depth to restrictive feature:** 20 to 40 inches to bedrock (lithic)

**Drainage class:** Well drained

**Slowest permeability:** About 0.20 in/hr (moderately slow)

**Available water capacity:** About 7.0 inches (moderate)

**Shrink-swell potential:** About 4.5 LEP (moderate)

**Flooding hazard:** None

**Seasonal water table minimum depth:** Greater than 6 feet

**Runoff class:** Medium

**Calcium carbonate maximum:** None

**Gypsum maximum:** None

**Salinity maximum:** About 0 mmhos/cm (nonsaline)

**Sodicity maximum:** About 0 SAR (nonsodic)

**Ecological site:** Pinyon-Juniper Forest

**Present native vegetation:** Gambel’s oak, antelope bitterbrush, banana yucca, big sagebrush, blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, muttongrass, oneseed juniper, prairie junegrass, twoneedle pinyon, western wheatgrass

**Land capability (nonirrigated):** 6c

**Conservation Tree/Shrub Group:** 6D
Figure 9.—Typical landscape of Parklei-Fraguni complex, 1 to 8 percent slopes. Profile of the Parklei soil in a roadcut.

**Typical Profile:**
- A—0 to 2 inches; fine sandy loam
- Bt1—2 to 9 inches; loam
- Bt2—9 to 36 inches; clay loam
- R—36 inches; sandstone bedrock

**Arabrab soils**

- **Geomorphic position:** Dipslopes on cuestas and summits on mesas
- **Parent material:** Eolian material and slope alluvium over residuum derived from sandstone
- **Slope:** 2 to 6 percent
- **Surface fragments:** About 23 percent
- **Depth to restrictive feature:** 10 to 20 inches to bedrock (lithic)
- **Drainage class:** Well drained
- **Slowest permeability:** About 0.20 in/hr (moderately slow)
- **Shrink-swell potential:** About 4.0 LEP (moderate)
- **Flooding hazard:** None
- **Seasonal water table minimum depth:** Greater than 6 feet
- **Runoff class:** High

**Calcium carbonate maximum:** About 10 percent

**Gypsum maximum:** None

**Salinity maximum:** About 2 mmhos/cm (nonsaline)

**Sodicity maximum:** About 0 SAR (nonsodic)

**Ecological site:** Pinyon-Juniper Forest

**Present native vegetation:** big sagebrush, muttongrass, Utah serviceberry, banana yucca, bottlebrush squirreltail, cliff fendlerbush, thrifty goldenweed, toadflax penstemon, oneseed juniper, twoneedle pinyon

**Land capability (nonirrigated):** 7s

**Conservation Tree/Shrub Group:** 10

**Typical Profile:**
- A—0 to 2 inches; gravelly fine sandy loam
- Bt1—2 to 7 inches; sandy clay loam
- Bt2—7 to 12 inches; clay loam
- Btk—12 to 17 inches; gravelly clay loam
- R—17 inches; sandstone bedrock

**Minor Components**

- Highdye and similar soils
- **Composition:** About 3 percent
**McKinley County Area, New Mexico**

**Slope:** 2 to 6 percent  
**Depth to restrictive feature:** 5 to 20 inches to bedrock (lithic)  
**Drainage class:** Well drained  
**Ecological site:** Pinyon-Juniper Forest  
**Parkelei and similar soils**  
- **Composition:** About 5 percent  
- **Slope:** 2 to 6 percent  
- **Depth to restrictive feature:** None within 60 inches  
- **Drainage class:** Well drained  
- **Ecological site:** Pinyon-Juniper Forest  

**Rock outcrop**  
- **Composition:** About 2 percent  
- Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

### 335—Venadito clay, 1 to 3 percent slopes

**Map Unit Setting**
- **MLRA:** 36  
- **Elevation:** 6,600 to 7,100 feet (2,012 to 2,164 meters)  
- **Mean annual precipitation:** 10 to 13 inches (254 to 330 millimeters)  
- **Average annual air temperature:** 49 to 53 degrees F (9 to 12 degrees C)  
- **Frost-free period:** 120 to 140 days

**Map Unit Composition**
- Venadito and similar soils: 85 percent  
- Minor components: 15 percent

**Component Descriptions**

**Venadito soils**
- **Geomorphic position:** Swales, depressions, and flood plains on valley floors and alluvial fans on valley sides  
- **Parent material:** Fan and stream alluvium derived from shale  
- **Slope:** 1 to 3 percent  
- **Depth to restrictive feature:** None within 60 inches  
- **Drainage class:** Well drained  
- **Slowest permeability:** About 0.01 in/hr (very slow)  
- **Available water capacity:** About 8.9 inches (moderate)  
- **Shrink-swell potential:** About 7.5 LEP (high)  
- **Flooding hazard:** Frequent  
- **Seasonal water table minimum depth:** Greater than 6 feet  
- **Runoff class:** Very high  
- **Calcium carbonate maximum:** About 10 percent  
- **Gypsum maximum:** About 1 percent  
- **Salinity maximum:** About 4 mmhos/cm (very slightly saline)  
- **Sodicity maximum:** About 10 SAR (slightly sodic)  
- **Ecological site:** Clayey Bottomland  
- **Present native vegetation:** western wheatgrass, alkali sacaton, fourwing saltbush, galleta, blue grama, spike muhly, mat muhly, broom snakeweed, rabbitbrush  
- **Land capability (irrigated):** 4w  
- **Land capability (nonirrigated):** 6w  
- **Conservation Tree/Shrub Group:** 4CC

**Typical Profile:**
- A—0 to 3 inches; clay  
- BCss1—3 to 30 inches; clay  
- BCss2—30 to 65 inches; clay

**Minor Components**

**Suwanee and similar soils**
- **Composition:** About 10 percent  
- **Slope:** 0 to 2 percent  
- **Depth to restrictive feature:** None within 60 inches  
- **Drainage class:** Well drained  
- **Ecological site:** Bottomland

**Nuffel and similar soils**
- **Composition:** About 5 percent  
- **Slope:** 0 to 2 percent  
- **Depth to restrictive feature:** None within 60 inches  
- **Drainage class:** Well drained  
- **Ecological site:** Bottomland

### 336—Nuffel-Venadito complex, 1 to 3 percent slopes

**Map Unit Setting**
- **MLRA:** 36  
- **Elevation:** 6,100 to 6,500 feet (1,859 to 1,981 meters)  
- **Mean annual precipitation:** 10 to 13 inches (254 to 330 millimeters)  
- **Average annual air temperature:** 49 to 53 degrees F (9 to 12 degrees C)  
- **Frost-free period:** 120 to 140 days

**Map Unit Composition**
- Nuffel and similar soils: 45 percent  
- Venadito and similar soils: 35 percent  
- Minor components: 20 percent

**Component Descriptions**

**Nuffel soils**
- **Geomorphic position:** Flood plains on valley floors
**Parent material:** Stream alluvium derived from siltstone and shale  
**Slope:** 1 to 3 percent  
**Depth to restrictive feature:** None within 60 inches  
**Drainage class:** Well drained  
**Slowest permeability:** About 0.06 in/hr (slow)  
**Available water capacity:** About 10.5 inches (high)  
**Shrink-swell potential:** About 4.5 LEP (moderate)  
**Flooding hazard:** Frequent  
**Seasonal water table minimum depth:** Greater than 6 feet  
**Runoff class:** Medium  
**Calcium carbonate maximum:** About 10 percent  
**Gypsum maximum:** None  
**Salinity maximum:** About 2 mmhos/cm (nonsaline)  
**Sodicity maximum:** About 5 SAR (slightly sodic)  
**Ecological site:** Bottomland  
**Present native vegetation:** alkali sacaton, western wheatgrass, fourwing saltbush, galleta, blue grama, spineless horsebrush  
**Land capability (irrigated):** 4w  
**Land capability (nonirrigated):** 6c  
**Conservation Tree/Shrub Group:** 8  

**Typical Profile:**  
A—0 to 2 inches; silt loam  
C1—2 to 10 inches; sandy loam  
C2—10 to 17 inches; silt loam  
C3—17 to 20 inches; loam  
C4—20 to 47 inches; silty clay loam  
2Ab—47 to 65 inches; silty clay  

**Venadito soils**

**Geomorphic position:** Flood plains, depressions and swales on valley floors  
**Parent material:** Stream alluvium derived from shale  
**Slope:** 1 to 3 percent  
**Depth to restrictive feature:** None within 60 inches  
**Drainage class:** Well drained  
**Slowest permeability:** About 0.03 in/hr (very slow)  
**Available water capacity:** About 7.7 inches (moderate)  
**Shrink-swell potential:** About 11.0 LEP (very high)  
**Flooding hazard:** Frequent  
**Seasonal water table minimum depth:** Greater than 6 feet  
**Runoff class:** Very high  
**Calcium carbonate maximum:** About 10 percent  
**Gypsum maximum:** None  
**Salinity maximum:** About 4 mmhos/cm (very slightly saline)  
**Sodicity maximum:** About 5 SAR (slightly sodic)  
**Ecological site:** Clayey Bottomland  

**Present native vegetation:** western wheatgrass, alkali sacaton, fourwing saltbush, galleta, blue grama, spike muhly, mat muhly, broom strawbush, rabbitbrush  
**Land capability (irrigated):** 4w  
**Land capability (nonirrigated):** 6c  
**Conservation Tree/Shrub Group:** 4CC  

**Typical Profile:**  
A—0 to 2 inches; clay  
BCss1—2 to 9 inches; clay  
BCss2—9 to 11 inches; silty clay  
BCss3—11 to 65 inches; clay  

**Minor Components**

**Hawaiikuh and similar soils**

**Composition:** About 8 percent  
**Slope:** 0 to 2 percent  
**Depth to restrictive feature:** None within 60 inches  
**Drainage class:** Well drained  
**Ecological site:** Clayey  

**Aquima and similar soils**

**Composition:** About 8 percent  
**Slope:** 1 to 5 percent  
**Depth to restrictive feature:** None within 60 inches  
**Drainage class:** Well drained  
**Ecological site:** Loamy  

**Penistaja and similar soils**

**Composition:** About 4 percent  
**Slope:** 1 to 5 percent  
**Depth to restrictive feature:** None within 60 inches  
**Drainage class:** Well drained  
**Ecological site:** Loamy  

**338—Zyme-Lockerby association, 5 to 35 percent slopes**

**Map Unit Setting**

**MLRA:** 36  
**Elevation:** 6,500 to 7,200 feet (1,981 to 2,195 meters)  
**Mean annual precipitation:** 10 to 13 inches (254 to 330 millimeters)  
**Average annual air temperature:** 46 to 49 degrees F (8 to 9 degrees C)  
**Frost-free period:** 100 to 135 days  

**Map Unit Composition**

**Zyme and similar soils:** 50 percent  
**Lockerby and similar soils:** 40 percent
Component Descriptions

Rock outcrop

Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

Tuces soils

Geomorphic position: Escarpments on cuestas
Parent material: Slope alluvium and colluvium over residuum derived from sandstone and shale
Slope: 20 to 40 percent
Surface fragments: About 75 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (paralithic)
Drainage class: Well drained
Slowest permeability: About 0.06 in/hr (slow)
Available water capacity: About 3.5 inches (low)
Shrink-swell potential: About 7.5 LEP (high)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Very high
Calcium carbonate maximum: About 10 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 1 SAR (slightly sodic)
Ecological site: Pinyon-Juniper Forest
Present native vegetation: Gambel’s oak, banana yucca, blue grama, bottlebrush squirreltail, buckwheat, cliffrose, fourwing saltbush, galleta, mountainmahogany, muttongrass, needlegrass, oneseed juniper, sideoats grama, threeawn, twoneedle pinyon
Land capability (nonirrigated): 8
Conservation Tree/Shrub Group: 10

Typical Profile:
A—0 to 1 inches; extremely gravelly clay loam
Bk1—1 to 4 inches; clay
Bk2—4 to 24 inches; clay
Cr—24 inches; shale

Minor Components

Vessilla and similar soils
Composition: About 10 percent
Slope: 2 to 15 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (paralithic)
Drainage class: Somewhat excessively drained
Ecological site: Shallow Sandstone

Fikel and similar soils
Composition: About 5 percent
Slope: 2 to 6 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained

Ecological site: Clayey

Venzuni and similar soils
Composition: About 5 percent
Slope: 1 to 3 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained

Ecological site: Meadow

350—Toldohn-Vessilla-Rock outcrop complex, 8 to 35 percent slopes

Map Unit Setting

Elevation: 6,800 to 8,000 feet (2,073 to 2,438 meters)
Mean annual precipitation: 13 to 16 inches (330 to 406 millimeters)
Mean annual air temperature: 46 to 49 degrees F (8.0 to 9.4 degrees C)
Frost-free period: 100 to 135 days

Map Unit Composition

Toldohn and similar soils: 35 percent
Vessilla and similar soils: 30 percent
Rock outcrop: 20 percent
Minor components: 15 percent

Component Descriptions

Toldohn soils
Landform: Breaks, ridges, hills
Parent material: Slope alluvium over residuum derived from shale
Slope: 8 to 35 percent
Surface fragments: About 25 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (paralithic)
Drainage class: Well drained
Slowest permeability: .06 to 0.2 in/hr (slow)
Available water capacity: About 1.5 inches (very low)
Shrink-swell potential: About 7.5 percent (high)
Runoff class: Very high
Calcium carbonate maximum: About 5 percent
Gypsum maximum: None
Salinity maximum: About 0 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: About 2 (slightly sodic)
Ecological site: pinyon-juniper forest
Potential native vegetation:
- Common trees: oneseed juniper, Rocky Mountain juniper, Gambel oak, twoneedle pinyon
- Other plants: Gambel oak, antelope bitterbrush, banana yucca, big sagebrush, blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, little bluestem, mountain mahogany, muttongrass, oneseed juniper, prairie junegrass, sideoats grama, twoneedle pinyon

Land capability subclass (nonirrigated): 7s

Typical Profile:
- A—0 to 4 inches; gravelly clay loam
- 2BC—4 to 11 inches; clay
- 2Cr—11 to 20 inches; weathered bedrock

Vessilla soils

Landform: Breaks, structural benches on ridges, structural benches on hills
Parent material: Eolian and slope alluvium derived from sandstone
Slope: 8 to 15 percent
Depth to restrictive feature: 5 to 20 inches to bedrock
Drainage class: Somewhat excessively drained
Slowest permeability: 2.0 to 6.0 in/hr (moderately rapid)
Available water capacity: About 1.5 inches (very low)
Calcium carbonate maximum: About 5 percent
Gypsum maximum: None
Salinity maximum: About 0 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: About 0 (nonsodic)
Ecological site: pinyon-juniper forest
Potential native vegetation:
- Common trees: oneseed juniper, Rocky Mountain juniper, Gambel oak, twoneedle pinyon
- Other plants: Gambel oak, antelope bitterbrush, banana yucca, big sagebrush, blue grama, broom snakeweed, buckwheat, little bluestem, mountain mahogany, muttongrass, oneseed juniper, prairie junegrass, sideoats grama, twoneedle pinyon

Land capability subclass (nonirrigated): 7s

Typical Profile:
- A—0 to 2 inches; fine sandy loam
- C—2 to 11 inches; fine sandy loam
- 2R—11 to 20 inches; unweathered bedrock

Rock outcrop

Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

Minor Components

Galzuni and similar soils
- Composition: About 5 percent
- Slope: 5 to 8 percent
- Drainage class: Well drained
- Ecological site: Clayey

Parkelei and similar soils
- Composition: About 5 percent
- Slope: 5 to 8 percent
- Drainage class: Well drained
- Ecological site: Pinyon-Juniper Forest

Bryway and similar soils
- Composition: About 5 percent
- Slope: 5 to 8 percent
- Depth to restrictive feature: 20 to 40 inches to bedrock (paralithic)
- Drainage class: Well drained
- Ecological site: Pinyon-Juniper Forest

351—Rock outcrop-Vessilla complex, 35 to 70 percent slopes

Map Unit Setting

Elevation: 6,800 to 8,000 feet (2,073 to 2,438 meters)
Mean annual precipitation: 13 to 16 inches (330 to 406 millimeters)
Mean annual air temperature: 46 to 49 degrees F (8.0 to 9.4 degrees C)
Frost-free period: 100 to 135 days

Map Unit Composition

Rock outcrop: 60 percent
Vessilla and similar soils: 30 percent
Minor components: 10 percent

Component Descriptions

Rock outcrop

Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale. Slopes range from about 5 to 15 percent on treads (structural benches) to almost vertical cliffs on the risers (escarpment face).

Vessilla soils

Landform: Escarpments on cuestas, escarpments on mesas
Parent material: Eolian material and slope alluvium derived from sandstone
Slope: 35 to 50 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)

Drainage class: Somewhat excessively drained
Slowest permeability: 2.0 to 6.0 in/hr (moderately rapid)
Available water capacity: About 0.7 inches (very low)
Shrink-swell potential: About 1.5 percent (low)
Runoff class: Medium
Calcium carbonate maximum: About 5 percent
Gypsum maximum: None
Salinity maximum: About 0 mmhos/cm (nonsaline)
Sodium adsorption ratio maximum: About 0 (nonsodic)
Ecological site: Draft Shallow Savannah 9-14" P.z.
Potential native vegetation: Gambel oak, antelope bitterbrush, banana yucca, big sagebrush, blue grama, broom snakeweed, buckwheat, little bluestem, mountainmahogany, muttongrass, oneseed juniper, prairie junegrass, sideoats grama
Land capability subclass (nonirrigated): 7s

Typical Profile:
A—0 to 5 inches; fine sandy loam
2R—5 to 20 inches; unweathered bedrock

Minor Components

Rubble Land
Composition: About 3 percent
Depth to restrictive feature: 0 inches to bedrock (lithic)

Mido and similar soils
Composition: About 3 percent
Slope: 5 to 10 percent
Drainage class: Excessively drained
Ecological site: Deep Sand

Toldohn and similar soils
Composition: About 2 percent
Slope: 20 to 35 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (paralithic)
Drainage class: Well drained
Ecological site: Clayey

Vessilla and similar soils
Composition: About 2 percent
Slope: 5 to 35 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Shallow Sandstone

352—Zia sandy loam, 1 to 5 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,000 to 6,800 feet (1,829 to 2,073 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Average annual air temperature: 49 to 53 degrees F (9 to 12 degrees C)
Frost-free period: 120 to 140 days

Map Unit Composition
Zia and similar soils: 80 percent
Minor components: 20 percent

Component Descriptions

Zia soils
Geomorphic position: Stream terraces on valley floors and alluvial fans on valley sides
Parent material: Eolian material and fan and stream alluvium derived from sandstone
Slope: 1 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Somewhat excessively drained
Slowest permeability: About 2.00 in/hr (moderately rapid)
Available water capacity: About 7.1 inches (moderate)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Very low
Calcium carbonate maximum: About 5 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 2 SAR (slightly sodic)
Ecological site: Sandy
Present native vegetation: blue grama, western wheatgrass, Indian ricegrass, fourwing saltbush, sand dropseed, needleandthread, spike dropseed, winterfat, galleta, ring muhly, rabbitbrush, sand sagebrush, spineless horsebrush
Land capability (irrigated): 3e
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 5

Typical Profile:
A—0 to 3 inches; sandy loam
McKinley County Area, New Mexico

C1—3 to 31 inches; sandy loam
C2—31 to 65 inches; fine sandy loam

Minor Components

Mido and similar soils
Composition: About 10 percent
Slope: 1 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Excessively drained
Ecological site: Deep Sand

Penistaja and similar soils
Composition: About 5 percent
Slope: 1 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Loamy

Aquima and similar soils
Composition: About 5 percent
Slope: 1 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Loamy

353—Mido loamy fine sand, 1 to 6 percent slopes

Map Unit Setting

MLRA: 36
Elevation: 6,300 to 6,700 feet (1,920 to 2,042 meters)
Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Average annual air temperature: 49 to 53 degrees F (9 to 12 degrees C)
Frost-free period: 120 to 140 days

Map Unit Composition

Mido and similar soils: 90 percent
Minor components: 10 percent

Component Descriptions

Mido soils
Geomorphic position: Dunes on valley sides and valley floors
Parent material: Eolian material derived from sandstone
Slope: 1 to 6 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Excessively drained
Slowest permeability: About 6.00 in/hr (rapid)

Available water capacity: About 4.8 inches (low)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Negligible
Calcium carbonate maximum: About 1 percent
Gypsum maximum: None
Salinity maximum: About 0 mmhos/cm (nonsaline)
Sodicity maximum: About 0 SAR (nonsodic)
Ecological site: Deep Sand
Present native vegetation: Indian ricegrass,
blue grama, antelope bitterbrush, broom
snakeweed, fourwing saltbush, sand dropseed,
sandhill muhly
Land capability (irrigated): 3e
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 5

Fragua and similar soils
Composition: About 5 percent
Slope: 1 to 6 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Somewhat excessively drained
Ecological site: Sandy Slopes

354—Knifehill loam, 1 to 5 percent slopes

Map Unit Setting

MLRA: 36
Elevation: 6,900 to 7,500 feet (2,103 to 2,286 meters)
Mean annual precipitation: 13 to 16 inches (330 to 406 millimeters)
Average annual air temperature: 46 to 49 degrees F (8 to 9 degrees C)
Frost-free period: 100 to 135 days

Map Unit Composition

Knifehill and similar soils: 80 percent
Minor components: 20 percent
Component Descriptions

Knifehill soils

**Geomorphic position:** Stream terraces on valley floors and fan remnants on valley sides

**Parent material:** Fan and stream alluvium derived from sandstone and shale

**Slope:** 1 to 5 percent

**Depth to restrictive feature:** None within 60 inches

**Drainage class:** Well drained

**Slowest permeability:** About 0.06 in/hr (slow)

**Available water capacity:** About 9.4 inches (high)

**Shrink-swell potential:** About 7.5 LEP (high)

**Flooding hazard:** None

**Seasonal water table minimum depth:** Greater than 6 feet

**Runoff class:** High

**Calcium carbonate maximum:** About 15 percent

**Gypsum maximum:** None

**Salinity maximum:** About 2 mmhos/cm (nonsaline)

**Sodicity maximum:** About 0 SAR (nonsodic)

**Ecological site:** Meadow

**Present native vegetation:** western wheatgrass, rush, sedge, slender wheatgrass, California brome, muttongrass, willow

**Land capability (irrigated):** 3c

**Land capability (nonirrigated):** 4c

**Conservation Tree/Shrub Group:** 4C

**Typical Profile:**

A—0 to 2 inches; loam

Bw—2 to 6 inches; clay loam

Bt1—6 to 11 inches; clay loam

Bt2—11 to 26 inches; clay

Btk—26 to 35 inches; clay

Bk—35 to 65 inches; clay

**Minor Components**

Silcat and similar soils

**Composition:** About 10 percent

**Slope:** 1 to 5 percent

**Depth to restrictive feature:** None within 60 inches

**Drainage class:** Well drained

**Ecological site:** Clayey

Parkelei and similar soils

**Composition:** About 10 percent

**Slope:** 1 to 5 percent

**Depth to restrictive feature:** None within 60 inches

**Drainage class:** Well drained

**Ecological site:** Loamy

355—Rizno-Tekapo-Rock outcrop complex, 2 to 45 percent slopes

**Map Unit Setting**

**MLRA:** 36

**Elevation:** 6,200 to 6,700 feet (1,890 to 2,042 meters)

**Mean annual precipitation:** 10 to 13 inches (254 to 330 millimeters)

**Average annual air temperature:** 49 to 54 degrees F (9 to 12 degrees C)

**Frost-free period:** 120 to 140 days

**Map Unit Composition**

Rizno and similar soils: 35 percent

Tekapo and similar soils: 30 percent

Rock outcrop: 20 percent

Minor components: 15 percent

**Component Descriptions**

**Rizno soils**

**Geomorphic position:** Structural benches on escarpments on cuestas and mesas

**Parent material:** Eolian material over residuum derived from sandstone

**Slope:** 2 to 20 percent

**Depth to restrictive feature:** 5 to 20 inches to bedrock (lithic)

**Drainage class:** Well drained

**Slowest permeability:** About 2.00 in/hr (moderately rapid)

**Available water capacity:** About 0.9 inches (very low)

**Shrink-swell potential:** About 1.5 LEP (low)

**Flooding hazard:** None

**Seasonal water table minimum depth:** Greater than 6 feet

**Runoff class:** Medium

**Calcium carbonate maximum:** About 10 percent

**Gypsum maximum:** None

**Salinity maximum:** About 2 mmhos/cm (nonsaline)

**Sodicity maximum:** About 0 SAR (nonsodic)

**Ecological site:** Shallow Sandstone

**Present native vegetation:** Indian ricegrass, New Mexico feathergrass, blue grama, little bluestem, sideoats grama, Bigelow’s sagebrush, fourwing saltbush, galleta, sand dropseed, antelope bitterbrush, cliffrose, Mormon tea, oneseed juniper

**Land capability (nonirrigated):** 7s

**Conservation Tree/Shrub Group:** 10
Typical Profile:
A—0 to 3 inches; fine sandy loam
C—3 to 8 inches; sandy loam
2R—8 inches; sandstone bedrock

Tekapo soils

Geomorphic position: Escarpments on mesas and cuestas
Parent material: Slope alluvium and colluvial material over residuum derived from shale and siltstone
Slope: 10 to 45 percent
Surface fragments: About 20 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (paralithic)
Drainage class: Well drained
Slowest permeability: About 0.06 in/hr (slow)
Available water capacity: About 1.6 inches (very low)
Shrink-swell potential: About 7.5 LEP (high)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Very high
Calcium carbonate maximum: About 5 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 0 SAR (nonsodic)
Ecological site: Shale Hills
Present native vegetation: alkali sacaton, galleta, Indian ricegrass, blue grama, bottlebrush squirreltail, fourwing saltbush, little bluestem, needleandthread, sideoats grama, western wheatgrass, mound saltbush, shadscale saltbush, Bigelow’s sagebrush, oneseed juniper, winterfat
Land capability (nonirrigated): 7s
Conservation Tree/Shrub Group: 10

Typical Profile:
A—0 to 2 inches; channery silty clay loam
C—2 to 10 inches; silty clay
2Cr—10 inches; shale

Rock outcrop

Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

Minor Components

Aquima and similar soils
Composition: About 5 percent
Slope: 2 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Loamy

Mido and similar soils
Composition: About 5 percent
Slope: 2 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Excessively drained
Ecological site: Deep Sand

Monpark and similar soils
Composition: About 5 percent
Slope: 2 to 5 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (paralithic)
Drainage class: Well drained
Ecological site: Clayey

357—Heshotauthla clay, 0 to 1 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,300 to 7,000 feet (1,920 to 2,134 meters)
Mean annual precipitation: 13 to 16 inches (330 to 406 millimeters)
Average annual air temperature: 46 to 49 degrees F (8 to 9 degrees C)
Frost-free period: 100 to 135 days

Map Unit Composition
Heshotauthla and similar soils: 85 percent
Minor components: 15 percent

Component Descriptions

Heshotauthla soils

Geomorphic position: Stream terraces on valley floors and flood plains on valley floors
Parent material: Stream alluvium derived from sandstone and shale
Slope: 0 to 1 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Slowest permeability: About 0.01 in/hr (very slow)
Available water capacity: About 5.4 inches (low)
Shrink-swell potential: About 7.5 LEP (high)
Flooding hazard: Occasional
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: High
Calcium carbonate maximum: About 5 percent
Gypsum maximum: About 1 percent
Salinity maximum: About 16 mmhos/cm (moderately saline)
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: High
Calcium carbonate maximum: About 5 percent
Gypsum maximum: None
Salinity maximum: About 4 mmhos/cm (very slightly saline)
Sodicity maximum: About 2 SAR (slightly sodic)
Ecological site: Clayey
Present native vegetation: western wheatgrass, needleandthread, winterfat, Indian ricegrass, big sagebrush, blue grama, bottlebrush squirreltail, galleta, pingue hymenoxys, rabbitbrush
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4C

Typical Profile:
Ap1—0 to 1 inches; clay loam
Ap2—1 to 5 inches; clay
Btss—5 to 32 inches; clay
Btkss—32 to 51 inches; clay
Btkz—51 to 65 inches; clay

Minor Components
Fraguni and similar soils
Composition: About 5 percent
Slope: 1 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Somewhat excessively drained
Ecological site: Sandy

Parkelei and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Loamy

Silcat and similar soils
Composition: About 5 percent
Slope: 0 to 3 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Clayey

361—Monpark silty clay, 2 to 8 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,000 to 7,000 feet (1,829 to 2,134 meters)

Mean annual precipitation: 10 to 13 inches (254 to 330 millimeters)
Average annual air temperature: 49 to 53 degrees F (9 to 12 degrees C)
Frost-free period: 120 to 140 days

Map Unit Composition
Monpark and similar soils: 80 percent
Minor components: 20 percent

Component Descriptions

Monpark soils
Geomorphic position: Hills and valley sides
Parent material: Slope alluvium over residuum derived from shale
Slope: 2 to 8 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (paralithic)
Drainage class: Well drained
Slowest permeability: About 0.03 in/hr (very slow)
Available water capacity: About 4.1 inches (low)
Shrink-swell potential: About 7.5 LEP (high)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: High
Calcium carbonate maximum: About 10 percent
Gypsum maximum: None
Salinity maximum: About 4 mmhos/cm (very slightly saline)
Sodicity maximum: About 5 SAR (slightly sodic)
Ecological site: Clayey
Present native vegetation: western wheatgrass, alkali sacaton, blue grama, galleta, Indian ricegrass, fourwing saltbush, winterfat, bottlebrush squirreltail, rabbitbrush, broom snakeweed
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4CK

Typical Profile:
A—0 to 4 inches; silty clay
BC—4 to 7 inches; silty clay
2BCss—7 to 27 inches; clay
2Cr—27 inches; shale

Minor Components
Tekapo and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (paralithic)
Drainage class: Well drained
Ecological site: Shale Hills
Rizno and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Somewhat excessively drained
Ecological site: Shallow Sandstone

Venadito and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Clayey Bottomland

Aquima and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Loamy

365—Vessilla-Rock outcrop complex, 2 to 15 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,500 to 8,000 feet (1,981 to 2,469 meters)
Mean annual precipitation: 13 to 14 inches (330 to 356 millimeters)
Average annual air temperature: 46 to 49 degrees F (8 to 9 degrees C)
Frost-free period: 100 to 135 days

Map Unit Composition
Vessilla and similar soils: 55 percent
Rock outcrop: 35 percent
Minor components: 10 percent

Component Descriptions
Vessilla soils
Geomorphic position: Summits on mesas and dipslopes on cuestas
Parent material: Eolian material derived from sandstone
Slope: 2 to 15 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Slowest permeability: About 2.00 in/hr (moderately rapid)
Available water capacity: About 2.1 inches (very low)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Medium
Calcium carbonate maximum: About 15 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 0 SAR (nonsodic)
Ecological site: Pinyon-Juniper Forest
Present native vegetation: Bigelow’s sagebrush, blue grama, fourwing saltbush, Indian ricegrass, New Mexico feathergrass, galleta, little bluestem, sideoats grama, winterfat, cliffrose, Mormon tea, oneseed juniper, twoneedle pinyon
Land capability (nonirrigated): 7s
Conservation Tree/Shrub Group: 10

Rock outcrop
Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

Arabrab and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Pinyon-Juniper Forest

Evpark and similar soils
Composition: About 3 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Pinyon-Juniper Forest

Parkelei and similar soils
Composition: About 2 percent
Slope: 2 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Pinyon-Juniper Forest
McKinley County Area, New Mexico

Bt1—2 to 7 inches; fine sandy loam
Bt2—7 to 20 inches; sandy clay loam
Bt3—20 to 28 inches; sandy clay loam
2R—28 inches; sandstone bedrock

Stozuni soils

**Geomorphic position:** Summits on mesas and dipslopes on cuestas
**Parent material:** Eolian material and slope alluvium derived from sandstone
**Slope:** 2 to 8 percent
**Depth to restrictive feature:** 5 to 20 inches to bedrock (lithic)
**Drainage class:** Somewhat excessively drained
**Slowest permeability:** About 2.00 in/hr (moderately rapid)
**Available water capacity:** About 2.1 inches (very low)
**Shrink-swell potential:** About 1.5 LEP (low)
**Flooding hazard:** None
**Seasonal water table minimum depth:** Greater than 6 feet
**Runoff class:** Very high
**Calcium carbonate maximum:** None
**Gypsum maximum:** None
**Salinity maximum:** About 2 mmhos/cm (nonsaline)
**Sodicity maximum:** About 0 SAR (nonsodic)
**Ecological site:** Ponderosa Pine Forest
**Present native vegetation:** Arizona fescue, Gambel’s oak, blue grama, bottlebrush squirreltail, mountain muhly, muttongrass, prairie junegrass

Conservation Tree/Shrub Group: 10

Typical Profile:
A—0 to 2 inches; sandy loam
C1—2 to 10 inches; fine sandy loam
C2—10 to 15 inches; fine sandy loam
2R—15 inches; sandstone bedrock

Minor Components

Rock outcrop
**Composition:** About 5 percent
**Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.**

Knifehill and similar soils
**Composition:** About 5 percent
**Slope:** 1 to 5 percent
**Depth to restrictive feature:** None within 60 inches
**Drainage class:** Well drained
**Ecological site:** Meadow

Zunalei and similar soils

**Composition:** About 5 percent
**Slope:** 2 to 8 percent
**Depth to restrictive feature:** None within 60 inches
**Drainage class:** Well drained
**Ecological site:** Ponderosa Forest

Valnor and similar soils

**Composition:** About 5 percent
**Slope:** 2 to 8 percent
**Depth to restrictive feature:** 20 to 40 inches to bedrock (paralithic)
**Drainage class:** Well drained
**Ecological site:** Ponderosa Forest

403—Valnor-Techado complex, 2 to 25 percent slopes

**Map Unit Setting**

**MLRA:** 39
**Elevation:** 7,100 to 7,800 feet (2,164 to 2,377 meters)
**Mean annual precipitation:** 16 to 20 inches (406 to 508 millimeters)
**Average annual air temperature:** 40 to 45 degrees F (4 to 7 degrees C)
**Frost-free period:** 90 to 110 days

**Map Unit Composition**

Valnor and similar soils: 50 percent
Techado and similar soils: 30 percent
Minor components: 20 percent

**Component Descriptions**

**Valnor soils**

**Geomorphic position:** Sideslopes on hills and ridges
**Parent material:** Slope alluvium derived from shale
**Slope:** 2 to 15 percent
**Depth to restrictive feature:** 20 to 40 inches to bedrock (paralithic)
**Drainage class:** Well drained
**Slowest permeability:** About 0.06 in/hr (slow)
**Available water capacity:** About 0.21 inches (low)
**Shrink-swell potential:** About 1.5 LEP (low)
**Flooding hazard:** None
**Seasonal water table minimum depth:** Greater than 6 feet
**Runoff class:** Very high
**Calcium carbonate maximum:** About 5 percent
**Gypsum maximum:** None
**Salinity maximum:** About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 0 SAR (nonsodic)  
Ecological site: Ponderosa Pine Forest  
Present native vegetation: Arizona fescue, Gambel’s oak, blue grama, bottlebrush squirreltail, buckwheat, mountainmahogany, mountain muhly, muttongrass, rabbitbrush  
Land capability (nonirrigated): 6e  
Conservation Tree/Shrub Group: 4C

Typical Profile:  
A—0 to 2 inches; clay loam  
Bw—2 to 4 inches; clay loam  
Bt—4 to 20 inches; clay  
2Crk—20 to 34 inches; clay  
2Cr—34 inches; shale

Techado soils  
Geomorphic position: Sideslopes on hills and ridges  
Parent material: Slope alluvium and colluvium over residuum derived from shale  
Slope: 5 to 25 percent  
Surface fragments: About 25 percent  
Depth to restrictive feature: 10 to 20 inches to bedrock (paralithic)  
Drainage class: Well drained  
Slowest permeability: About 0.06 in/hr (slow)  
Available water capacity: About 1.9 inches (very low)  
Shrink-swell potential: About 7.5 LEP (high)  
Flooding hazard: None  
Seasonal water table minimum depth: Greater than 6 feet  
Runoff class: Very high  
Calcium carbonate maximum: None  
Gypsum maximum: None  
Salinity maximum: About 2 mmhos/cm (nonsaline)  
Sodicity maximum: About 1 SAR (slightly sodic)  
Ecological site: Ponderosa Pine Forest  
Present native vegetation: Arizona fescue, Gambel’s oak, blue grama, bottlebrush squirreltail, buckwheat, mountainmahogany, mountain muhly, muttongrass, rabbitbrush  
Land capability (nonirrigated): 7s  
Conservation Tree/Shrub Group: 10

Typical Profile:  
A—0 to 3 inches; gravelly clay  
2C—3 to 13 inches; clay  
2Cr—13 inches; shale

Minor Components  
Zunalei and similar soils  
Composition: About 5 percent  
Slope: 2 to 8 percent

Depth to restrictive feature: None within 60 inches  
Drainage class: Well drained  
Ecological site: Ponderosa Pine Forest

Knifehill and similar soils  
Composition: About 5 percent  
Slope: 1 to 5 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Well drained  
Ecological site: Meadow

Shoemaker and similar soils  
Composition: About 5 percent  
Slope: 2 to 8 percent  
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)  
Drainage class: Moderately well drained  
Ecological site: Meadow

Stozuni and similar soils  
Composition: About 5 percent  
Slope: 2 to 8 percent  
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)  
Drainage class: Somewhat excessively drained  
Ecological site: Ponderosa Pine Forest

404—Rock outcrop-Techado-Stozuni complex, 5 to 60 percent slopes

Map Unit Setting  
Elevation: 6,600 to 8,000 feet (2,012 to 2,438 meters)  
Mean annual precipitation: 16 to 20 inches (406 to 508 millimeters)  
Mean annual air temperature: 40 to 45 degrees F (4.4 to 7.0 degrees C)  
Frost-free period: 90 to 110 days

Map Unit Composition  
Rock outcrop: 35 percent  
Techado and similar soils: 35 percent  
Stozuni and similar soils: 25 percent  
Minor components: 5 percent

Component Descriptions  
Rock outcrop  
Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale. Slopes range from about 5 to 15 percent on treads (structural benches) to almost vertical cliffs on the risers (escarpment face).
McKinley County Area, New Mexico

**Techado soils**

*Landform:* Sideslopes on hills and ridges, and escarpments on cuestas and mesas  
*Parent material:* Slope alluvium and colluvium over residuum derived from shale  
*Slope:* 5 to 60 percent  
*Surface fragments:* About 15 percent  
*Depth to restrictive feature:* 10 to 20 inches to bedrock (paralithic)  
*Drainage class:* Well drained  
*Slowest permeability:* .06 to 0.2 in/hr (slow)  
*Available water capacity:* About 0.7 inches (very low)  
*Shrink-swell potential:* About 7.5 percent (high)  
*Runoff class:* Very high  
*Calcium carbonate maximum:* None  
*Gypsum maximum:* None  
*Salinity maximum:* About 2 mmhos/cm (nonsaline)  
*Sodium adsorption ratio maximum:* About 1 (slightly sodic)  
*Ecological site:* Ponderosa Pine Forest  
*Potential native vegetation:*  
- Common trees: Rocky Mountain juniper, alligator juniper, twoneedle pinyon, Gambel oak, ponderosa pine, Douglas-fir  
- Other plants: Arizona fescue, Gambel oak, blue grama, bottlebrush squirreltail, buckwheat, mountainmahogany, mountain muhly, muttongrass, rabbitbrush  
*Land capability subclass (nonirrigated):* 7

**Typical Profile:**  
A—0 to 1 inch; gravelly sandy loam  
C1—1 inch to 7 inches; gravelly sandy loam  
C2—7 to 20 inches; weathered bedrock

**Stozuni soils**

*Landform:* Summits on hills and ridges and structural benches on escarpments  
*Parent material:* Eolian material and slope alluvium derived from sandstone  
*Slope:* 5 to 15 percent  
*Surface fragments:* About 25 percent  
*Depth to restrictive feature:* 5 to 20 inches to bedrock (lithic)  
*Drainage class:* Somewhat excessively drained  
*Slowest permeability:* 2.0 to 6.0 in/hr (moderately rapid)  
*Available water capacity:* About 0.7 inches (very low)  
*Shrink-swell potential:* About 1.5 percent (low)  
*Runoff class:* Medium  
*Calcium carbonate maximum:* About 1 percent  
*Gypsum maximum:* None  

**Salinity maximum:** About 0 mmhos/cm (nonsaline)  
**Sodium adsorption ratio maximum:** About 0 (nonsodic)  
**Ecological site:** Ponderosa Pine Forest  
**Potential native vegetation:**  
- Common trees: Rocky Mountain juniper, alligator juniper, twoneedle pinyon, Gambel oak, ponderosa pine, Douglas-fir  
- Other plants: Arizona fescue, Gambel oak, blue grama, bottlebrush squirreltail, buckwheat, mountainmahogany, mountain muhly, muttongrass, rabbitbrush  
*Land capability subclass (nonirrigated):* 7s

**Typical Profile:**  
A—0 to 1 inch; gravelly sandy loam  
C—1 inch to 7 inches; gravelly sandy loam  
R—7 to 20 inches; unweathered bedrock

**Minor Components**

Valnor and similar soils  
*Composition:* About 3 percent  
*Slope:* 2 to 15 percent  
*Depth to restrictive feature:* 20 to 40 inches to bedrock (paralithic)  
*Drainage class:* Well drained  
*Ecological site:* Ponderosa Pine Forest

Asaayi and similar soils  
*Composition:* About 2 percent  
*Slope:* 2 to 15 percent  
*Depth to restrictive feature:* 5 to 20 inches to bedrock (lithic)  
*Drainage class:* Well drained  
*Ecological site:* Ponderosa Pine Forest

**405—Fortwingate-Owlrock complex, 2 to 8 percent slopes**

**Map Unit Setting**

*MLRA:* 39  
*Elevation:* 7,200 to 8,200 feet (2,195 to 2,499 meters)  
*Mean annual precipitation:* 16 to 20 inches (406 to 508 millimeters)  
*Average annual air temperature:* 40 to 45 degrees F (4 to 7 degrees C)  
*Frost-free period:* 90 to 110 days

**Map Unit Composition**

Fortwingate and similar soils: 50 percent  
Owlrock and similar soils: 35 percent  
Minor components: 15 percent
Component Descriptions

Fortwingate soils

Geomorphic position: Dipslopes on cuestas
Parent material: Slope alluvium over residuum derived from sandstone, shale, and dolomitic limestone
Slope: 2 to 8 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)
Drainage class: Well drained
Slowest permeability: About 0.06 in/hr (slow)
Available water capacity: About 3.6 inches (low)
Shrink-swell potential: About 7.5 LEP (high)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Very high
Calcium carbonate maximum: None
Gypsum maximum: None
Salinity maximum: About 0 mmhos/cm (nonsaline)
Sodicity maximum: About 0 SAR (nonsodic)
Ecological site: Ponderosa Pine Forest
Present native vegetation: Arizona fescue, Gambel’s oak, Kentucky bluegrass, Rocky Mountain juniper, antelope bitterbrush, blue grama, bottlebrush squirreltail, mountain muhly, muttongrass, sideoats grama
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4C

Typical Profile:
OI—0 to 1 inches; slightly decomposed plant material
A—1 to 4 inches; loam
Bt—4 to 9 inches; clay loam
Btss—9 to 26 inches; clay
2R—26 inches; sandstone and limestone bedrock

Owlrock soils

Geomorphic position: Dipslopes on cuestas
Parent material: Residuum derived from dolomitic limestone
Slope: 2 to 8 percent
Surface fragments: About 55 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Slowest permeability: About 0.60 in/hr (moderate)
Available water capacity: About 1.7 inches (very low)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet

Runoff class: High
Calcium carbonate maximum: About 20 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 0 SAR (nonsodic)
Ecological site: Ponderosa Pine Forest
Present native vegetation: Arizona fescue, Gambel’s oak, Rocky Mountain juniper, barberry, blue grama, bottlebrush squirreltail, buckwheat, little bluestem, mountain muhly, muttongrass, sideoats grama
Land capability (nonirrigated): 7s
Conservation Tree/Shrub Group: 10

Minor Components

Rock outcrop
Composition: About 5 percent
Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

Asaayi and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Ponderosa Pine Forest

Osoridge and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Ponderosa Pine Forest

406—Polich silt loam, 0 to 3 percent slopes

Map Unit Setting

MLRA: 39
Elevation: 7,600 to 8,000 feet (2,316 to 2,438 meters)
Mean annual precipitation: 16 to 20 inches (406 to 508 millimeters)
Average annual air temperature: 40 to 45 degrees F (4 to 7 degrees C)
Frost-free period: 90 to 110 days
McKinley County Area, New Mexico

**Depth to restrictive feature:** 20 to 40 inches to bedrock (lithic)
**Drainage class:** Well drained
**Ecological site:** Ponderosa Pine Forest

Osoridge and similar soils
- **Composition:** About 2 percent
- **Slope:** 1 to 5 percent
- **Depth to restrictive feature:** 5 to 20 inches to bedrock (lithic)
- **Drainage class:** Well drained
- **Ecological site:** Ponderosa Pine Forest

414—Zunalei-Corzuni loamy fine sands, 2 to 10 percent slopes

**Map Unit Setting**
- **MLRA:** 39
- **Elevation:** 7,000 to 7,500 feet (2,134 to 2,286 meters)
- **Mean annual precipitation:** 16 to 20 inches (406 to 508 millimeters)
- **Average annual air temperature:** 45 to 48 degrees F (7 to 9 degrees C)
- **Frost-free period:** 90 to 110 days

**Map Unit Composition**
- Zunalei and similar soils: 50 percent
- Corzuni and similar soils: 40 percent
- Minor components: 10 percent

**Component Descriptions**

**Zunalei soils**
- **Geomorph position:** Fan remnants on valley sides and dipslopes on cuestas
- **Parent material:** Eolian material and fan alluvium derived from sandstone
- **Slope:** 2 to 10 percent
- **Depth to restrictive feature:** None within 60 inches
- **Drainage class:** Well drained
- **Slowest permeability:** About 0.60 in/hr (moderate)
- **Available water capacity:** About 8.4 inches (moderate)
- **Shrink-swell potential:** About 1.5 LEP (low)
- **Flooding hazard:** None
- **Seasonal water table minimum depth:** Greater than 6 feet
- **Runoff class:** Medium
- **Calcium carbonate maximum:** About 5 percent
- **Gypsum maximum:** None
- **Salinity maximum:** About 2 mmhos/cm (nonsaline)
- **Sodicity maximum:** About 0 SAR (nonsodic)
- **Ecological site:** Ponderosa Pine Forest
- **Present native vegetation:** blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, fringed sagewort, little bluestem, muttongrass, needlegrass, pine dropseed, prairie junegrass
- **Land capability (nonirrigated):** 6c
- **Conservation Tree/Shrub Group:** 4

**Typical Profile:**
- Oi—0 to 1 inches; slightly decomposed plant material
- A—0 to 1 inches; loamy fine sand
- AB—1 to 6 inches; fine sandy loam
- Bt1—6 to 20 inches; sandy clay loam
- Bt2—20 to 50 inches; fine sandy loam
- BCk—50 to 70 inches; fine sandy loam

**Corzuni soils**
- **Geomorph position:** Fan remnants on valley sides and dipslopes on cuestas
- **Parent material:** Eolian material and fan alluvium derived from sandstone
- **Slope:** 2 to 10 percent
- **Depth to restrictive feature:** None within 60 inches
- **Drainage class:** Somewhat excessively drained
- **Slowest permeability:** About 2.00 in/hr (moderately rapid)
- **Available water capacity:** About 7.9 inches (moderate)
- **Shrink-swell potential:** About 1.5 LEP (low)
- **Flooding hazard:** None
- **Seasonal water table minimum depth:** Greater than 6 feet
- **Runoff class:** Low
- **Calcium carbonate maximum:** About 5 percent
- **Gypsum maximum:** None
- **Salinity maximum:** About 2 mmhos/cm (nonsaline)
- **Sodicity maximum:** About 0 SAR (nonsodic)
- **Ecological site:** Ponderosa Pine Forest
- **Present native vegetation:** blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, fringed sagewort, little bluestem, muttongrass, needlegrass, pine dropseed, prairie junegrass
- **Land capability (nonirrigated):** 6c
- **Conservation Tree/Shrub Group:** 3

**Typical Profile:**
- Oi—0 to 1 inches; slightly decomposed plant material
- A—0 to 1 inches; loamy fine sand
- Bt1—6 to 20 inches; sandy clay loam
- Bt2—20 to 45 inches; fine sandy loam
- Bk—45 to 70 inches; fine sandy loam

**Minor Components**

Knifehill and similar soils
- **Composition:** About 5 percent
Slope: 1 to 5 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Well drained  
Ecological site: Meadow

Fikel and similar soils  
Composition: About 3 percent  
Slope: 2 to 10 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Well drained  
Ecological site: Meadow

Shoemaker and similar soils  
Composition: About 2 percent  
Slope: 2 to 8 percent  
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)  
Drainage class: Moderately well drained  
Ecological site: Ponderosa Pine Forest

415—Tsoodzil-Rubble land complex, 10 to 55 percent slopes

Map Unit Setting  
MLRA: 39  
Elevation: 7,600 to 9,000 feet (2,316 to 2,743 meters)  
Mean annual precipitation: 16 to 20 inches (406 to 508 millimeters)  
Average annual air temperature: 40 to 45 degrees F (4 to 7 degrees C)  
Frost-free period: 90 to 110 days

Map Unit Composition  
Tsoodzil and similar soils: 60 percent  
Rubble land: 20 percent  
Minor components: 20 percent

Component Descriptions  
Tsoodzil soils  
Geomorphic position: Escarpments on lava plateaus  
Parent material: Eolian material and slope alluvium derived from basalt  
Slope: 10 to 55 percent  
Surface fragments: About 45 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Well drained  
Slowest permeability: About 0.06 in/hr (slow)  
Available water capacity: About 8.0 inches (moderate)  
Shrink-swell potential: About 7.5 LEP (high)  
Flooding hazard: None

Seasonal water table minimum depth: Greater than 6 feet  
Runoff class: Very high  
Calcium carbonate maximum: About 2 percent  
Gypsum maximum: None  
Salinity maximum: About 2 mmhos/cm (nonsaline)  
Sodicity maximum: About 0 SAR (nonsodic)  
Ecological site: Ponderosa Pine Forest  
Present native vegetation: blue grama, broom snakeweed, little bluestem, muttongrass, pine dropseed  
Land capability (nonirrigated): 7e  
Conservation Tree/Shrub Group: 4C

Typical Profile:  
E—0 to 3 inches; very cobbly loam  
Bt—3 to 7 inches; clay loam  
Btss1—7 to 22 inches; gravelly clay  
Btss2—22 to 65 inches; clay

Rubble land  
Rubble land consists of areas of cobbles, stones, and boulders. Most areas are at the base of escarpments.

Slope: 0 to 200 percent  
Drainage class: Excessively drained  
Flooding hazard: None  
Seasonal water table minimum depth: Greater than 6 feet  
Runoff class: Low  
Conservation Tree/Shrub Group: 10

Minor Components  
Rock outcrop  
Composition: About 9 percent  
Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

Montillo and similar soils  
Composition: About 5 percent  
Slope: 10 to 15 percent  
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)  
Drainage class: Well drained  
Ecological site: Ponderosa Pine Forest

Canoneros and similar soils  
Composition: About 3 percent  
Slope: 2 to 6 percent  
Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)
Bluesky soils

**Landform:** Structural benches on escarpments

**Parent material:** Eolian material and slope alluvium derived from sandstone

**Slope:** 5 to 20 percent

**Depth to restrictive feature:** 5 to 20 inches to bedrock (lithic)

**Drainage class:** Excessively drained

**Slowest permeability:** Greater than 20 in/hr (very rapid)

**Available water capacity:** About 0.5 inches (very low)

**Shrink-swell potential:** About 1.5 percent (low)

**Runoff class:** Medium

**Calcium carbonate maximum:** None

**Gypsum maximum:** None

**Salinity maximum:** About 0 mmhos/cm (nonsaline)

**Sodium adsorption ratio maximum:** About 0 (nonsodic)

**Ecological site:** Ponderosa Pine Forest

**Potential native vegetation:**
- Common trees: Rocky Mountain juniper, Douglas-fir, twoneedle pinyon, ponderosa pine
- Other plants: Gambel oak, Indian ricegrass, blue grama, bottlebrush squirreltail, buckwheat, cliffrose, little bluestem, mountainmahogany, mountain muhly, muttongrass, pine dropseed, sideoats grama, yucca

**Land capability subclass (nonirrigated):** 8

**Typical Profile:**
- A—0 to 5 inches; fine sand
- C—5 to 8 inches; fine sand
- R—8 inches; sandstone bedrock

**Minor Components**

Stozuni and similar soils

**Composition:** About 5 percent

**Slope:** 5 to 8 percent

**Depth to restrictive feature:** 5 to 20 inches to bedrock (lithic)

**Drainage class:** Somewhat excessively drained

**Ecological site:** Ponderosa Pine Forest

Shoemaker and similar soils

**Composition:** About 3 percent

**Slope:** 5 to 8 percent

**Depth to restrictive feature:** 20 to 40 inches to bedrock (lithic)

**Drainage class:** Moderately well drained

**Ecological site:** Ponderosa Pine Forest

Royosa and similar soils

**Composition:** About 2 percent

**Slope:** 1 to 15 percent

**Drainage class:** Excessively drained

**Ecological site:** Sandy Plains

418—Asaayi-Osoridge complex, 2 to 15 percent slopes

**Map Unit Setting**

**MLRA:** 39

**Elevation:** 7,500 to 7,900 feet (2,286 to 2,408 meters)

**Mean annual precipitation:** 16 to 20 inches (406 to 508 millimeters)

**Average annual air temperature:** 40 to 45 degrees F (4 to 7 degrees C)

**Frost-free period:** 90 to 110 days

**Map Unit Composition**

Asaayi and similar soils: 40 percent

Osoridge and similar soils: 35 percent

Minor components: 25 percent

**Component Descriptions**

**Asaayi soils**

**Geomorphic position:** Dipslopes on cuestas

**Parent material:** Slope alluvium derived from sandstone and shale

**Slope:** 2 to 15 percent

**Surface fragments:** About 50 percent

**Depth to restrictive feature:** 5 to 20 inches to bedrock (lithic)

**Drainage class:** Well drained

**Slowest permeability:** About 0.20 in/hr (moderately slow)

**Available water capacity:** About 2.4 inches (very low)

**Shrink-swell potential:** About 4.5 LEP (moderate)

**Flooding hazard:** None

**Seasonal water table minimum depth:** Greater than 6 feet

**Runoff class:** High

**Calcium carbonate maximum:** None

**Gypsum maximum:** None

**Salinity maximum:** About 0 mmhos/cm (nonsaline)

**Sodicity maximum:** About 0 SAR (nonsodic)

**Ecological site:** Ponderosa Pine Forest

**Present native vegetation:** Gambel's oak, blue grama, bottlebrush squirreltail, buckwheat, cliffrose, little bluestem, mountainmahogany, mountain muhly, pine dropseed, sideoats grama

**Land capability (nonirrigated):** 7s

**Conservation Tree/Shrub Group:** 10
APPENDIX B

McKinley County Area, New Mexico

Osoridge soils

Geomorphic position: Dipslopes on cuestas
Parent material: Slope alluvium over residuum derived from sandstone and shale
Slope: 2 to 15 percent
Surface fragments: About 40 percent
Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Ponderosa Pine Forest

Rauster and similar soils

Composition: About 5 percent
Slope: 2 to 15 percent
Depth to restrictive feature: 40 to 60 inches to bedrock (paralithic)
Drainage class: Well drained
Ecological site: Ponderosa Pine Forest

419—Fortwingate-Cinnadale-Rock outcrop complex, 5 to 45 percent slopes

Map Unit Setting

MLRA: 39
Elevation: 7,200 to 8,200 feet (2,195 to 2,499 meters)
Mean annual precipitation: 16 to 20 inches (406 to 508 millimeters)
Average annual air temperature: 40 to 45 degrees F (4 to 7 degrees C)
Frost-free period: 90 to 110 days

Map Unit Composition

Fortwingate and similar soils: 35 percent
Cinnadale and similar soils: 30 percent
Rock outcrop: 20 percent
Minor components: 15 percent

Component Descriptions

Fortwingate soils

Geomorphic position: Sideslopes on hills, ridges, hogbacks and escarpments on cuestas
Parent material: Slope alluvium over residuum derived from sandstone and shale
Slope: 5 to 45 percent
Surface fragments: About 45 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Ponderosa Pine Forest

Cinnadale and similar soils

Composition: About 10 percent
Slope: 2 to 15 percent
Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Ponderosa Pine Forest

Minor Components

Fortwingate and similar soils

Composition: About 10 percent
Slope: 2 to 15 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Ponderosa Pine Forest

Fortwingate and similar soils

Composition: About 10 percent
Slope: 2 to 15 percent
Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Ponderosa Pine Forest

Cinnadale and similar soils

Composition: About 10 percent
Slope: 2 to 15 percent
Depth to restrictive feature: 10 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Ponderosa Pine Forest

Rauster and similar soils

Composition: About 5 percent
Slope: 2 to 15 percent
Depth to restrictive feature: 40 to 60 inches to bedrock (paralithic)
Drainage class: Well drained
Ecological site: Ponderosa Pine Forest

Ecological site: Ponderosa Pine Forest

Land capability (nonirrigated): 7s

Conservation Tree/Shrub Group: 10
Depth to restrictive feature: 20 to 40 inches to bedrock (paralithic)
Drainage class: Well drained
Ecological site: Pinyon-Juniper Forest

550—Bryway-Galzuni loams, 1 to 8 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,800 to 7,600 feet (2,073 to 2,316 meters)
Mean annual precipitation: 13 to 16 inches (330 to 406 millimeters)
Average annual air temperature: 46 to 49 degrees F (8 to 9 degrees C)
Frost-free period: 100 to 135 days

Map Unit Composition
Bryway and similar soils: 50 percent
Galzuni and similar soils: 35 percent
Minor components: 15 percent

Component Descriptions

Bryway soils
Geomorphic position: Sideslopes on hills, dipslopes on cuestas, and summits on mesas
Parent material: Slope alluvium over residuum derived from shale and sandstone
Slope: 2 to 8 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (paralithic)
Drainage class: Well drained
Slowest permeability: About 0.06 in/hr (slow)
Available water capacity: About 4.8 inches (low)
Shrink-swell potential: About 4.5 LEP (moderate)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: High
Calcareous maximum: About 5 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 2 SAR (slightly sodic)
Ecological site: Clayey
Present native vegetation: western wheatgrass, needleandthread, winterfat, Indian ricegrass, big sagebrush, blue grama, bottlebrush squirreltail, galleta, pingue hymenoxys, rabbitbrush, spineless horsebrush
Land capability (irrigated): 4e
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4C

Typical Profile:
A—0 to 2 inches; loam
Bt1—2 to 4 inches; clay
Bt2—4 to 23 inches; clay
Btk—23 to 32 inches; clay loam
Bk1—32 to 52 inches; sandy clay
Bk2—52 to 65 inches; sandy clay loam

Galzuni soils
Geomorphic position: Sideslopes on hills, dipslopes on cuestas, and summits on mesas
Parent material: Eolian material and slope alluvium derived from shale and sandstone
Slope: 1 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Slowest permeability: About 0.06 in/hr (slow)
Available water capacity: About 9.6 inches (high)
Shrink-swell potential: About 4.5 LEP (moderate)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: High
Calcareous maximum: About 5 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 2 SAR (slightly sodic)
Ecological site: Clayey
Present native vegetation: western wheatgrass, needleandthread, winterfat, Indian ricegrass, big sagebrush, blue grama, bottlebrush squirreltail, galleta, pingue hymenoxys, rabbitbrush, spineless horsebrush
Land capability (irrigated): 4e
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4C

Typical Profile:
A—0 to 2 inches; loam
Bt—2 to 6 inches; clay
Btk—6 to 32 inches; clay
2Cr—32 inches; shale

Minor Components

Highdye and similar soils
Composition: About 6 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained  
Ecological site: Pinyon-Juniper Forest

Evpark and similar soils  
Composition: About 5 percent  
Slope: 2 to 8 percent  
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)  
Drainage class: Well drained  
Ecological site: Pinyon-Juniper Forest

Parkelei and similar soils  
Composition: About 5 percent  
Slope: 2 to 8 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Well drained  
Ecological site: Pinyon-Juniper Forest

Parkelei-Evpark fine sandy loams, 2 to 8 percent slopes

Map Unit Setting  
MLRA: 36  
Elevation: 6,800 to 8,000 feet (2,073 to 2,438 meters)  
Mean annual precipitation: 13 to 16 inches (330 to 406 millimeters)  
Average annual air temperature: 46 to 49 degrees F (8 to 9 degrees C)  
Frost-free period: 100 to 135 days

Map Unit Composition  
Parkelei and similar soils: 45 percent  
Evpark and similar soils: 35 percent  
Minor components: 20 percent

Component Descriptions  
Parkelei soils  
Geomorphic position: Sideslopes on ridges, dipslopes on cuestas, and summits on mesas  
Parent material: Eolian material and slope alluvium derived from sandstone and shale  
Slope: 2 to 8 percent  
Depth to restrictive feature: None within 60 inches  
Drainage class: Well drained  
Slowest permeability: About 0.20 in/hr (moderately slow)  
Available water capacity: About 8.1 inches (moderate)  
Shrink-swell potential: About 1.5 LEP (low)  
Flooding hazard: None  
Seasonal water table minimum depth: Greater than 6 feet  
Runoff class: High  
Calcium carbonate maximum: About 5 percent  
Gypsum maximum: None  
Salinity maximum: About 2 mmhos/cm (nonsaline)  
Sodicity maximum: About 1 SAR (slightly sodic)  
Ecological site: Pinyon-Juniper Forest  
Present native vegetation: Gambel’s oak, antelope bitterbrush, banana yucca, big sagebrush, blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, muttontailgrass, oneseed juniper, prairie junegrass, twoneedle pinyon, western wheatgrass  
Land capability (nonirrigated): 6c  
Conservation Tree/Shrub Group: 4

Typical Profile:  
A—0 to 3 inches; fine sandy loam  
Bt1—3 to 12 inches; clay loam  
Bt2—12 to 21 inches; sandy clay loam  
Bk—21 to 65 inches; sandy loam

Evpark soils  
Geomorphic position: Sideslopes and summits on ridges, dipslopes on cuestas, and summits on mesas  
Parent material: Eolian material and slope alluvium derived from sandstone and shale  
Slope: 2 to 8 percent  
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)  
Drainage class: Well drained  
Slowest permeability: About 0.20 in/hr (moderately slow)  
Available water capacity: About 6.1 inches (moderate)  
Shrink-swell potential: About 4.5 LEP (moderate)  
Flooding hazard: None  
Seasonal water table minimum depth: Greater than 6 feet  
Runoff class: High  
Calcium carbonate maximum: About 10 percent  
Gypsum maximum: None  
Salinity maximum: About 2 mmhos/cm (nonsaline)  
Sodicity maximum: About 1 SAR (slightly sodic)  
Ecological site: Pinyon-Juniper Forest  
Present native vegetation: Gambel’s oak, antelope bitterbrush, banana yucca, big sagebrush, blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, muttontailgrass, oneseed juniper, prairie junegrass, twoneedle pinyon, western wheatgrass  
Land capability (nonirrigated): 6c  
Conservation Tree/Shrub Group: 6D

Typical Profile:  
A—0 to 3 inches; fine sandy loam  
Bt1—3 to 16 inches; clay loam
Bt2—16 to 20 inches; clay loam
Bt3—20 to 29 inches; sandy clay loam
Btk—29 to 35 inches; sandy clay loam
2R—35 inches; sandstone bedrock

Minor Components

Arabrab and similar soils
Composition: About 10 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Pinyon-Juniper Forest

Highdye and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Pinyon-Juniper Forest

Bryway and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (paralithic)
Drainage class: Well drained
Ecological site: Pinyon-Juniper Forest

560—Flugle-Teczuni complex, 1 to 5 percent slopes

Map Unit Setting

MLRA: 36
Elevation: 6,800 to 7,200 feet (2,073 to 2,195 meters)
Mean annual precipitation: 13 to 14 inches (330 to 356 millimeters)
Average annual air temperature: 49 to 53 degrees F (9 to 12 degrees C)
Frost-free period: 115 to 135 days

Map Unit Composition

Flugle and similar soils: 45 percent
Teczuni and similar soils: 35 percent
Minor components: 20 percent

Component Descriptions

Flugle soils

Geomorphic position: Sideslopes on hills, fan remnants on valley sides, and dipslopes on cuestas

Parent material: Eolian material and fan and slope alluvium derived from sandstone and shale
Slope: 1 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Slowest permeability: About 0.60 in/hr (moderate)
Available water capacity: About 8.6 inches (moderate)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Low
Calcium carbonate maximum: About 15 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 1 SAR (slightly sodic)
Ecological site: Loamy
Present native vegetation: blue grama, bottlebrush squirreltail, western wheatgrass, Indian ricegrass, needleandthread, winterfat, fringed sagewort, broom snakeweed, oneseed juniper, rabbitbrush, spineless horsebrush, twoneedle pinyon
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4

Teczuni soils

Geomorphic position: Sideslopes on hills, fan remnants on valley sides, and dipslopes on cuestas

Parent material: Eolian material and fan and slope alluvium derived from sandstone and shale
Slope: 1 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Slowest permeability: About 0.06 in/hr (slow)
Available water capacity: About 10.5 inches (high)
Shrink-swell potential: About 4.5 LEP (moderate)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Medium
Calcium carbonate maximum: About 30 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 2 SAR (slightly sodic)
Ecological site: Loamy
Present native vegetation: blue grama, bottlebrush squirreltail, western wheatgrass, Indian ricegrass, needleandthread, winterfat, fringed sagewort,
broom snakeweed, rabbitbrush, spineless horsebrush, twoneedle pinyon

Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4C

Typical Profile:
A—0 to 2 inches; loam
Bt—2 to 16 inches; clay loam
Btk—16 to 33 inches; clay loam
Bk—33 to 65 inches; clay

Minor Components
Fragua and similar soils
Composition: About 10 percent
Slope: 1 to 5 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Somewhat excessively drained
Ecological site: Sandy Slopes

Atarque and similar soils
Composition: About 5 percent
Slope: 1 to 5 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Shallow Sandstone

Celavar and similar soils
Composition: About 5 percent
Slope: 1 to 5 percent
Depth to restrictive feature: 20 to 40 inches to bedrock (lithic)
Drainage class: Well drained
Ecological site: Savannah

561—Flugle-Plumasano association, 2 to 8 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,200 to 7,200 feet (1,890 to 2,195 meters)
Mean annual precipitation: 13 to 14 inches (330 to 356 millimeters)
Average annual air temperature: 49 to 53 degrees F (9 to 12 degrees C)
Frost-free period: 115 to 135 days

Map Unit Composition
Flugle and similar soils: 50 percent
Plumasano and similar soils: 40 percent
Minor components: 10 percent

Component Descriptions

Flugle soils
Geomorphic position: Dipslopes on cuestas, sideslopes on ridges, and fan remnants on valley sides
Parent material: Eolian material and fan and slope alluvium derived from sandstone and shale
Slope: 2 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Slowest permeability: About 0.60 in/hr (moderate)
Available water capacity: About 8.4 inches (moderate)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Medium
Calcium carbonate maximum: About 10 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 1 SAR (slightly sodic)
Ecological site: Pinyon-Juniper Forest
Present native vegetation: Indian ricegrass, antelope bitterbrush, blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, cliffrose, galleta, muttongrass, oneseed juniper, sand dropseed, spineless horsebrush, threawn, twoneedle pinyon, yucca
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 4

Typical Profile:
A—0 to 3 inches; fine sandy loam
Bt—3 to 17 inches; sandy clay loam
Bk—17 to 65 inches; fine sandy loam

Plumasano soils
Geomorphic position: Dipslopes on cuestas, sideslopes on ridges
Parent material: Eolian material and slope alluvium derived from sandstone
Slope: 2 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Somewhat excessively drained
Slowest permeability: About 0.60 in/hr (moderate)
Available water capacity: About 7.8 inches (moderate)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Low
Calcium carbonate maximum: About 15 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 0 SAR (nonsodic)
Ecological site: Pinyon-Juniper Forest
Present native vegetation: Bigelow’s sagebrush, Indian ricegrass, antelope bitterbrush, blue grama, cliffrose, galleta, muttongrass, oneseed juniper, rabbitbrush, ring muhly, sand dropseed, sideoats grama, twoneedle pinyon, yucca
Land capability (nonirrigated): 6c
Conservation Tree/Shrub Group: 5

Typical Profile:
A—0 to 2 inches; sandy loam
Bw—2 to 11 inches; sandy loam
Bk1—11 to 27 inches; sandy loam
Bk2—27 to 43 inches; fine sandy loam
Bk3—43 to 53 inches; fine sandy loam
Bk4—53 to 65 inches; sandy clay loam

Minor Components
Royosa and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Excessively drained
Ecological site: Sandy Slopes

Rizno and similar soils
Composition: About 3 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (lithic)
Drainage class: Somewhat excessively drained
Ecological site: Shallow Sandstone

Tekapo and similar soils
Composition: About 2 percent
Slope: 2 to 8 percent
Depth to restrictive feature: 5 to 20 inches to bedrock (paralithic)
Drainage class: Well drained
Ecological site: Shale Hills

565—Plumasano-Rock outcrop complex, 15 to 40 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,500 to 7,200 feet (1,981 to 2,195 meters)
Mean annual precipitation: 13 to 14 inches (330 to 356 millimeters)

Average annual air temperature: 49 to 53 degrees F (9 to 12 degrees C)
Frost-free period: 115 to 135 days

Map Unit Composition
Plumasano and similar soils: 65 percent
Rock outcrop: 20 percent
Minor components: 15 percent

Component Descriptions

Plumasano soils

Geomorphic position: Sideslopes on ridges and escarpments on plateaus and cuestas
Parent material: Eolian material and slope alluvium derived from sandstone
Slope: 15 to 40 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Somewhat excessively drained
Slowest permeability: About 2.00 in/hr (moderately rapid)
Available water capacity: About 6.5 inches (moderate)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Medium
Calcium carbonate maximum: About 15 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: None
Ecological site: Sandy Slopes
Present native vegetation: blue grama, galleta, sand dropseed, Indian ricegrass, antelope bitterbrush, cliffrose, muttongrass, oneseed juniper, rabbitbrush, ring muhly, sideoats grama, twoneedle pinyon, yucca
Land capability (nonirrigated): 7e
Conservation Tree/Shrub Group: 5

Minor Components

Rizno and similar soils
Composition: About 5 percent
Slope: 2 to 8 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Excessively drained
Ecological site: Sandy Slopes

Rock outcrop

Rock outcrop consists of barren or nearly barren areas of exposed sandstone and shale on ridges, ledges, and escarpments.

Minor Components

Rizno and similar soils
Composition: About 5 percent
McKinley County Area, New Mexico

Slope: 5 to 10 percent
Depth to restrictive feature: 5 to 10 percent
Depth to bedrock (lithic)
Drainage class: Somewhat excessively drained
Ecological site: Shallow Sandstone

Teczuni and similar soils
Composition: About 5 percent
Slope: 5 to 10 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Loamy

Flugle and similar soils
Composition: About 5 percent
Slope: 5 to 10 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Loamy

566—Bamac extremely gravelly sandy loam, 5 to 50 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,200 to 6,500 feet (1,890 to 1,981 meters)
Mean annual precipitation: 13 to 14 inches (330 to 356 millimeters)
Average annual air temperature: 49 to 53 degrees F (9 to 12 degrees C)
Frost-free period: 115 to 135 days

Map Unit Composition
Bamac and similar soils: 90 percent
Minor components: 10 percent

Component Descriptions

Bamac soils
Geomorphic position: Hills and ridges
Parent material: Slope alluvium derived from sandstone and conglomerate
Slope: 5 to 50 percent
Surface fragments: About 70 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Excessively drained
Slowest permeability: About 5.95 in/hr (very rapid)
Available water capacity: About 1.6 inches (very low)
Shrink-swell potential: About 1.5 LEP (low)
Flooding hazard: None
Seasonal water table minimum depth: Greater than 6 feet
Runoff class: Medium
Calcium carbonate maximum: About 15 percent
Gypsum maximum: None
Salinity maximum: About 2 mmhos/cm (nonsaline)
Sodicity maximum: About 0 SAR (nonsodic)
Ecological site: Gravelly
Present native vegetation: sideoats grama, black grama, galleta, Indian ricegrass, New Mexico feathergrass, antelope bitterbrush, blue grama, muttongrass, Bigelow's sagebrush, Mormon tea, oneseed juniper, twoneedle pinyon
Land capability (nonirrigated): 8
Conservation Tree/Shrub Group: 10

Minor Components
Plumasano and similar soils
Composition: About 5 percent
Slope: 5 to 40 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Well drained
Ecological site: Sandy Slopes

Royosa and similar soils
Composition: About 5 percent
Slope: 5 to 10 percent
Depth to restrictive feature: None within 60 inches
Drainage class: Excessively drained
Ecological site: Sandy Plains

575—Ramah-Pescado association, 1 to 8 percent slopes

Map Unit Setting
MLRA: 36
Elevation: 6,400 to 7,000 feet (1,951 to 2,134 meters)
Mean annual precipitation: 13 to 14 inches (330 to 356 millimeters)
Average annual air temperature: 46 to 49 degrees F (8 to 9 degrees C)
Frost-free period: 100 to 135 days

Map Unit Composition
Ramah and similar soils: 45 percent
Pescado and similar soils: 35 percent
Minor components: 20 percent
APPENDIX C

EXCERPTS FROM FINAL REMEDIAL INVESTIGATION/FEASIBILITY STUDY & RCRA CORRECTIVE ACTION PROGRAM DOCUMENT (ERM, 1997)
Three sediment samples were collected in the arroyo located immediately east (downgradient) of the Current Landfill. No VOCs, explosives, or pesticides were detected, and no nitrate/nitrite or total phosphorus were detected at concentrations above background levels in the sediment samples. Five metals were detected above background levels in the three sediment samples. Two metals (arsenic and iron) exceeded screening levels (arsenic in samples WSE11 and WSE12 and iron in sample WSE13).

Site Screening Evaluation - Current Landfill

The number of constituents detected in the samples collected at the Current Landfill that exceeded background and screening levels is shown in Table 7-68.

The presence of arsenic in exceedance of the screening level in the subsurface soil samples will be evaluated further for human health-based risks. The presence of arsenic and iron in exceedance of screening levels in the dry sediment samples will also be evaluated further for human health-based risks.

7.5.2 Old Landfill

Site Background

Based on previous information (M&E, 1992b), the Old Landfill was reportedly located near the water tower to the west of the Administration Area (Figure 2-2, Appendix A). Prior to 1968, the Old Landfill was used for the routine burial of garbage, trash, and debris generated at FWDA. In addition, solid waste was burned, and pesticide containers and ACM were reportedly disposed of. In 1968, the Old Landfill was covered by a layer of soil.

Previous Investigation

No prior sampling was performed at the Old Landfill area.

Current Investigation

The objectives of the current investigation were to accurately locate the landfill, to determine whether landfill gas is being emitted, and to evaluate whether subsurface soils have been impacted by landfiling operations or leachate migration to the north. The data collected were used to conduct a BRA.

Based on interviews with FWDA personnel conducted in the fall of 1992, the Old Landfill was suspected to be located approximately 1 mile to the
northeast of the water tower. Aerial photographs taken in 1962 identified access roads and disturbed ground in this area. A visible inspection of the area identified scrap metal, concrete rubble, and cinder piles on the ground surface. The debris-laden area is approximately 500 feet by 750 feet in size. This area was re-interpreted as the site of the Old Landfill and targeted for further investigation. The investigation included a geophysical survey and collection of subsurface soil samples.

Geophysical Survey

To determine whether an abandoned landfill was located adjacent to the water tower, limited geophysical surveys were performed in this area. An EM31 sweep was conducted by monitoring the in-phase and electromagnetic conductivity as the instrument operator traversed parallel lines. GPR lines were also completed to determine whether non-metallic/non-electrically conductive objects were buried in this region. The integrated geophysical surveys did not detect any anomalous region that would indicate that past land filling activities may have occurred at the inferred landfill location near the water tower.

To investigate the newly-identified former landfill area located approximately one mile to the northeast of the water tower, the following geophysical surveys were performed in this area (hereinafter referred to as the Old Landfill).

Electromagnetic Conductivity Data

Plan contour maps of the apparent conductivity and in-phase EM data collected at the Old Landfill are presented in Figures 7-67 and 7-68, respectively. The terrain conductivity data range from -10.4 to 72.6 mS/m and the in-phase data range from -2.01 to 8.75 ppt. As was noted in the Current Landfill geophysical data interpretations, the geophysical trends observed in the EM data seem to be more the result of geology and topography rather than the presence of landfill materials. A geo-electrical contrast between indigenous materials and landfill materials may not exist because of the semi-arid climate of the area and the relatively sandy materials. The increased terrain conductivity observed in the southeastern portion of the survey area corresponds to alluvial fill, and consequently might be the result of increased clay content in these soils. The EM survey was extended eastward into the alluvial fill and confirmed this interpretation.

Magnetic Data

The total field and vertical magnetic gradient ranged from 51,108 to 52,474 gammas and -272 to 465 gammas per meter, respectively. The magnetic
Figure 7-68
In-Phase EM Map
Old Landfill
Fort Wingate Depot Activity
Gallup, New Mexico
data contour maps (Figure 7-69, total field intensity; Figure 7-70, gradient) show linear, northwest trending features in the northeastern portion of the survey area. Similar, less pronounced, northwest-trending magnetic anomalies are depicted approximately 200 feet southwest of the northern anomaly. Because the trend of these anomalies is consistent with local geologic strike, these anomalies are considered to be due to bedrock features. Specifically, these zones probably contain higher quantities of ferromagnetic minerals.

**Soil Gas Survey**

A total of 38 soil gas samples were collected on the 50- by 50-foot grid established for the geophysical survey. Methane concentrations ranged from below the detection limit to 5 μg/g (see Table 7-69). Hydrogen sulfide gas was not detected in any of the 38 soil gas sampling locations.

The relatively low methane concentrations and absence of hydrogen sulfide at the Old Landfill suggest that landfill gas is not being produced in significant concentrations. Possible explanations for the absence of landfill gas at this location may be a lack of organic material, the semi-arid climate at FWDA, or a combination of these factors.

**Subsurface Soil Samples**

Three soil borings designated OLF01, OLF02, and OLF03 were drilled in downgradient locations to the west, north, and east, respectively, of the suspected Old Landfill (Figure 7-71). Each of the soil borings was advanced to a depth of 20 feet bgs.

Three soil samples were collected from each boring at depth intervals of 0 to 1 foot bgs, 8 to 10 feet bgs, and 18 to 20 feet bgs. Nine subsurface soil samples were collected and analyzed for TCL VOCs, TCL SVOCs, pesticides, PCBs, and TAL metals.

**Subsurface Soil Sample TCL VOC Results**

No VOCs were detected in the subsurface soil samples.

**Subsurface Soil Sample TCL SVOC Results**

No SVOCs were detected in the subsurface soil samples.

**Subsurface Soil Sample Pesticides Results**

No pesticides were detected in the subsurface soil samples.
Figure 7-69
Total Magnetic Field Map
Old Landfill
Fort Wingate Depot Activity
Gallup, New Mexico
Figure 7-70
Vertical Magnetic Gradient Map
Old Landfill
Fort Wingate Depot Activity
Gallup, New Mexico

Gradient (gammas/m)

Scale 1:1200

200 E 250 E 300 E 350 E 400 E 450 E 500 E 550 E 600 E 650 E 700 E 750 E 800 E 850 E

0 50 100 150 200 250
(Feet)

DEVELOPED BY, CHECKED BY, DATE/REV.
### Table 7-69
**Soil Gas Survey Results**  
**Old Landfill**  
**Fort Wingate Depot Activity**  
**Gallup, New Mexico**

<table>
<thead>
<tr>
<th>Station</th>
<th>Methane (ppm)</th>
<th>Hydrogen Sulfide (ppm)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>425N</td>
<td>200E</td>
<td>NA</td>
<td>Drill rejected at 2 feet.</td>
</tr>
<tr>
<td>325N</td>
<td>200E</td>
<td>NA</td>
<td>Drill rejected at 2.2 feet.</td>
</tr>
<tr>
<td>225N</td>
<td>300E</td>
<td>0.4</td>
<td>Drill rejected at 1.5 feet. Zeroed both before sampling.</td>
</tr>
<tr>
<td>325N</td>
<td>300E</td>
<td>ND</td>
<td>Refusal at 2.5 feet.</td>
</tr>
<tr>
<td>425N</td>
<td>300E</td>
<td>0.05</td>
<td>Refusal at 2.5 feet.</td>
</tr>
<tr>
<td>125N</td>
<td>300E</td>
<td>0.5</td>
<td>Refusal at 2.5 feet.</td>
</tr>
<tr>
<td>25N</td>
<td>300E</td>
<td>0.5</td>
<td>ND</td>
</tr>
<tr>
<td>75N</td>
<td>300E</td>
<td>4.2</td>
<td>ND</td>
</tr>
<tr>
<td>75N</td>
<td>400E</td>
<td>1.0</td>
<td>ND</td>
</tr>
<tr>
<td>25N</td>
<td>400E</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>125N</td>
<td>400E</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>325N</td>
<td>400E</td>
<td>1.0</td>
<td>Refusal at 2.75 feet.</td>
</tr>
<tr>
<td>325N</td>
<td>500E</td>
<td>1.6</td>
<td>Refusal at 2.5 feet.</td>
</tr>
<tr>
<td>225N</td>
<td>500E</td>
<td>2.0</td>
<td>Refusal at 2.5 feet. High wind.</td>
</tr>
<tr>
<td>125N</td>
<td>500E</td>
<td>0.4</td>
<td>ND</td>
</tr>
<tr>
<td>25N</td>
<td>500E</td>
<td>3.2</td>
<td>ND</td>
</tr>
<tr>
<td>75N</td>
<td>500E</td>
<td>ND</td>
<td>Refusal at 2.5 feet.</td>
</tr>
<tr>
<td>175N</td>
<td>500E</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>175N</td>
<td>400E</td>
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<td>ND</td>
</tr>
<tr>
<td>175N</td>
<td>300E</td>
<td>0.6</td>
<td>ND</td>
</tr>
<tr>
<td>275N</td>
<td>400E</td>
<td>ND</td>
<td>Refusal at 2.5 feet.</td>
</tr>
<tr>
<td>325N</td>
<td>600E</td>
<td>ND</td>
<td>Refusal at 1 foot.</td>
</tr>
<tr>
<td>225N</td>
<td>600E</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>125N</td>
<td>600E</td>
<td>ND</td>
<td>Refusal at 2 feet.</td>
</tr>
<tr>
<td>25N</td>
<td>600E</td>
<td>ND</td>
<td>Refusal at 2 feet.</td>
</tr>
<tr>
<td>75N</td>
<td>600E</td>
<td>ND</td>
<td>Refusal at 2 feet.</td>
</tr>
<tr>
<td>75N</td>
<td>700E</td>
<td>ND</td>
<td>Refusal at 2 feet.</td>
</tr>
<tr>
<td>25N</td>
<td>700E</td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td>125N</td>
<td>700E</td>
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</tr>
<tr>
<td>225N</td>
<td>700E</td>
<td>5.0</td>
<td>ND</td>
</tr>
<tr>
<td>325N</td>
<td>700E</td>
<td>4.0</td>
<td>Refusal at 2.5 feet.</td>
</tr>
<tr>
<td>425N</td>
<td>700E</td>
<td>ND</td>
<td>Refusal at 2.5 feet.</td>
</tr>
</tbody>
</table>

**NA** - Sample not analyzed.  
**ND** - Not detected.
Figure 7-71
Sample Locations
Old Landfill
Fort Wingate Depot Activity
Gallup, New Mexico

Legend

 Soil Boring Location

Scale in Feet

DEVELOPED BY: M.J.S.
CHECKED BY: S.J.E. DATE: 1/24/94
Subsurface Soil Sample PCB Results

No PCBs were detected in the subsurface soil samples.

Subsurface Soil Sample TAL Metals Results

Mercury was detected at concentrations above the background level in five of the nine subsurface soil samples collected (Table 7-70). Mercury concentrations ranged from a maximum concentration of 0.108 μg/g in OLF01 (0 to 1 foot) to a minimum concentration of 0.0578 μg/g in OLF01 (18 feet to 20 feet). Mercury was detected in the 0- to 1-foot sample interval in borings OLF02 and OLF03, and in each of the three sample intervals in boring OLF01, located west of the Old Landfill, at decreasing concentrations with depth. Barium was detected in sample OLF02-10 (542 μg/g), exceeding the background level of 484 μg/g (Table 7-70). Lead was detected in sample OLF03-1 (17.1 μg/g), exceeding the background level (16.4 μg/g) (Table 7-70).

Summary of Results

Based on available evidence, the location of the Old Landfill was reinterpreted to be approximately one mile to the northeast of the water tower. A geophysical survey was conducted in this area and in the former location identified by M&E (M&E, 1992b). The geophysical survey identified the approximate extent of the fill area. A soil gas survey was conducted in the newly identified landfill area and demonstrated the presence of relatively low methane concentrations. The absence of hydrogen sulfide at the Old Landfill suggest that landfill gas is not being produced in significant concentrations.

A total of nine subsurface soil samples were collected from three soil borings located downgradient of the landfill.

No VOCs, SVOCs, pesticides, or PCBs were detected in the subsurface soil samples. Mercury was detected at concentrations above the background level in five subsurface soil samples. Barium and lead were each detected in one subsurface soil sample at concentrations exceeding background levels.

Site Screening Evaluation

The number of constituents detected in the samples collected at the Old Landfill that exceeded background levels is shown in Table 7-71.

The positive detections of lead in the surface soil samples will be evaluated further for human health-based risks.
### Table 7-70
**Detected Target Parameters**
**Subsurface Soil Samples**
**Old Landfill**
**Fort Wingate Depot Activity**
**Gallup, New Mexico**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sample Type</th>
<th>Sample Depth (feet)</th>
<th>Sample Date</th>
<th>Units</th>
<th>Lab</th>
<th>CRL or CRQL</th>
<th>Method/Screening</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>CRQL</td>
</tr>
</tbody>
</table>

**Tal Metals**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sample Type</th>
<th>Sample Depth (feet)</th>
<th>Sample Date</th>
<th>Units</th>
<th>Lab</th>
<th>CRL or CRQL</th>
<th>Method/Screening</th>
<th>Levels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manganese</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
<td>SUBSURFACE SOIL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SUBSURFACE SOIL</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>SUBSURFACE SOIL</td>
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<td></td>
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<tr>
<td></td>
<td>SUBSURFACE SOIL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- UG: Uncertified
- G: Screening Limit
- L: Lower Report Limit
- M: Median
- UB: Upper Reporting Limit
- VM: Value More

**Key:** {} = Data Qualifiers  () = Flag Codes  CRL = Certified Reporting Limit  CRQL = Contract Required Quantitation Limit  ES:QST Labs  ET:EA Labs  UB:DataChem Labs  * = Exceeds Screening Level  > = Greater than Upper Reporting Limit  N/A = Not Available
### TABLE 7-70
DETECTED TARGET PARAMETERS
SUBSURFACE SOIL SAMPLES
OLD LANDFILL
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Sample ID</th>
<th>Sample Type</th>
<th>Sample Depth (feet)</th>
<th>Sample Date</th>
<th>Method/ Units</th>
<th>Lab</th>
<th>CRL or CRQL</th>
<th>05/17/93</th>
<th>05/17/93</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>OLF02-10</td>
<td>SUBSURFACE SOIL</td>
<td>0</td>
<td>10.0</td>
<td>UG</td>
<td>JS21</td>
<td>0.467</td>
<td>17.1</td>
<td>17.1</td>
</tr>
<tr>
<td>Barium</td>
<td>OLF03-1</td>
<td>SUBSURFACE SOIL</td>
<td>0</td>
<td>1.0</td>
<td>UG</td>
<td>JS12</td>
<td>3.29</td>
<td>542.0</td>
<td>542.0</td>
</tr>
<tr>
<td>Mercury</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td>UG</td>
<td>Y9</td>
<td>0.05</td>
<td>0.0828</td>
<td>0.0828</td>
</tr>
</tbody>
</table>

#### KEY:
- [:Data Qualifiers:](#)
- [:Flag Codes:](#)
- [:Certified Reporting Limit:](#)
- [:Contract Required Quantitation Limit:](#)
- [:Exceeds Screening Level:](#)
- [:Greater than Upper Reporting Limit:](#)
- [:Not Available:](#)

Key: | Data Qualifiers: | Flag Codes: | Certified Reporting Limit: | Contract Required Quantitation Limit: | Exceeds Screening Level: | Greater than Upper Reporting Limit: | Not Available: |
---|------------------|--------------|----------------------------|-------------------------------------|-------------------------|------------------------------------|---------------|
### Table 7-71
**Summary of Screening Evaluation**

**Old Landfill**  
**Fort Wingate Depot Activity**  
**Gallup, New Mexico**

<table>
<thead>
<tr>
<th>Compound Name</th>
<th>Media Type</th>
<th>Number of Samples</th>
<th>Number of Detections</th>
<th>Number of Hits Above Background</th>
<th>Number of Hits Above Screening Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barium</td>
<td>Soil</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Lead</td>
<td>Soil</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Manganese</td>
<td>Soil</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Mercury</td>
<td>Soil</td>
<td>9</td>
<td>5</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

Note: Field duplicate samples were considered in the sample count.
APPENDIX D

EXcerpts from Eastern Landfill Delineation release Assessments Project (TTNUS, 2000)
Eastern Landfill Delineation
Release Assessments Project

Fort Wingate Depot Activity
Gallup, New Mexico

Contract No. DACA63-97-D-0030; D.O. No. 0018
Tetra Tech NUS Project No. 158C

Prepared for:
US Army Corps
of Engineers
Fort Worth District

Prepared by:
Tetra Tech NUS, Inc.
Houston, Texas
4.0 SITE INVESTIGATION RESULTS

4.1 Discussion of Geophysical Results

The geophysical results indicated that there were ten (10) anomalies (A1 through A10), see Figure 4.1-1 and Figure 4.1-2, that required further investigation either by visual or physical means. The anomalies located near the intersection of 800N and 300E and the intersection of 600N and 1000E were identified to be due to lithologic influences, which is indicated by the broad intermediate response. This could also be due to the drainage patterns in the area concentrating moisture in these two (2) anomalies A1 and A2. The other eight (8) anomalies are large and abrupt, resembling man-made features see Figure 4.1-3. Ten (10) locations were excavated and the results confirmed the presence of landfill material in four out of ten (10) anomalies, see Figure 4.1-4. Detailed descriptions of the excavations are provided in Section 4.2.

The anomalies A3 through A5 are interpreted as surface burn material with no underlying buried material indicating a landfill cell, see also Figure 4.1-5. A6 and A7 resemble isolated scrap metal. The last anomalies A8 through A10 are long linear features that are parallel to one another and are interpreted as landfill trenches. The anomalies also coincide with minor topographic lows consistent with man-made feature (landfill trench). A8 is the largest anomaly consisting of two linear features that are in close proximity and are considered as potentially one cell.

The Eastern Landfill Hillside area was surveyed using the magnetic locator and the G-858. The terrain in the hillside area was highly variable from steep to flat over short linear distances. The hillside soil was dominantly gravel and sand with some clay and silt, which better suited the magnetic locator and magnetometer. The survey did not identify any significant anomalies. Any anomalies that were discovered corresponded to surface debris. In the hillside magnetometer survey a 5-gallon metal container was the source of the one anomaly, see Figure 4.1-6.

4.2 Discussion of Excavation Results

TtNUS performed shallow subsurface investigations of each of the anomalies with the exception of A2. In the case where the source of the anomaly were identified (i.e., metal bucket, pipe), the object was removed and the area surveyed with a magnetic locator. If the anomaly persisted the excavation continued until the location was considered or discounted as a landfill.

The excavation result for A10 was inconclusive. The geophysical data shows intermittent responses along a line parallel to the other landfill cells. The excavation did not reveal any evidence of landfill associated materials, but the excavation may have missed the source areas. The geophysical data does however show strong similarities to A8 and A9, which are landfill cells. A10 could be a collection of debris located along an old road or a landfill cell. In any case, it is an accumulation of buried debris that needs to be considered in complying with the New Mexico Solid Waste Management Regulations. The results of the shallow subsurface investigation are listed in Table 4.2-1.
4.3 **Identification and Delineation of the Eastern Landfill**

The physical identification of the edge of the landfill was matched with geophysical anomalies and from the result, Figure 4.3-1 was prepared, which identifies the Eastern Landfill consisting of several trenches or cells. The Eastern Landfill cells are outlined along with other collections of burned material and debris. The figure shows the outlined landfill cells overlain with the surface contours. It appears that the landfill consists of three (3) trenches, A8, A9, and A10, that are oriented parallel to one another. There are three (3) areas of surface debris, A3, A4, and A5, which should also be considered for the next phase of regulatory compliance.
### TABLE 4.2-1
Shallow Subsurface Investigation Results
Eastern Landfill Delineation, FWDA
Gallup, New Mexico

<table>
<thead>
<tr>
<th>Anomaly ID</th>
<th>Excavation Number</th>
<th>Excavation Type</th>
<th>Excavation Max Depth (ft)</th>
<th>Visual Description</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A1</td>
<td>FWELF-01</td>
<td>Pit</td>
<td>5</td>
<td>Clay soil with gravel, rock at 4-foot, very high clay content.</td>
<td>Natural Feature</td>
</tr>
<tr>
<td>A2</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>Drainage feature</td>
<td>Natural Feature</td>
</tr>
<tr>
<td>A3</td>
<td>FWELF-02</td>
<td>Pit</td>
<td>6</td>
<td>Clay soil with gravel, coal ash and burned material on surface near pit.</td>
<td>Surface anomaly, burned material.</td>
</tr>
<tr>
<td>A4</td>
<td>FWELF-08</td>
<td>Pit</td>
<td>5</td>
<td>Clay soil with gravel, burned material and ammunition can lids on surface.</td>
<td>Surface anomaly, burned material, metal lids.</td>
</tr>
<tr>
<td>A5</td>
<td>FWELF-09</td>
<td>Pit</td>
<td>5</td>
<td>Clay soil with gravel, burned material and ammunition can lids on surface.</td>
<td>Surface anomaly, burned material, metal lids.</td>
</tr>
<tr>
<td>A6</td>
<td>FWELF-05</td>
<td>Pit</td>
<td>3</td>
<td>Clay soil with lots of gravel, 5-gallon metal bucket at 1 foot.</td>
<td>Anomaly produced by metal bucket.</td>
</tr>
<tr>
<td>A7</td>
<td>FWELF-04</td>
<td>Pit</td>
<td>3</td>
<td>Clay soil with lots of gravel, 8-inch by 15-foot metal pipe at 1 foot.</td>
<td>Anomaly produced by metal pipe.</td>
</tr>
<tr>
<td>A8</td>
<td>FWELF-03</td>
<td>Trench</td>
<td>4</td>
<td>Clay soil overburden, waste - glass, wood, batteries (car) plastic, metal, other burned material.</td>
<td>Landfill Cell</td>
</tr>
<tr>
<td></td>
<td>FWELF-10</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A9</td>
<td>FWELF-06</td>
<td>Trench</td>
<td>2</td>
<td>Clay soil overburden, waste - glass, wood, batteries (car) plastic, metal, other burned material.</td>
<td>Landfill Cell</td>
</tr>
<tr>
<td>A10</td>
<td>FWELF-07</td>
<td>Trench</td>
<td>5</td>
<td>Clay soil mixed with small amounts of glass. Linear trench-like surface feature.</td>
<td>Landfill Cell</td>
</tr>
</tbody>
</table>

Note:
NA = Not Applicable
See Figure 4.1-4 for corresponding excavation locations.
FIGURE 4.1-1
EASTERN LANDFILL DELINEATION
EM-31 IN-PHASE RESPONSE
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO
FIGURE 4.1-2

EM-61 RESPONSE
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO

TETRA TECH NUS, INC.
Houston, Texas

SITE MANAGER: K. BELL
CHECKED BY: K. BELL
DRAWN BY: J. FLESCH
DATE: 11-17-00
SCALE: 1"=200'
CAD DWG. NO.: 158C_4
PROJ. NO.: N7551.158C
FIGURE 4.1-3
EASTERN LANDFILL DELINEATION
EM-61 BOUNDARY INTERPRETATIONS
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO

TETRA TECH NUS, INC.
Houston, Texas
FIGURE 4.1-6
EASTERN LANDFILL DELINEATION
HILLSIDE MAGNETIC DATA
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO
FIGURE 4.3-1
EASTERN LANDFILL DELINEATION
EASTERN LANDFILL TOPOGRAPHIC MAP
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO

NOTES
1. BASIS OF CONTROL IS USGS MONUMENT "ERIC 1966" AND USDI MONUMENT "TS674 1965".
   DRAWING COORDINATES ARE NEW BRAZIL 63 (T.M.) PLANE COORDINATES (RADIUS AT ELEVATION)
   MODIFIED WITH A COMBINED ELEVATION AND GRID SCALE FACTOR OF .99964736.
2. BASIS OF VERTICAL CONTROL IS EXISTING MONUMENT "ERIC 1966" WITH A PUBLISHED ELEVATION
   OF 6812.0' (NAVD88).
3. ELEVATIONS WERE ESTABLISHED BY TRIG. LEVELS FROM MONUMENT "ERIC 1966".
4. CONTINUITY INTERVAL IS 1 FOOT AND THE DRAWING SCALE IS 1" = 60'.
5. SURVEY WAS PERFORMED ON OCTOBER 24, 2000 UTILIZING A ONE MAN SERVO DRIVEN INSTRUMENT.

TETRA TECH NUS, INC.
Houston, Texas

SURVEY CONTROL POINT
CELL BOUNDARY (BASED ON GEOPHYSICAL SURVEY)

CHECKED BY: K. BELL
SITE MANAGER: K. BELL

DATE: 11-22-00
SCALE: 1"=60'
APPENDIX A

Geophysical Investigation of the Eastern Landfill Area
Fort Wingate Army Depot
New Mexico
Geophysical Investigation of the Eastern Landfill Area
Fort Wingate Army Depot
New Mexico

Prepared for:

Tetra Tech NUS Inc.
2315 West Sam Houston Parkway
Houston, Texas 77043-2018

Sidney S. Brandwein
David A. Hyndman

November 2000
4.0 Conclusions

4.1 Eastern Landfill Area

• One large feature, one intermediate feature, and one small linear feature, interpreted to be landfill trenches were delineated near grid lines 600N, 400N and 275N, respectively. The EM-61 data provide the most robust and detailed delineation of buried waste, and are used for outlining the boundaries on Figure 9.

• The large trench area (grid 600N) appears to consist of two parallel trenches each about 370 - 400 feet long by 50 - 60 feet wide. Each trench appears to be the product of multiple landfilling episodes.

• The intermediate trench (grid 400N) is about 300 feet long and 30 feet wide and appears to contain less metallic debris than the large trench.

• The small trench (grid 275N) is parallel to an old road and associated ditch. It is about 280 feet long, is very narrow, may not contain much metal and appears to be discontinuous.

• The three trench areas coincide with minor topographic lows.

• An area of surface cinders, slag and metallic debris near grid 300E, 600N, causing a local arcuate topographic high, is prominent in the geophysical surveys. The extent of the cinder, slag and metallic debris appears to coincide with the surface exposure, with no indication of major burial within the arc.

• Two areas of concentrated, near surface, small debris were located in the vicinity of grid 350N, 700E.

• Nine proposed locations for backhoe verification and groundtruthing of anomalies were identified, as shown on Figure 10.

4.2 Hillside Area

• No other buried debris were located by the detailed magnetometer survey in the immediate vicinity of the rusted 5 gallon container.

• No buried waste was detected by the magnetic screening in the hills to the west of the landfill.

• Some linear surface features in the hillside screening area may be related to borrow activity.
APPENDIX E

EXCERPTS FROM GROUNDWATER INVESTIGATION REPORT, EASTERN LANDFILL (TTNUS, 2005)
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Groundwater Investigation Report
Eastern Landfill
Fort Wingate Depot Activity, Gallup, New Mexico

Contract No. DACA63-97-D-0030; D.O. No. 024
Tetra Tech NUS Project No. 794A

Prepared for:

US Army Corps
of Engineers
Fort Worth District

Prepared by:

Tetra Tech NUS, Inc.
Houston, Texas


5.0 GROUNDWATER INVESTIGATION RESULTS

5.1 Analytical Parameters and Methods

5.1.1 Soil Samples

Soil samples for chemical analysis were not collected during the Groundwater Investigation.

5.1.2 Groundwater Samples

Four (4) groundwater samples (2 investigation, 1 duplicate [QC] and 1 triplicate [QA]) were collected for chemical analysis as described in Section 3.3.4. Groundwater samples collected for chemical analysis were analyzed using the methods listed in Table 5.1.2-1. A list of site-specific constituents is presented in table 5.1.2-2.

Table 5.1.2-1

SUMMARY OF CHEMICAL ANALYSES FOR GROUNDWATER SAMPLES

Groundwater Investigation – Eastern Landfill
Fort Wingate Depot Activity, Gallup, New Mexico

<table>
<thead>
<tr>
<th>Analysis Test Method</th>
<th>Method Code</th>
</tr>
</thead>
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<tr>
<td>Appendix IX VOCs + Methyl Tert Butyl Ether (MTBE)</td>
<td>SW-846 8260B</td>
</tr>
<tr>
<td>Appendix IX SVOCs</td>
<td>SW-846 8270C</td>
</tr>
<tr>
<td>Appendix IX Pesticides</td>
<td>SW-846 8081A</td>
</tr>
<tr>
<td>Appendix IX Pesticides</td>
<td>SW-846 8141</td>
</tr>
<tr>
<td>Appendix IX PCBs</td>
<td>SW-846 8082</td>
</tr>
<tr>
<td>Appendix IX Herbicides</td>
<td>SW-846 8151A</td>
</tr>
<tr>
<td>Appendix IX Dioxins</td>
<td>SW-846 8290</td>
</tr>
<tr>
<td>Appendix IX Metals (totals) + Al, Fe, Mn</td>
<td>SW-846 6010B, 6020, 7470</td>
</tr>
<tr>
<td>Appendix IX Metals (dissolved) + Al, Fe, Mn</td>
<td>SW-846 6010B, 6020, 7470</td>
</tr>
<tr>
<td>Anions (Nitrate as Nitrogen, Chloride, Fluoride, Sulfate)</td>
<td>EPA 300.0</td>
</tr>
<tr>
<td>Cyanide</td>
<td>SW-846 9012A</td>
</tr>
<tr>
<td>Expanded List Explosives</td>
<td>SW-846 8330 Mod.</td>
</tr>
<tr>
<td>Nitrate/Nitrite Nonspecific</td>
<td>EPA 353.2</td>
</tr>
<tr>
<td>pH</td>
<td>EPA 150.1</td>
</tr>
<tr>
<td>Sulfide</td>
<td>EPA 376.1</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>EPA 160.1</td>
</tr>
</tbody>
</table>
5.1.3 QA/QC Samples

QA/QC for samples collected during the Groundwater Investigation at the Eastern Landfill included the following:

- Field Blanks (see Section 4.4.1);
- Trip Blanks (see Section 4.4.2);
- Equipment blanks (see Section 4.4.3);
- Duplicates (see Section 4.4.4);
- Triplicates (see Section 4.4.5); and
- Temperature Blanks (see Section 4.4.6).

Trip blanks were analyzed for volatile organics only. QA/QC samples were analyzed for the full suite of parameters using the methods listed in Table 5.1.2-1.

5.2 Discussion of Analytical Results

The Groundwater Investigation conducted at the Eastern Landfill consisted of the installation of four monitor wells. Two groundwater samples were collected from two of the four monitor wells for chemical analysis. Groundwater samples were collected from monitor wells EMW02 and EMW03. Monitor wells EMW01 and EMW04 did not contain a sufficient amount of water for sampling.

The analytical data presented in this Groundwater Investigation Report were subjected to a data validation process performed by TtNUS personnel to ensure the integrity and defensibility of the data. The Data Validation Report is presented in Appendix D. A list of the data qualified by TtNUS personnel is included in Appendix F. Samples collected for chemical analysis during the Groundwater Investigation were analyzed by Severn Trent Laboratories of Houston, Texas. Quality assurance samples (triplicates) were analyzed by Datachem Laboratories of Salt Lake City, Utah.

For reporting purposes, all detected concentrations of analyzed groundwater samples are discussed in this section. Chemical analytical results discussed in this section are summarized in Table 5.2-1 for organic compounds and in Table 5.2-2 for metals. As discussed in the following subsections, analytical results were compared to EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003). It should be noted that not all compounds detected had corresponding screening levels.

5.2.1 Volatiles

Four volatile organics (acetone, toluene, xylene-totals, and methyl ethyl ketone) were detected above the reporting limits in the groundwater samples collected at the Eastern Landfill site. The compounds were all detected in samples collected from one location, monitor well EMW03. The concentrations detected are less than the respective EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003) for these compounds.
# Table 5.2-1

## ANALYTICAL RESULTS - ORGANICS

Groundwater Investigation - Eastern Landfill
Fort Wingate Depot Activity, Gallup, New Mexico

### Appendix IX VOCs

<table>
<thead>
<tr>
<th>(8260B)</th>
<th>Screening Level</th>
<th>EMW02</th>
<th>EMW03</th>
<th>EMW03 DUP</th>
<th>EMW03 FTRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetone</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>33</td>
<td>0.0116</td>
<td>0.0133</td>
<td>0.011</td>
<td></td>
</tr>
<tr>
<td>Toluene</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.72</td>
<td>0.0035</td>
<td>0.00087</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td>Xylene, Total</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.2</td>
<td>0.00065</td>
<td>J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MEK</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.1</td>
<td>0.00235</td>
<td>J</td>
<td></td>
<td></td>
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### Appendix IX SVOCs

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<th>(8270)</th>
<th>EMW02</th>
<th>EMW03</th>
<th>EMW03 DUP</th>
<th>EMW03 FTRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bis(2-ethylhexyl)phthalate</td>
<td>(mg/L)</td>
<td>(mg/L)</td>
<td>(mg/L)</td>
<td>(mg/L)</td>
</tr>
<tr>
<td></td>
<td>0.0048</td>
<td>0.00379</td>
<td>J</td>
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</tr>
<tr>
<td>Acetophenone</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.7</td>
<td>0.0016</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td>Butylbenzylphthalate</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.3</td>
<td>0.00341</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td>2-Methylnaphthalene</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>0.00191</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td>Naphthalene</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0062</td>
<td>0.00024</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td>Phenol</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>11.0</td>
<td>0.00321</td>
<td>J</td>
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### Appendix IX Pesticides

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<tr>
<th>(8081 and 8141)</th>
<th>EMW02</th>
<th>EMW03</th>
<th>EMW03 DUP</th>
<th>EMW03 FTRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dieldrin</td>
<td>(mg/L)</td>
<td>(mg/L)</td>
<td>(mg/L)</td>
<td>(mg/L)</td>
</tr>
<tr>
<td></td>
<td>0.0000042</td>
<td>0.0000139</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td>Endosulfan II</td>
<td>(1)</td>
<td>0.0000138</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td>Eindrin Aldehyde</td>
<td>(1)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gamma-BHC</td>
<td>(1)</td>
<td>0.0001112</td>
<td>J</td>
<td></td>
</tr>
<tr>
<td>Heptachlor Epoxide</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.0000074</td>
<td>0.0000587</td>
<td>J</td>
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</table>

### Appendix IX Herbicides

<table>
<thead>
<tr>
<th>(8151)</th>
<th>EMW02</th>
<th>EMW03</th>
<th>EMW03 DUP</th>
<th>EMW03 FTRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>All compounds were non detect</td>
<td></td>
<td></td>
<td></td>
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</table>

### Explosives

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<tr>
<th>(830 Mod)</th>
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<th>EMW03 DUP</th>
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<tbody>
<tr>
<td>RDX</td>
<td>(ug/L)</td>
<td>(ug/L)</td>
<td>(ug/L)</td>
<td>(ug/L)</td>
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<tr>
<td></td>
<td>0.61</td>
<td>2.9</td>
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</tr>
<tr>
<td>Nitrobenzene</td>
<td>(ug/L)</td>
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<td></td>
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<tr>
<td></td>
<td>3.4</td>
<td>0.22 J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2,4,6-TNT</td>
<td>(ug/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.38</td>
<td>0.11 J</td>
<td></td>
<td>0.11 J</td>
</tr>
<tr>
<td>Nitroglycerin</td>
<td>(ug/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7.4</td>
<td>30 J</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DNT</td>
<td>(ug/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.4</td>
<td>0.53 J</td>
<td></td>
<td>0.53 J</td>
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### Appendix IX PCB and Conjoiners

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<th>(8082)</th>
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<th>EMW03</th>
<th>EMW03 DUP</th>
<th>EMW03 FTRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>2-monochlorobiphenyl</td>
<td>(ug/L)</td>
<td>(ug/L)</td>
<td>(ug/L)</td>
<td>(ug/L)</td>
</tr>
<tr>
<td></td>
<td>0.028</td>
<td>0.028</td>
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<td></td>
</tr>
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</table>

### Appendix IX PCDDs and PCDFs

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<th>EMW03 DUP</th>
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<tbody>
<tr>
<td>All compounds were non detect</td>
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### Water Quality Parameters

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<tr>
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<th>EMW03 DUP</th>
<th>EMW03 FTRP</th>
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<tbody>
<tr>
<td>pH (pH units)</td>
<td>(mg/L)</td>
<td>(mg/L)</td>
<td>(mg/L)</td>
<td>(mg/L)</td>
</tr>
<tr>
<td></td>
<td>11.47</td>
<td>11.63</td>
<td>11.55</td>
<td>11.5</td>
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<tr>
<td>Nitrate as Nitrogen</td>
<td>(mg/L)</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>10</td>
<td>0.189 B</td>
<td>0.122 B</td>
<td>0.274</td>
</tr>
<tr>
<td>Chloride</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>258</td>
<td>213</td>
<td>213</td>
</tr>
<tr>
<td>Fluoride</td>
<td>(mg/L)</td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td>0.848</td>
<td>1.7</td>
<td>2.48</td>
</tr>
<tr>
<td>Sulfate</td>
<td>(mg/L)</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>2550</td>
<td>2130</td>
<td>2190</td>
</tr>
<tr>
<td>Nitrate/Nitrite Nonspecific</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.0</td>
<td>0.082</td>
<td>0.669</td>
<td>0.466</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>(mg/L)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1)</td>
<td>4940</td>
<td>3920</td>
<td>4050</td>
</tr>
</tbody>
</table>

### Notes:

1. No Screening Level provided by US EPA.
2. Analytical results are compared to EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003).
3. Blank entry indicates the analyte was not detected above the reporting limit.
4. Bold indicates an exceedance of Screening Level.
5. J - indicates estimated value.
6. mg/L - milligrams per liter
7. ug/L - micrograms per liter
8. pg/L - picograms per liter
<table>
<thead>
<tr>
<th>Metals (6000/7000)</th>
<th>Screening Level</th>
<th>EMW02 (Dissolved)</th>
<th>EMW02 (Total)</th>
<th>EMW03 (Dissolved)</th>
<th>EMW03 (Total)</th>
<th>EMW03 DUP (Dissolved)</th>
<th>EMW03 DUP (Total)</th>
<th>EMW03 FTRP (Dissolved)</th>
<th>EMW03 FTRP (Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>37</td>
<td>0.0427</td>
<td>1.14</td>
<td>1.6</td>
<td>1.46</td>
<td>1.99</td>
<td>1.75</td>
<td>1.5</td>
<td>1.75</td>
</tr>
<tr>
<td>Arsenic</td>
<td>0.015</td>
<td>0.000045</td>
<td>0.00355</td>
<td>0.005</td>
<td>0.00725</td>
<td>0.00856</td>
<td>0.000393</td>
<td>0.000852</td>
<td></td>
</tr>
<tr>
<td>Barium</td>
<td>0.073</td>
<td>0.0641</td>
<td>0.06</td>
<td>0.107</td>
<td>0.113</td>
<td>0.0954</td>
<td>0.119</td>
<td>0.0978</td>
<td>0.131</td>
</tr>
<tr>
<td>Beryllium</td>
<td>0.018</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.000182</td>
<td></td>
</tr>
<tr>
<td>Chromium</td>
<td>0.11 (1)</td>
<td>0.00952</td>
<td>0.00985</td>
<td>0.103</td>
<td>0.0941</td>
<td>0.117</td>
<td>0.0882</td>
<td>0.0986</td>
<td>0.0898</td>
</tr>
<tr>
<td>Cobalt</td>
<td>0.73</td>
<td>0.00125</td>
<td>0.00082</td>
<td>0.045</td>
<td>0.151</td>
<td>0.0969</td>
<td>0.169</td>
<td>0.075</td>
<td>0.225</td>
</tr>
<tr>
<td>Copper</td>
<td>1.4</td>
<td>0.00598</td>
<td>0.00597</td>
<td>0.0117</td>
<td>0.0122</td>
<td>0.0136</td>
<td>0.0116</td>
<td>0.0135</td>
<td>0.0123</td>
</tr>
<tr>
<td>Iron</td>
<td>11</td>
<td>0.148</td>
<td>0.473</td>
<td>0.0703</td>
<td>0.151</td>
<td>0.0969</td>
<td>0.169</td>
<td>0.075</td>
<td>0.225</td>
</tr>
<tr>
<td>Lead</td>
<td>0.015</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.000325</td>
<td>0.000869</td>
</tr>
<tr>
<td>Manganese</td>
<td>1.7</td>
<td>0.00218</td>
<td>0.0781</td>
<td>0.00144</td>
<td>0.00214</td>
<td>0.00276</td>
<td>0.004</td>
<td>0.004</td>
<td>0.0056</td>
</tr>
<tr>
<td>Mercury</td>
<td>0.011</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.000031</td>
<td></td>
</tr>
<tr>
<td>Nickel</td>
<td>0.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.00917</td>
<td>0.00929</td>
</tr>
<tr>
<td>Selenium</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.00131</td>
<td>0.000882</td>
</tr>
<tr>
<td>Silver</td>
<td>0.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.000586</td>
<td></td>
</tr>
<tr>
<td>Thallium</td>
<td>(2)</td>
<td>0.00586</td>
<td></td>
<td>0.00509</td>
<td></td>
<td>0.00511</td>
<td>0.0000973</td>
<td>0.0000973</td>
<td>0.0000973</td>
</tr>
<tr>
<td>Tin</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.00331</td>
<td>0.000753</td>
<td>0.000665</td>
<td>0.000665</td>
</tr>
<tr>
<td>Vanadium</td>
<td>0.037</td>
<td>0.00302</td>
<td>0.0859</td>
<td>0.0871</td>
<td>0.0936</td>
<td>0.081</td>
<td>0.0893</td>
<td>0.0865</td>
<td>0.0865</td>
</tr>
<tr>
<td>Zinc</td>
<td>11</td>
<td>0.0244</td>
<td>0.00862</td>
<td>0.00871</td>
<td>0.00799</td>
<td>0.00142</td>
<td>0.00297</td>
<td>0.000857</td>
<td>0.000857</td>
</tr>
</tbody>
</table>

Note:
1. Screening Level for Chromium VI used for comparison.
2. No Screening Level provided by US EPA.
Analytical results are compared to EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003).
Blank entry indicates the analyte was not detected above the reporting limit.
Bold indicates an exceedance of Screening Level.
mg/L - milligrams per liter
5.2.2 Semivolatiles

Six semivolatile organics (acetophenone, butylbenzylphthalate, 2-methylnaphthalene, bis(2-ethylhexyl)phthalate, naphthalene and phenol) were detected above the reporting limits in groundwater samples collected at the Eastern Landfill site. With the exception of one compound in one sample, the concentrations detected are less than the respective EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003) for these compounds.

The concentration of bis(2-ethylhexyl)phthalate in the duplicate sample collected from monitor well EMW03 (0.00682 mg/L) exceeds the EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003) for bis(2-ethylhexyl)phthalate of 0.0048 mg/L.

5.2.3 Pesticides

Five pesticides (Dieldrin, Endosulfan II, Endrin Aldehyde, gamma-BHC and Heptachlor Epoxide) were detected above the reporting limits in one groundwater sample collected at the Eastern Landfill site. The concentrations of Dieldrin (0.0000139 mg/L) and Heptachlor Epoxide (0.0000587 mg/L) detected in the triplicate sample collected from monitor well EMW03 exceed the EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003) for these compounds of 0.0000042 mg/L and 0.0000074 mg/L, respectively.

5.2.4 Polychlorinated Biphenyls and Congeners

One PCB congener (2-monochlorobiphenyl) was detected above the reporting limit in one groundwater sample collected at the Eastern Landfill site. An EPA Region 6 Human Health Medium-Specific Screening Level for Tap Water (Version 6, November 2003) for this compound is not available.

5.2.5 Herbicides

Herbicides were not detected above the reporting limits in the groundwater samples collected at the Eastern Landfill site.

5.2.6 Dioxins and Furans

Dioxins and Furans were not detected above the reporting limits in the groundwater samples collected at the Eastern Landfill site.

5.2.7 Explosives

Five explosives (RDX, nitrobenzene, 2,4,6-TNT, nitroglycerin and DNX) were detected above the reporting limits in groundwater samples collected at the Eastern Landfill site. The concentration of RDX (2.9 micrograms per liter [µg/L]) detected in one groundwater sample collected from monitor well EMW02 exceeds the EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water.
(Version 6, November 2003) for this compound of 0.61 ug/L.

5.2.8 Metals

Analyzed metals were detected in the groundwater samples collected at the Eastern Landfill site. Sixteen metals (aluminum, antimony, barium, beryllium, cadmium, cobalt, copper, iron, lead, manganese, mercury, nickel, selenium, thallium, tin and zinc) were detected above the reporting limits but at concentrations below the respective EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003) for these compounds. One compound (silver) was not detected above the reporting limits in any of the groundwater samples.

Arsenic was detected above the reporting limit in three groundwater samples collected from monitor well EMW03 at concentrations ranging from 0.00355 mg/L to 0.00725 mg/L. The concentrations detected exceed the EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003) for arsenic of 0.000045 mg/L.

Chromium was detected above the reporting limit in four groundwater samples collected from monitor wells EMW02 and EMW03 at concentrations ranging from 0.00952 mg/L to 0.117 mg/L. The concentration (0.117 mg/L) detected in the duplicate sample collected from monitor well BMW03 exceeds the EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003) for chromium VI of 0.11 mg/L.

Vanadium was detected above the reporting limit in four groundwater samples collected from monitor wells BMW02 and BMW03 at concentrations ranging from 0.00302 mg/L to 0.0936 mg/L. The concentrations (0.081 mg/L to 0.0936 mg/L) detected in the groundwater samples collected from monitor well EMW03 exceed the EPA Region 6 Human Health Medium-Specific Screening Levels for Tap Water (Version 6, November 2003) for vanadium of 0.037 mg/L.

5.2.9 Water Quality Parameters

Various water quality parameters were analyzed for as part of the Groundwater Investigation. The analytical results for the water quality parameters are presented in Table 5.2-1.

5.3 Groundwater Elevation Measurements

A groundwater elevation survey was conducted at nine monitoring wells located at the Eastern Landfill, Work Shop, Administration and TNT Leaching Bed Areas. These monitor wells included TMW02, TMW05, TMW14A, TMW16, TMW17, TMW18, TMW19, FW35 and TMW28.

All water level measurements were obtained with an electronic water level monitor. Measurements were made relative to a notch or other permanent mark which serves as a consistent reference point. These measurements were accurate to 0.01 feet. Table 5.3-1 presents the results of the groundwater
Table 5.3-1

WATER LEVEL MEASUREMENTS FOR EXISTING MONITOR WELLS

Groundwater Investigation – Eastern Landfill
Fort Wingate Depot Activity, Gallup, New Mexico

<table>
<thead>
<tr>
<th>Monitor Well</th>
<th>Depth to Water (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMW02</td>
<td>53.88</td>
</tr>
<tr>
<td>TMW05</td>
<td>35.88</td>
</tr>
<tr>
<td>TMW14A</td>
<td>62.95</td>
</tr>
<tr>
<td>TMW16</td>
<td>54.58</td>
</tr>
<tr>
<td>TMW17</td>
<td>61.46</td>
</tr>
<tr>
<td>TMW18</td>
<td>53.27</td>
</tr>
<tr>
<td>TMW19</td>
<td>41.00</td>
</tr>
<tr>
<td>TMW28</td>
<td>18.45</td>
</tr>
<tr>
<td>FW35</td>
<td>14.50</td>
</tr>
</tbody>
</table>

Note:
1. Water level measurements collected between 12:15 and 13:40 hours on 07/30/04.
2. Water level measured in feet from top of casing.

Water level measurements were collected at the monitor wells installed during the Groundwater Investigation. Table 5.3-2 presents the results of the water level measurements at the monitor wells EMW01 through EMW04 installed as part of the Groundwater Investigation.

Monitor well EMW01 was installed on July 14, 2004. Water was not detected in the monitor well until August 2, 2004. At the completion of field activities on August 3, 2004, the height of the column of water measured was approximately 14 feet.

Monitor well EMW02 was installed on July 19, 2004. Water was detected in the well the next day. The maximum water column height measured was approximately 75 feet.

Monitor well EMW03 was installed on July 21, 2004. Water was detected in the well the next day. The maximum water column height measured was approximately 64 feet high.

Monitor well EMW04 was installed on July 23, 2004. Water was not detected in the monitor well until August 2, 2004. At the completion of field activities on August 3, 2004, the maximum water column height measured was approximately 0.5 feet.
## Table 5.3-2

**WATER LEVEL MEASUREMENTS FOR NEWLY INSTALLED MONITOR WELLS**

**Groundwater Investigation – Eastern Landfill**  
**Fort Wingate Depot Activity, Gallup, New Mexico**

<table>
<thead>
<tr>
<th>Date</th>
<th>EMW01</th>
<th>EMW02</th>
<th>EMW03</th>
<th>EMW04</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>7/14/04</td>
<td>Dry</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>7/16/04</td>
<td>Dry</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>7/20/04</td>
<td>--</td>
<td>98.05</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>7/21/04</td>
<td>Dry</td>
<td>86.64</td>
<td>89.80</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>7/22/04</td>
<td>--</td>
<td>68.51</td>
<td>79.66</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>7/23/04</td>
<td>Dry</td>
<td>56.35</td>
<td>48.71</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>7/26/04</td>
<td>Dry</td>
<td>35.55</td>
<td>36.30</td>
<td>Dry</td>
<td>Developed EMW02 and EMW03</td>
</tr>
<tr>
<td>7/27/04</td>
<td>--</td>
<td>77.95</td>
<td>63.65</td>
<td>--</td>
<td>Developed EMW02 and EMW03</td>
</tr>
<tr>
<td>7/28/04</td>
<td>--</td>
<td>80.56</td>
<td>--</td>
<td>--</td>
<td>Sampled EMW02</td>
</tr>
<tr>
<td>7/29/04</td>
<td>--</td>
<td>--</td>
<td>54.88</td>
<td>--</td>
<td>Sampled EMW03</td>
</tr>
<tr>
<td>7/30/04</td>
<td>Dry</td>
<td>66.90</td>
<td>77.35</td>
<td>Dry</td>
<td></td>
</tr>
<tr>
<td>8/2/04</td>
<td>119.90</td>
<td>50.61</td>
<td>46.30</td>
<td>116.99</td>
<td></td>
</tr>
<tr>
<td>8/3/04</td>
<td>106.95</td>
<td>47.57</td>
<td>43.78</td>
<td>117.05</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
1. – indicates that the well was not yet installed or a measurement was not collected for that day.
2. Water level measured in feet from top of casing.
As discussed above and shown on Table 5.3-2, recharge to the wells was very slow. The water levels did not reach stabilization in any of the wells during the field activities. Because of this lack of stabilization, the direction and gradient of groundwater flow at the Eastern Landfill could not be determined.

5.4 Aquifer Testing

Aquifer tests (rising and falling head slug tests) were performed on monitor wells EMW02 and EMW03 to estimate hydraulic conductivity. The procedures employed for performing the slug tests are discussed in Section 3.4.

Hydraulic conductivities were calculated using the slug test methods of Bouwer and Rice, 1976 and Hvorslev, 1951. Graphical solutions and calculations were performed using AQTESOLV for Windows Professional (Version 3.50), an aquifer test analysis software package. Aquifer test data and calculations are included in Appendix G.

Table 5.4-1 presents hydraulic conductivity estimates for monitor wells EMW02 and EMW03.

Table 5.4-1

<table>
<thead>
<tr>
<th>SUMMARY OF AQUIFER TEST RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater Investigation – Eastern Landfill</td>
</tr>
<tr>
<td>Fort Wingate Depot Activity, Gallup, New Mexico</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Monitor Well</th>
<th>Falling Head (ft/sec)</th>
<th>Rising Head (ft/sec)</th>
<th>Falling Head (ft/sec)</th>
<th>Rising Head (ft/sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EMW02</td>
<td>9.219 x 10^-6</td>
<td>5.925 x 10^-7</td>
<td>1.856 x 10^-5</td>
<td>1.183 x 10^-6</td>
</tr>
<tr>
<td>EMW03</td>
<td>2.294 x 10^-7</td>
<td>1.196 x 10^-7</td>
<td>4.625 x 10^-7</td>
<td>1.879 x 10^-7</td>
</tr>
</tbody>
</table>

Note:
2. Hvorslev Method.

ft/sec – feet second
SOIL BORING LOGS
**PROJECT INFORMATION**

- **PROJECT:** Eastern Landfill
- **SITE LOCATION:** Fort Wingate Depot Activity
- **JOB NO.:** 794A
- **LOGGED BY:** Larry Basilio
- **PROJECT MANAGER:** Theresa Thompson
- **DATE DRILLED:** 7/13/04 to 7/14/04

**DRILLING INFORMATION**

- **DRILLING CO.:** Enviro-Drill
- **DRILLER:** Matt Cain
- **RIG TYPE:** CME 75
- **METHOD OF DRILLING:** Hollow Stem Auger / Air Rotary
- **TOTAL DEPTH:** 120 feet BGS

**NOTES:** Dry, Sparse Vegetation

---

**DEPTH (FEET) | SOIL SYMBOL | USCS: SOIL DESCRIPTION | SAMPLE NUMBER | ADVANCE INTERVAL | PID (ppm) | WELL DETAIL | WELL DESCRIPTION**

<p>| 0  | ML: SILT - red (2.5 YR 4/6), loose, poorly consolidated, dry, trace of &lt; 1/2-inch gravel | 48/60 |  | 4 ft x 4 ft aboveground concrete surface completion |
| 5  |  | 60/60 |  | Borehole diameter 7 3/4&quot; to 120 ft using hollow stem augers |
| 10 |  | 12/60 |  | 2&quot; PVC riser with cement/bentonite grout |
| 15 | SM: SAND - red (2.5 YR 4/8), very silty to very clayey in parts, dry, increasing clay content with depth |  |  |  |
| 20 | CL: CLAY - reddish brown (2.5 YR 4/4), very silty, partially indurated, broken, dry, sandy in parts, gray clay inclusions |  |  |  |
| 25 | ML: SILT - red (2.5 YR 4/6), very clayey, very stiff, broken to blocky, dry, gray clay inclusions |  |  |  |
| 30 | CL: CLAY - red (2.5 YR 4/6), very stiff to hard, broken to crumbly, very silty, non to very slightly plastic, dry, trace to abundant gray clay inclusions |  |  |  |
| 35 | ML: SILT - red (2.5 YR 4/6), very clayey, poor to fair induration, slightly sandy in parts, dry |  |  |  |
| 40 | ML: SILT - dark red (2.5 YR 3/6), trace of gray mottle, very clayey, slightly to moderately indurated, more indurated with depth, broken, blocky, dry |  |  |  |
| 45 | CL: CLAY - red (2.5 YR 4/6), very stiff to hard, blocky, crumbly, silty, trace of soft to hard gray clay inclusions, dry |  |  |  |
| 50 | CL: CLAY - reddish brown (2.5 YR 4/4), very stiff to hard, blocky, crumbly, silty, dry |  |  |  |
| 55 | CL: CLAY - red (2.5 YR 4/6), hard, dense, non plastic, slightly silty, dry |  |  |  |
| 60 | CL: CLAY - red (2.5 YR 4/6), some light gray |  |  |  |</p>
<table>
<thead>
<tr>
<th>DEPTH (FEET)</th>
<th>SOIL SYMBOLS</th>
<th>USCS: SOIL DESCRIPTION</th>
<th>SAMPLE NUMBER</th>
<th>ADVANCE/RECOVER (feet)</th>
<th>PID ppm</th>
<th>BORING COMPLETION</th>
<th>WELL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>-75</td>
<td></td>
<td>mottle, very stiff to hard, non to very slightly plastic, silty, dry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-80</td>
<td></td>
<td>CL: CLAY - red (2.5 YR 4/8), very stiff to hard, broken, silty, dry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-85</td>
<td></td>
<td>CL: CLAY - as above with increased sand content, very fine grained, dry to very slightly damp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-90</td>
<td></td>
<td>CL: CLAY - reddish brown (2.5 YR 4/3), some mottling of color, hard, non plastic, slightly silty, some fine bedding and fissility present, dry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-95</td>
<td></td>
<td>CL: CLAY - dark red (2.5 YR 3/6), hard, blocky, fair to well indurated in parts, silty, dry, bedding planes present in lower part, grades to siltstone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-100</td>
<td></td>
<td>ML: SILT - hard, well indurated, fissile, dry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-105</td>
<td></td>
<td>SM: SAND - gray, very fine grained, interbedded with siltstone and claystone, moderately friable, dry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-110</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-115</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-120</td>
<td></td>
<td>Total Depth = 120.7 feet below ground surface</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.010&quot; slot 2&quot; diameter PVC screen with 20/40 silica sand filter pack</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bentonite seal</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bottom cap</td>
</tr>
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</table>
**BOREHOLE No.: EMW02**

**NORTHING:** 1643388.64  
**EASTING:** 2502478.93  
**GROUND ELEVATION:** 6699.14 MSL

**PROJECT INFORMATION**

<table>
<thead>
<tr>
<th>PROJECT</th>
<th>Eastern Landfill</th>
</tr>
</thead>
<tbody>
<tr>
<td>SITE LOCATION</td>
<td>Fort Wingate Depot Activity</td>
</tr>
<tr>
<td>JOB NO.</td>
<td>794A</td>
</tr>
<tr>
<td>LOGGED BY</td>
<td>Larry Basilio</td>
</tr>
<tr>
<td>PROJECT MANAGER</td>
<td>Theresa Thompson</td>
</tr>
<tr>
<td>DATE DRILLED</td>
<td>7/15/04 to 7/19/04</td>
</tr>
</tbody>
</table>

**NOTES:** Dry, Sparse Vegetation

---

**DRILLING INFORMATION**

<table>
<thead>
<tr>
<th>DRILLING CO.</th>
<th>Enviro-Drill</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRILLER</td>
<td>Matt Cain</td>
</tr>
<tr>
<td>RIG TYPE</td>
<td>CME 75</td>
</tr>
<tr>
<td>METHOD OF DRILLING</td>
<td>Hollow Stem Auger / Air Rotary</td>
</tr>
<tr>
<td>SAMPLING METHODS</td>
<td>5 ft CME Barrel / Drill Cuttings</td>
</tr>
<tr>
<td>TOTAL DEPTH</td>
<td>120 feet BGS</td>
</tr>
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</table>

**PROJECT MANAGER:** Theresa Thompson

**SAMPLE NUMBER/ INTERVAL**

<table>
<thead>
<tr>
<th>DEPTH (FEET)</th>
<th>SOIL SYMBOL</th>
<th>USCS: SOIL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>CL: CLAY - dark reddish brown (2.5 YR 3/3), very stiff, slightly plastic, very silty, trace rootlets, trace caliche, homogenous, slightly damp</td>
<td></td>
</tr>
<tr>
<td>-5</td>
<td>CL: CLAY - dark reddish brown (2.5 YR 3/3), very stiff to hard, very slightly plastic, silty, fairly dense, homogenous, slightly damp, trace caliche from 12 to 14 ft bgs, trace coal inclusions</td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>ML: SILT - dark red (2.5 YR 3/6), poorly indurated, broken, clayey laminae, non plastic, weak dry strength, dry, trace of very fine grained sand</td>
<td></td>
</tr>
<tr>
<td>-15</td>
<td>ML: SILT - dark red (2.5 YR 3/6), very stiff to hard, very clayey to slightly sandy in parts, non to very slightly plastic, slightly damp, trace scattered caliche, towards base interbedded with &lt; 1/2-inch thick gray very fine grained sandstone, well cemented, dry, slightly to moderately friable</td>
<td></td>
</tr>
<tr>
<td>-20</td>
<td>CL: CLAY - red (2.5 YR 4/6), very sandy, less sandy with depth, very stiff to hard, non to very slightly plastic, silty, slightly damp in parts, trace mica crystals</td>
<td></td>
</tr>
<tr>
<td>-25</td>
<td>CL: CLAY - red (2.5 YR 5/6), some varigated shades of red, hard, non to very slightly plastic, dense, broken, crumbly in parts, silty, trace gray caliche, dry</td>
<td></td>
</tr>
<tr>
<td>-30</td>
<td>CL: CLAY - very stiff to hard, non to very slightly plastic, broken to dense, slightly silty, trace sand, dry</td>
<td></td>
</tr>
<tr>
<td>-35</td>
<td>SC: SAND - gray, hard, very fine grained, well to poorly indurated, interbedded with clays, hard drilling - drill rig is chattering</td>
<td></td>
</tr>
<tr>
<td>-40</td>
<td>ML: SILT - reddish brown (2.5 YR 5/4), dense to brittle, crumbly, fair induration in parts, clayey, trace gray clay inclusion</td>
<td></td>
</tr>
<tr>
<td>-45</td>
<td>ML: SILT - red (2.5 YR 5/8), some varigated colors, dense, blocky to crumbly, gray very fine grained sandstone scattered throughout, dry,</td>
<td></td>
</tr>
<tr>
<td>-50</td>
<td>ML: SILT - reddish brown (2.5 YR 5/8), some varigated colors, dense, blocky to crumbly, gray very fine grained sandstone scattered throughout, dry,</td>
<td></td>
</tr>
<tr>
<td>-55</td>
<td>ML: SILT - red (2.5 YR 5/8), some varigated colors, dense, blocky to crumbly, gray very fine grained sandstone scattered throughout, dry,</td>
<td></td>
</tr>
<tr>
<td>-60</td>
<td>ML: SILT - red (2.5 YR 5/8), some varigated colors, dense, blocky to crumbly, gray very fine grained sandstone scattered throughout, dry,</td>
<td></td>
</tr>
<tr>
<td>-65</td>
<td>ML: SILT - red (2.5 YR 5/8), some varigated colors, dense, blocky to crumbly, gray very fine grained sandstone scattered throughout, dry,</td>
<td></td>
</tr>
<tr>
<td>-70</td>
<td>ML: SILT - red (2.5 YR 5/8), some varigated colors, dense, blocky to crumbly, gray very fine grained sandstone scattered throughout, dry,</td>
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</tr>
</tbody>
</table>

**RECOVER/ ADVANCE (inches)**

<table>
<thead>
<tr>
<th>DEPTH</th>
<th>INTERVAL</th>
<th>RECOVER ADVANCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>One groundwater sample (FW-EMW02) along with a QA and QC sample was collected for laboratory analyses. No soil samples were collected for laboratory analyses.</td>
<td>48/60</td>
</tr>
<tr>
<td>50/60</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>60/60</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>65/60</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>70/60</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

**WELL DESCRIPTION**

- 4 ft x 4 ft aboveground concrete surface completion
- Borehole diameter 7 3/4" to 67.5 ft using hollow stem augers
- 2" PVC riser with cement/bentonite grout
- Encounter refusal with HSA. Switch to...
<table>
<thead>
<tr>
<th>DEPTH (FEET)</th>
<th>SOIL SYMBOLS</th>
<th>USCS: SOIL DESCRIPTION</th>
<th>SAMPLE NUMBER</th>
<th>ADVANCE/RECOVER (feet)</th>
<th>PID ppm</th>
<th>BORING COMPLETION</th>
<th>WELL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>-75</td>
<td></td>
<td>hard drilling, drill rig is chattering</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-80</td>
<td>ML: SILT</td>
<td>reddish brown (2.5 YR 4/4), clayey, trace of fine grained sand, dry</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-85</td>
<td>ML: SILT</td>
<td>red (2.5 YR 5/6), very clayey, crumbly, dry</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-90</td>
<td>CL: CLAY</td>
<td>red (2.5 YR 5/6), silty, very stiff to hard, blocky, dry</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-95</td>
<td>ML: SILT</td>
<td>reddish brown (2.5 YR 4/4), clayey, fair induration, dry</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-100</td>
<td>CL: CLAY</td>
<td>reddish brown (2.5 YR 5/4), very stiff, broken, silty, moist at 103 ft bgs</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-105</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-110</td>
<td>ML: SILT</td>
<td>very clayey, slightly plastic, loose, moist</td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-115</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-120</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total Depth = 120 feet below ground surface
## PROJECT INFORMATION

- **PROJECT:** Eastern Landfill
- **SITE LOCATION:** Fort Wingate Depot Activity
- **JOB NO.:** 794A
- **LOGGED BY:** Larry Basilio
- **PROJECT MANAGER:** Theresa Thompson
- **DATE DRILLED:** 7/19/04 to 7/21/04

## DRILLING INFORMATION

- **DRILLING CO.:** Enviro-Drill
- **DRILLER:** Matt Cain
- **RIG TYPE:** CME 75
- **METHOD OF DRILLING:** Hollow Stem Auger / Air Rotary
- **SAMPLING METHODS:** 5 ft CME Barrel / Drill Cuttings
- **TOTAL DEPTH:** 100 feet BGS

## NOTES:
- Dry, Sparse Vegetation
- Initial Water Level
- Static Water Level

## DEPTH (FEET) | SOIL SYMBOL | USCS: SOIL DESCRIPTION | SAMPLE NUMBER | INTERVAL | RECOVERY ADVANCE (INCHES) | PID (ppm) | WELL DETAIL | WELL DESCRIPTION
--- | --- | --- | --- | --- | --- | --- | --- | ---
0 | CL: CLAY - silty, very stiff, very slightly plastic, dry, fair dry strength, rootlets present
-5 | ML: SILT - light reddish brown (2.5 YR 6/4), very stiff to hard, non plastic, fair induration, clayey, dry
-10 | CL: CLAY - very stiff to hard, non plastic, silty, broken, abundant soft gray inclusions
-15 | ML: SILT - reddish brown (2.5 YR 5/4), clayey, crumbly, dry, low dry strength
-20 | ML: SILT - hard, blocky, slightly clayey, laminated with gray sandstone, dry, less sandy with depth
-25 | CL: CLAY - red (2.5 YR 4/6), silty, hard, non plastic, blocky, very silty in parts
-30 | CL: CLAY - red (2.5 YR 4/6), some varigated shades of red, very stiff to hard, non to very slightly plastic, silty, more silty with depth, crumbly, dry
-35 | ML: SILT - red (2.5 YR 5/6), crumbly, broken, clayey in parts, dry
-40 | 48/60
-45 | 60/60
-50 | 60/60
-55 | 60/60
-60 | 60/60
-65 | 60/60
-70 | 60/60

- 4 ft x 4 ft aboveground concrete surface completion
- Borehole diameter 7 3/4" to 85 ft using hollow stem augers
- 2" PVC riser with cement/bentonite grout
- Bentonite Seal
<table>
<thead>
<tr>
<th>DEPTH (FEET)</th>
<th>SOIL SYMBOLS</th>
<th>USCS: SOIL DESCRIPTION</th>
<th>SAMPLE NUMBER</th>
<th>ADVANCE/RECOVER (feet)</th>
<th>PID ppm</th>
<th>BORING COMPLETION</th>
<th>WELL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>-75</td>
<td></td>
<td>ML: SILT - light reddish brown (2.5 YR 6/4), fair to well indurated in parts, slightly sandy, dry, gray sandy laminae towards base, dry to very slightly damp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-80</td>
<td></td>
<td>ML: SILT - reddish brown (2.5 YR 4/4), hard, fair to good induration towards base, trace of gray sand, very fine grained, damp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-85</td>
<td></td>
<td>ML: SILT - red (2.5 YR 4/8), powdery, clayey, to very slightly sandy, damp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-90</td>
<td></td>
<td></td>
<td>60/60</td>
<td>0</td>
<td></td>
<td></td>
<td>0.010&quot; slot 2&quot; diameter PVC screen with 20/40 silica sand filter pack</td>
</tr>
<tr>
<td>-95</td>
<td></td>
<td></td>
<td>48/60</td>
<td>0</td>
<td></td>
<td></td>
<td>Encounter refusal with HSA. Switch to air rotary drilling at 85 ft. Borehole diameter 6&quot;, 85 ft to 100 ft.</td>
</tr>
<tr>
<td>-100</td>
<td></td>
<td></td>
<td>60/60</td>
<td>0</td>
<td></td>
<td></td>
<td>Slough</td>
</tr>
</tbody>
</table>

Total Depth = 100 ft below ground surface
**PROJECT INFORMATION**

**PROJECT:** Eastern Landfill  
**SITE LOCATION:** Fort Wingate Depot Activity  
**JOB NO.:** 794A  
**LOGGED BY:** Larry Basilio  
**PROJECT MANAGER:** Theresa Thompson  
**DATE DRILLED:** 7/21/04 to 7/23/04

**NOTES:** Dry, Sparse Vegetation

<table>
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<th>DEPTH (FEET)</th>
<th>SOIL SYMBOL</th>
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<th>SAMPLE NUMBER</th>
<th>RECOVERY INTERVAL</th>
<th>PID</th>
<th>WELL DETAIL</th>
<th>WELL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>ML: SILT - reddish brown (2.5 YR 4/4), very clayey, broken to powdery, dry</td>
<td>36/60</td>
<td>No soil or groundwater samples were collected for laboratory analyses.</td>
<td>4 ft x 4 ft aboveground concrete surface completion</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-5</td>
<td>CL: CLAY - reddish brown (2.5 YR 5/4), very hard, non plastic, very silty, well to poorly indurated, blocky in parts, dry, abundant weathered white caliche, abundant soft gray clay inclusions</td>
<td>60/60</td>
<td>0</td>
<td>Borehole diameter 7 3/4&quot; to 42 ft using hollow stem augers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-10</td>
<td>ML: SILT - reddish brown (2.5 YR 4/4), more red (2.5 YR 4/6) with depth, hard, well indurated, clayey, slightly sandy, dry, broken, looser and more powdery with depth, less inclusions</td>
<td>60/60</td>
<td>0</td>
<td>2&quot; PVC riser with cement/bentonite grout</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-15</td>
<td>ML: SILT - reddish brown (2.5 YR 4/4), very clayey, fair induration, broken and powdery in parts, dry, trace gray clay inclusions</td>
<td>60/60</td>
<td>0</td>
<td>Encounter refusal with HSA. Switch to air rotary drilling at 42 ft. Borehole diameter 6&quot;, 42 ft to 120 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-20</td>
<td>ML: SILT - reddish brown (2.5 YR 4/4), very clayey, increased clay content with depth, broken to crumbly, hard in parts, dry, trace gray clay inclusions</td>
<td>60/60</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-25</td>
<td>CL: CLAY - red (2.5 YR 5/6), hard, non to slightly plastic in parts, blocky to crumbly, dry</td>
<td>60/60</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-30</td>
<td>CL: CLAY - reddish brown (2.5 YR 5/4), hard, broken, blocky, silty to very silty in parts, fair to well indurated, dry</td>
<td>60/60</td>
<td>0</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>-35</td>
<td>ML: SILT - reddish brown (2.5 YR 5/4), hard, blocky, clayey, slightly sandy, well indurated, dry</td>
<td>24/24</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-40</td>
<td>ML: SILT - red (2.5 YR 5/6), clayey, powdery, dry</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-45</td>
<td>ML: SILT - light red (2.5 YR 6/6), crumbly to powdery, dry</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-50</td>
<td>ML: SILT - light red (2.5 YR 6/6), crumbly to powdery, dry</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-55</td>
<td>ML: SILT - light red (2.5 YR 6/6), crumbly to powdery, dry</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-60</td>
<td>ML: SILT - light red (2.5 YR 6/6), crumbly to powdery, dry</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-65</td>
<td>ML: SILT - light red (2.5 YR 6/6), crumbly to powdery, dry</td>
<td>0</td>
<td>0</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>-70</td>
<td>ML: SILT - light red (2.5 YR 6/6), crumbly to powdery, dry</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DEPTH (FEET)</td>
<td>SOIL SYMBOLS</td>
<td>USCS: SOIL DESCRIPTION</td>
<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-75</td>
<td></td>
<td>ML: SILT - as above, slightly damp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-80</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-85</td>
<td></td>
<td>ML: SILT - red (2.5 YR 4/6), loose, powdery, very clayey, dry to slightly damp</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-90</td>
<td></td>
<td>CL: CLAY - light red (2.5 YR 6/4), powdery, slightly silt, dry</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-95</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>-100</td>
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<tr>
<td>-115</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>-120</td>
<td></td>
<td>Total Depth = 120 ft below ground surface</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**WELL DESCRIPTION**

- Bentonite Seal
- 0.010" slot 2" diameter PVC screen with 30/40 silica sand filter pack
- Bottom cap
- Slough
APPENDIX F

AERIAL PHOTOGRAPHS
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APPENDIX G

RESULTS OF BATTELLE AIRBORNE GEOPHYSICS SURVEY
Legend

- Parcel 18 Boundary
- Landfill Trench/Surface Debris Areas
- Monitoring Well
- Water Trough

Results of Battelle Airborne Geophysics Survey (Battelle, 2009)
Phantom text generated by the system.

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC Environment & Infrastructure, Inc.

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 IR WORK PLAN

ANALYTIC SIGNAL MAP OF THE EAST LANDFILL

Legend
- Parcel 18 Boundary
- Landfill Trench/Surface Debris Areas

Results of Battelle Airborne Geophysics Survey (Battelle, 2009)

1 inch = 100 feet

912640002.0002.01
APPENDIX H

DOCUMENTATION OF CULTURAL RESOURCES CONSULTATION
This appendix contains information for which the distribution is limited to protect sensitive information or the privacy of private land owners. If you need to access this appendix please contact:

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Fort Wingate Depot Activity
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