# Final

# Investigation and Remediation Work Plan Parcel 18, Eastern Landfill

Fort Wingate Depot Activity
McKinley County, New Mexico

May 10, 2012

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
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_____

Mr. Mark Patterson
FWDA BRAC Environmental Coordinator

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## PREFACE

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 December 2011. 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.

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|---|---|
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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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# LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| µg/L | micrograms per liter |
| °C | degree centigrade |
| AMEC | AMEC Environment & Infrastructure, Inc. |
| ASTM | American Society for Testing Materials |
| bgs | below ground surface |
| BMPs | Best Management Practices |
| BRAC | Base Realignment and Closure |
| BRACD | BRAC Division |
| CFR | U.S. Code of Federal Regulations |
| COC | chain of custody |
| COPC | contaminant of potential concern |
| DOI | Department of the Interior |
| DRO | diesel range organics |
| EPA | U.S. Environmental Protection Agency |
| ERM | ERM Program Management Corporation |
| FWDA | Fort Wingate Depot Activity |
| GPS | Global Positioning System |
| GRO | gasoline range organics |
| HASP | Health and Safety Plan |
| HAZWOPER | Hazardous Waste Operations and Emergency Response |
| HHMSSL | Human Health Medium-Specific Screening Level |
| ID | identification |
| IDW | investigation-derived waste |
| LEL | lower explosive limit |
| LCS | laboratory control sample |
| MCL | Maximum Contaminant Level |
| MEC | munitions and explosives of concern |
| mg/L | milligrams per liter |
| mg/kg | micrograms per liter |
| MS/MSD | matrix spike/matrix spike duplicate |

## LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

| | |
|---|---|
| NAD | North America Datum |
| NESHAPS | National Emissions Standards for Hazardous Air Pollutants |
| NMED-HWB | New Mexico Environment Department-Hazardous Waste Bureau |
| NMED-SSL | NMED Soil Screening Level |
| OSE | Office of the State Engineer |
| PAH | polynuclear aromatic hydrocarbon |
| pg/L | picograms per liter |
| PCB | polychlorinated biphenyl |
| PID | photo-ionization detector |
| PPE | personal protective equipment |
| QA | quality assurance |
| QC | quality control |
| QA/QC | quality assurance/quality control |
| RCRA | Resource Conservation and Recovery Act |
| RDX | Royal Demolition Explosive |
| RPD | Relative Percent Difference |
| RSL | Regional Screening Level |
| RI | Remedial Investigation |
| SOW | Statement of Work |
| SSL | Soil Screening Levels |
| SSO | Site Safety Officer |
| SVOC | semivolatile organic compound |
| SWMU | Solid Waste Management Unit |
| SWPPP | Stormwater Pollution Prevention Plan |
| TEAD | Tooele Army Depot |
| TPH | total petroleum hydrocarbon |
| TtNUS | Tetra Tech NUS, Inc. |
| USACE | U.S. Army Corps of Engineers |
| UXO | unexploded ordnance |
| VOA | volatile organic analysis |
| VOC | volatile organic compound |
| WSMR | White Sands Missile Range |
| WQCC | Water Quality Control Commission |

# 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.

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);
- 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.

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# 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.

## 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:

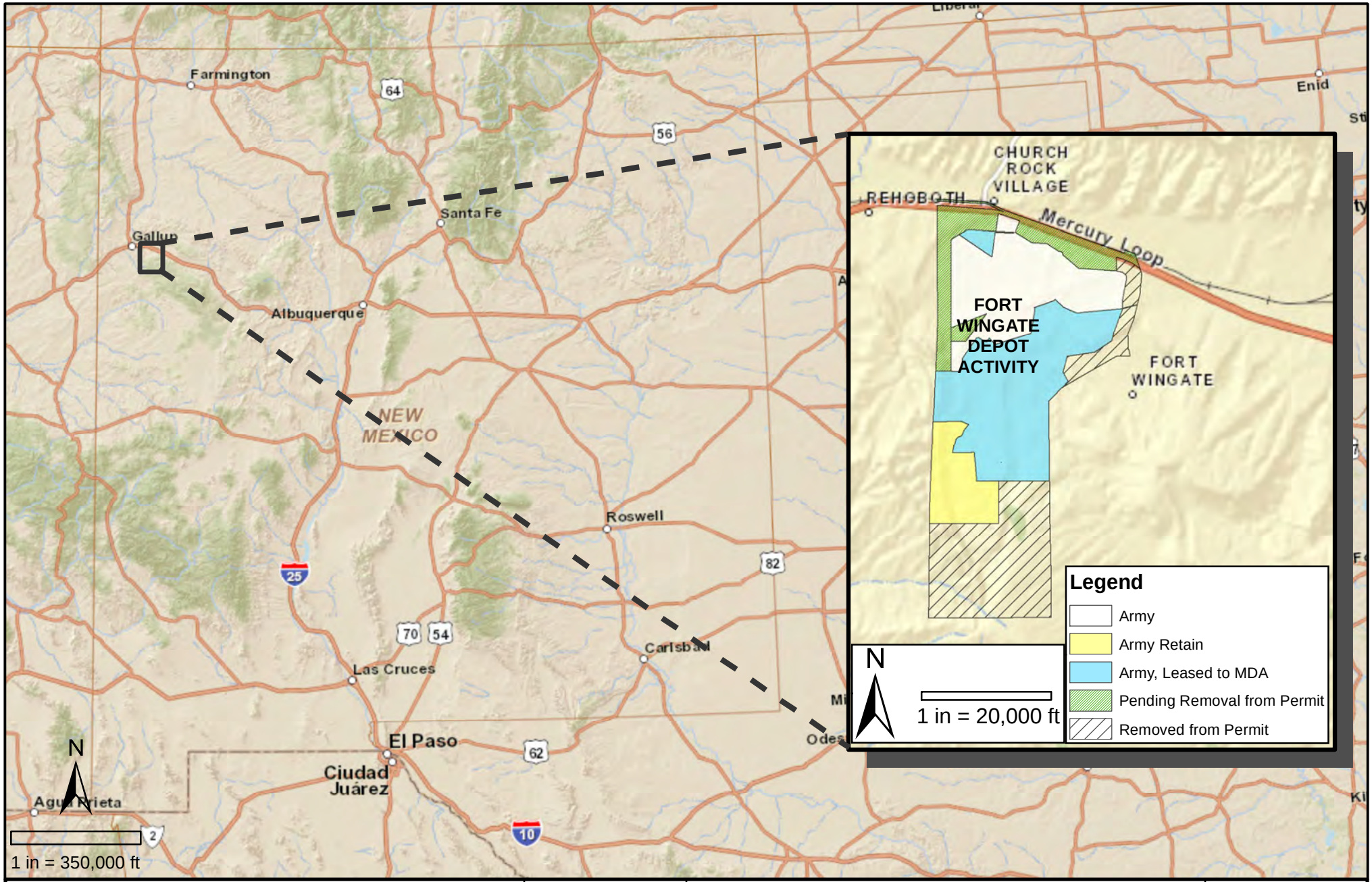
Section 2 – Provides background information related to FWDA and specifically Parcel 18, including a summary of previous investigations.

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.

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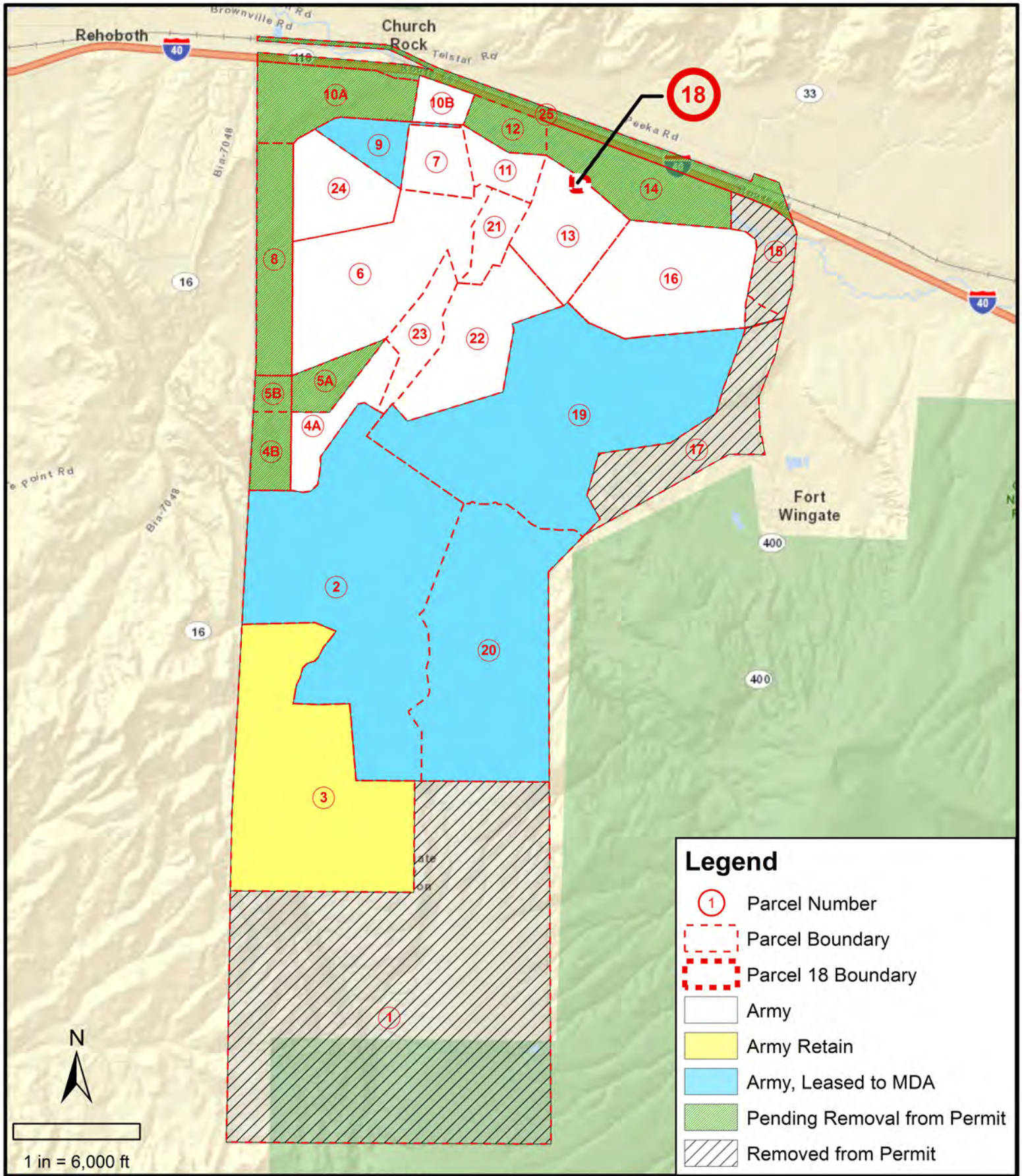
| **AMEC**<br>**Environment & Infrastructure, Inc.** | | **SITE LOCATION MAP** | FIGURE NO.: **1-1** |

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| AMEC<br>ENVIRONMENT & INFRASTRUCTURE, INC. | | PARCEL LOCATION MAP | FIGURE NO.: 1-2 |

# 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 A. As presented in Figure 2-3 and Appendix A, 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 HydrogeologyFour 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 C. The location of the monitoring wells is 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.

## 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 B, 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 C 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. One 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). Additional sampling was recommended by TtNUS. Appendix D 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.

### 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. 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.

The wells are assumed to be completed in the Painted Desert Member in silt/claystone with extremely low hydraulic conductivity. 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 E. 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 Batelle 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 F.

### 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.

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

| Month | High (°F) | Low (°F) | Mean (°F) | Average Precipitation (in) |
|---|---|---|---|---|
| January | 37.1 | 7.2 | 22.2 | 1.03 |
| February | 43.0 | 15.0 | 29.0 | 1.10 |
| March | 55.3 | 21.3 | 38.3 | 0.31 |
| April | 60.4 | 26.4 | 43.4 | 0.91 |
| May | 67.6 | 35.0 | 51.3 | 1.26 |
| June | 82.8 | 44.4 | 63.6 | 0.53 |
| July | 86.0 | 52.1 | 69.0 | 1.72 |
| August | 82.6 | 52.6 | 67.6 | 4.39 |
| September | 77.5 | 44.4 | 61.0 | 0.56 |
| October | 68.4 | 31.4 | 49.9 | 0.36 |
| November | 60.4 | 23.4 | 41.9 | 0.41 |
| December | 40.6 | 15.6 | 28.1 | 1.81 |
| Annual Mean | 63.5 | 30.7 | 47.1 | 14.39 |

## Table 2-2. Summary of Monitor Well Analytical Data

| Well ID | Analyte | Units | April 2009 | | October 2009 | | April 2010 | | October 2010 | | Standard Value | Standard Used | Standard Exceeded |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Result | Flag | Result | Flag | Result | Flag | Result | Flag | | | |
| EMW01 | Perchlorate | µg/L[1] | 0.52 | | 3.5 | | ND[2] | | ND | | 6 | Permit[3] | No |
| | Acetone | µg/L | 17 | | 6.1 | | ND | | ND | | 22000 | NC[4] | No |
| | Benzene | µg/L | 0.16 | J[5] | ND | | ND | | ND | | 5 | MCL[6] | No |
| | Chloromethane | µg/L | ND | | 0.2 | J | ND | | ND | | 190 | CA[7] | No |
| | Methyl ethyl ketone (2-Butanone) | µg/L | 2.2 | J | ND | | ND | | ND | | 7100 | NC | No |
| | Methyl isobutyl ketone (4-methyl-2-pentanone) | µg/L | 0.39 | J | ND | | ND | | ND | | 2000 | NC | No |
| | Toluene | µg/L | ND | | ND | | 1.28 | | ND | | 750 | WQCC[8] | No |
| | Vinyl chloride | µg/L | 0.088 | J | ND | | ND | | ND | | 1 | WQCC | No |
| | Bis(2-ethylhexyl)phthalate | µg/L | ND | | ND | | ND | | 2.26 | J | 6 | MCL | No |
| | Caprolactam | µg/L | ND | | 0.64 | J | ND | | ND | | 18000 | NC | No |
| | Phenol | µg/L | ND | | ND | | 1.16 | J | ND | | 5 | WQCC | No |
| | HPCDD,2,3,7,8- | pg/L[9] | ND | | ND | | ND | | 1.50 | J | N/A[10] | N/A | N/A |
| | Total tetrachlorodibenzofuran | pg/L | ND | | ND | | 1.06 | J | ND | | N/A | N/A | N/A |
| | **Arsenic** | mg/L[11] | **0.0116** | | NS[12] | | NS | | NS | | **0.0100** | **MCL** | **Yes** |
| | **Thallium** | mg/L | NS | | **0.00467** | **J** | NS | | NS | | **0.002** | **MCL** | **Yes** |
| EMW02 | Nitrate | mg/L | ND | | ND | | 0.697 | | 1.80 | J | 10 | MCL | No |
| | Bis(2-ethylhexyl)phthalate | µg/L | 4.4 | J | ND | | ND | | ND | | 6 | MCL | No |
| | Phenol | µg/L | ND | | ND | | 1.59 | J | ND | | 5 | WQCC | No |
| | **Manganese** | mg/L | **0.218** | | **0.221** | | NS | | NS | | **0.2** | **WQCC** | **Yes** |
| EMW03 | Nitrate | mg/L | ND | | 0.340 | J | 0.437 | J | ND | | 10 | MCL | No |
| | Nitrite | mg/L | ND | | 0.0700 | J | ND | | ND | | 1 | MCL | No |
| | Acetone | µg/L | ND | | ND | | ND | | 5.48 | J | 22000 | NC | No |
| | Methylene Chloride | µg/L | ND | | 0.2 | J | ND | | ND | | 5 | MCL | No |
| | Bis(2-ethylhexyl)phthalate | µg/L | 5.2 | J | ND | | ND | | ND | | 6 | MCL | No |

## Table 2-2. Summary of Monitor Well Analytical Data (Continued)

| Well ID | Analyte | Units | April 2009 | | October 2009 | | April 2010 | | October 2010 | | Standard Value | Standard Used | Standard Exceeded |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Result | Flag | Result | Flag | Result | Flag | Result | Flag | | | |
| EMW03 (Cont.) | Phenol | µg/L | ND | | ND | | 1.92 | J | 1.18 | J | 5 | WQCC | No |
| | Dibutyl phthalate | µg/L | ND | | ND | | 1.39 | J | ND | | 3700 | NC | No |
| | HPCDD,2,3,7,8- | pg/L | 0.854 | | ND | | ND | | ND | | N/A | N/A | N/A |
| | OCDF | pg/L | ND | | ND | | 1.01 | J | 2.66 | J | N/A | N/A | N/A |
| | Total tetrachlorodibenzofuran | pg/L | ND | | ND | | 7.10 | J | ND | | N/A | N/A | N/A |
| EMW04 | **Nitrate** | mg/L | 0.0200 | J | 1.20 | | **15.6** | **J** | **15.0** | **J** | **10** | **MCL** | **Yes** |
| | Chloroform | µg/L | 0.083 | J | ND | | ND | | ND | | 0.19 | CA | No |
| | Methylene Chloride | µg/L | ND | | 0.1 | J | ND | | ND | | 5 | MCL | No |
| | Toluene | µg/L | ND | | 35 | | 9.13 | | 1.07 | | 750 | WQCC | No |
| | Bis(2-ethylhexyl)phthalate | µg/L | 4.8 | J | ND | | ND | | 2.18 | J | 6 | MCL | No |
| | Phenol | µg/L | ND | | ND | | 1.30 | J | ND | | 5 | WQCC | No |
| | **Arsenic** | mg/L | **0.0185** | | NS | | NS | | NS | | **0.0100** | **MCL** | **Yes** |
| | **Chromium** | mg/L | NS | | NS | | **0.175** | | **1.05** | | **0.1** | **MCL** | **Yes** |
| | **Manganese** | mg/L | **0.49** | | **0.312** | | **0.372** | J | **2.01** | **J** | **0.2** | **WQCC** | **Yes** |
| | **Nickel** | mg/L | NS | | **0.304** | | **0.416** | | **1.17** | | **0.2** | **WQCC** | **Yes** |

[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

| Well ID | Date | Purge Volume | Units | Notes |
|---|---|---|---|---|
| EMW01 | 24-Apr-09 | 17 | G | Pumped dry |
| | 15-Oct-09 | NR | | Low flow |
| | 10-Apr-10 | 14.18 | L | Low flow |
| | 12-Oct-10 | 2.59 | L | Pumped dry |
| EMW02 | 24-Oct-08 | 17 | G | Pumped dry |
| | 15-Oct-09 | NR | | Pumped dry |
| | 5-Oct-10 | 9.0 | L | Pumped dry |
| EMW03 | 24-Oct-08 | 29.2 | G | Pumped dry |
| | 16-Oct-09 | 3.25 | L | Low flow |
| | 17-Apr-10 | 2.8 | L | Low flow |
| | 9-Oct-10 | 20.5 | G | Pumped dry |
| EMW04 | 16-Apr-09 | 13 | G | Grundfos pump, pumped dry |
| | 14-Oct-09 | 8.0 | G | Bennett pump, pumped dry |
| | 12-Apr-10 | 2.5 | G | Bennett pump, pumped dry |
| | 9-Oct-10 | 6 | G | Bennett pump |

G = Gallons
L = Liters
NR = Not Recorded

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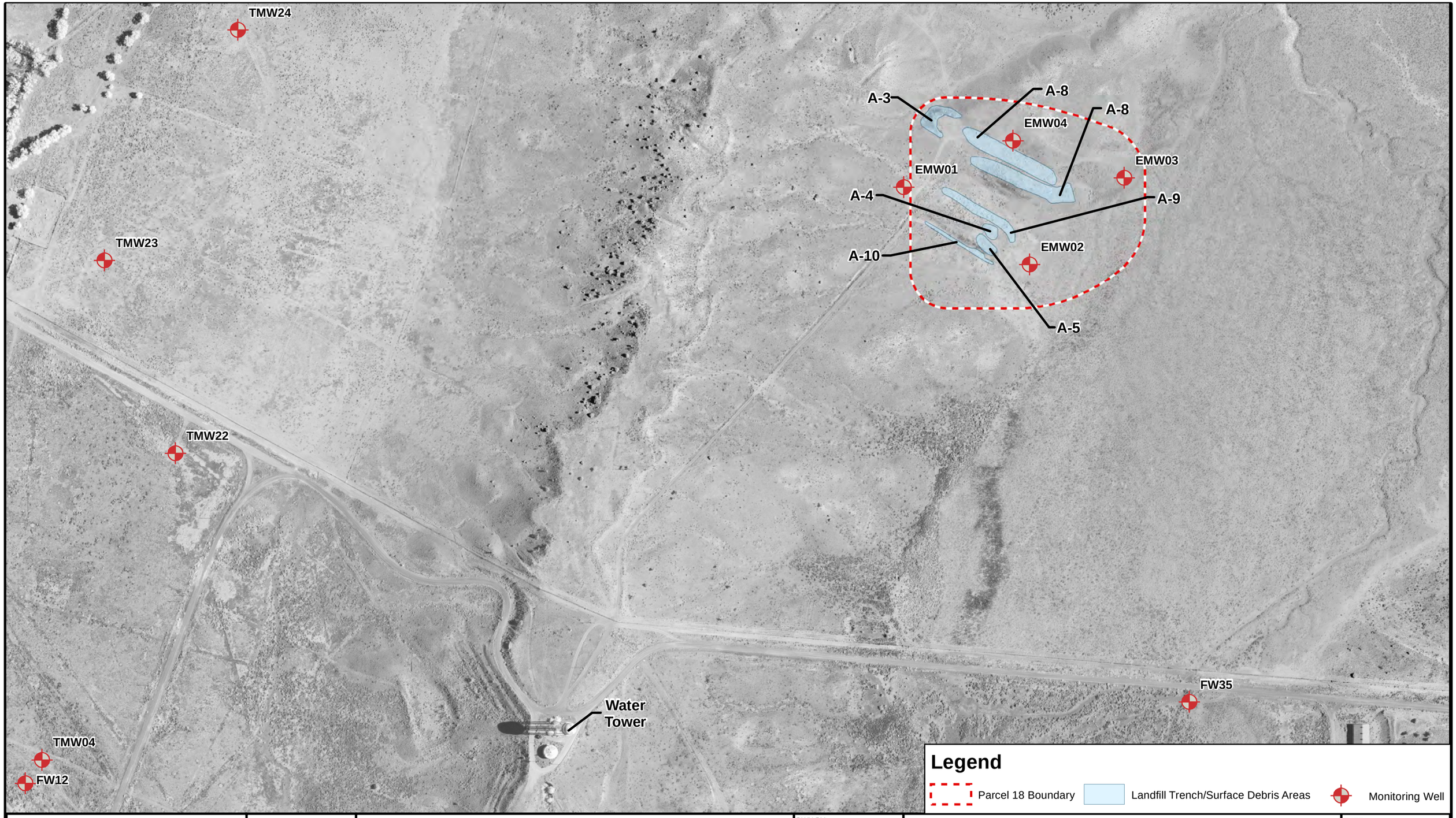


N

1 inch = 300 feet

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FORT WORTH DISTRICT

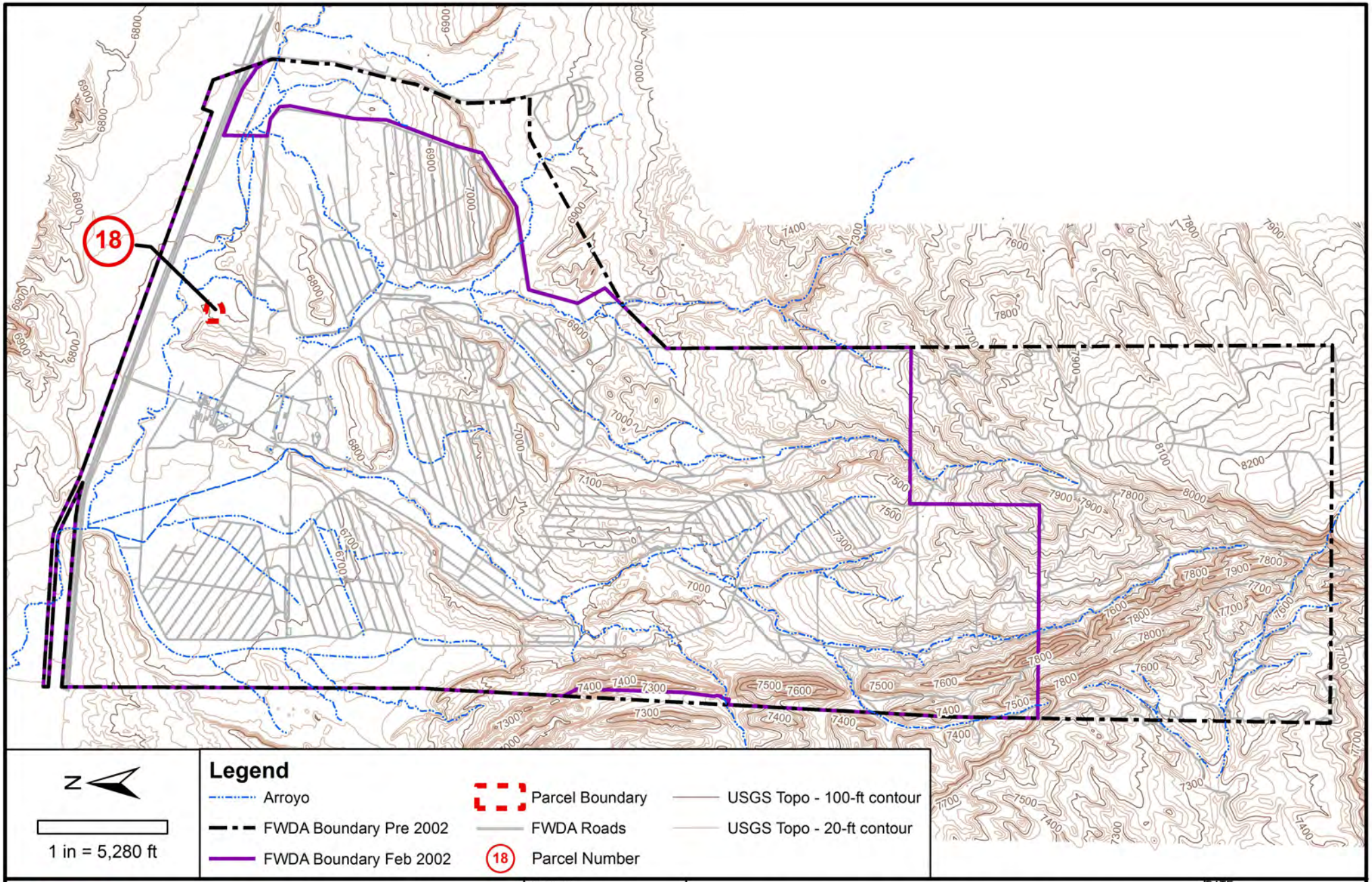
AMEC Environment & Infrastructure, Inc.

| | |
|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:3,600 |

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 IR WORK PLAN

SITE LOCATION

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0002.01 |
| FIGURE NO.: | 2-1 |

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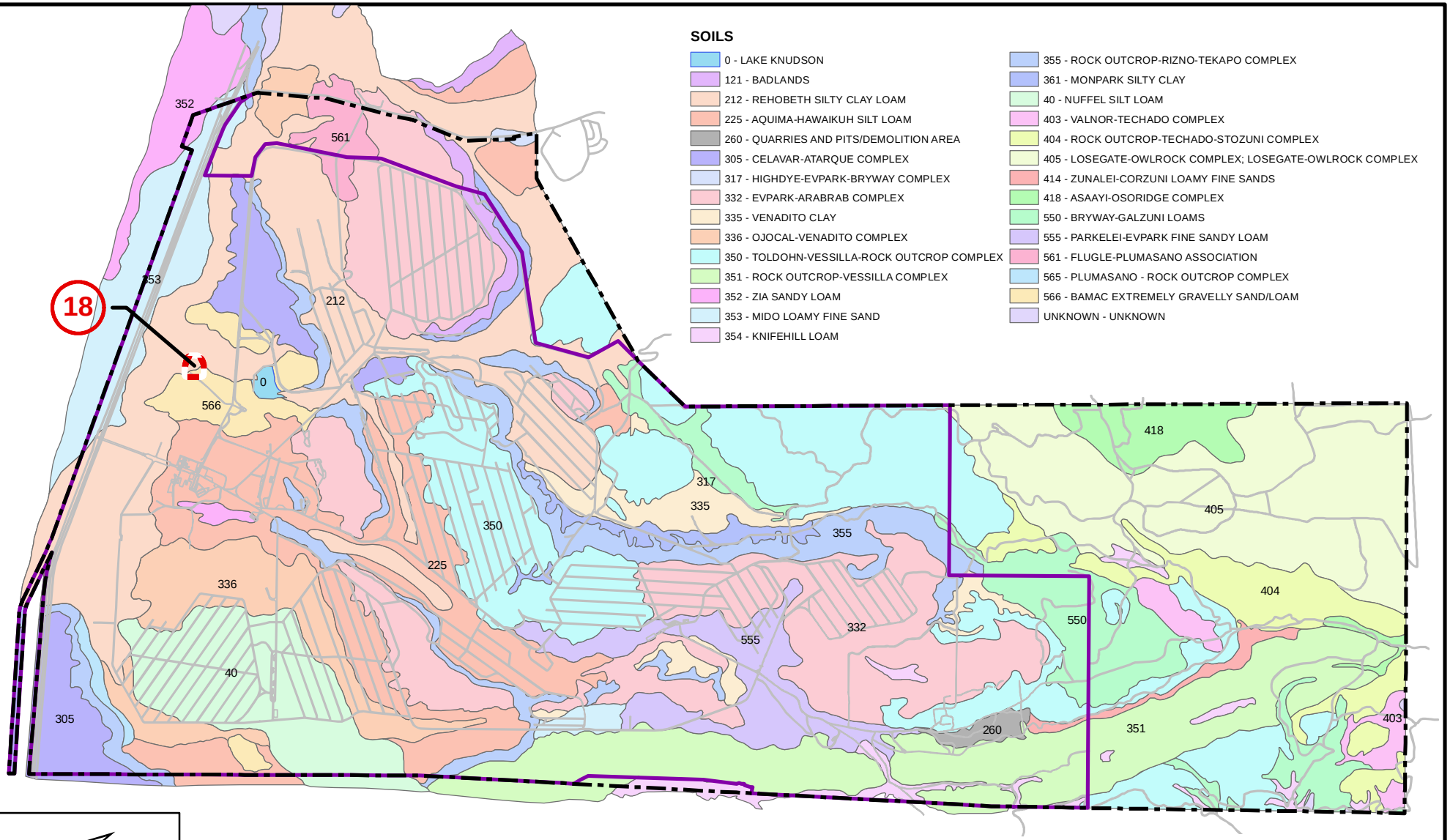
| | |
|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:63,360 |

# FORT WINGATE DEPOT ACTIVITY
# PARCEL 18 IR WORK PLAN

## FACILITY-WIDE TOPOGRAPHIC MAP

DATE: FEBRUARY 2012
PROJECT NO.: 912640002.0002.01
FIGURE NO.: 2-2




N

1 in = 5,280 ft

**Legend**

- FWDA Boundary Pre 2002
- FWDA Boundary Feb 2002
- Parcel Boundary
- 18 Parcel Number
- FWDA Roads

Source:
Natural Resources Conservation Service (NRCS)

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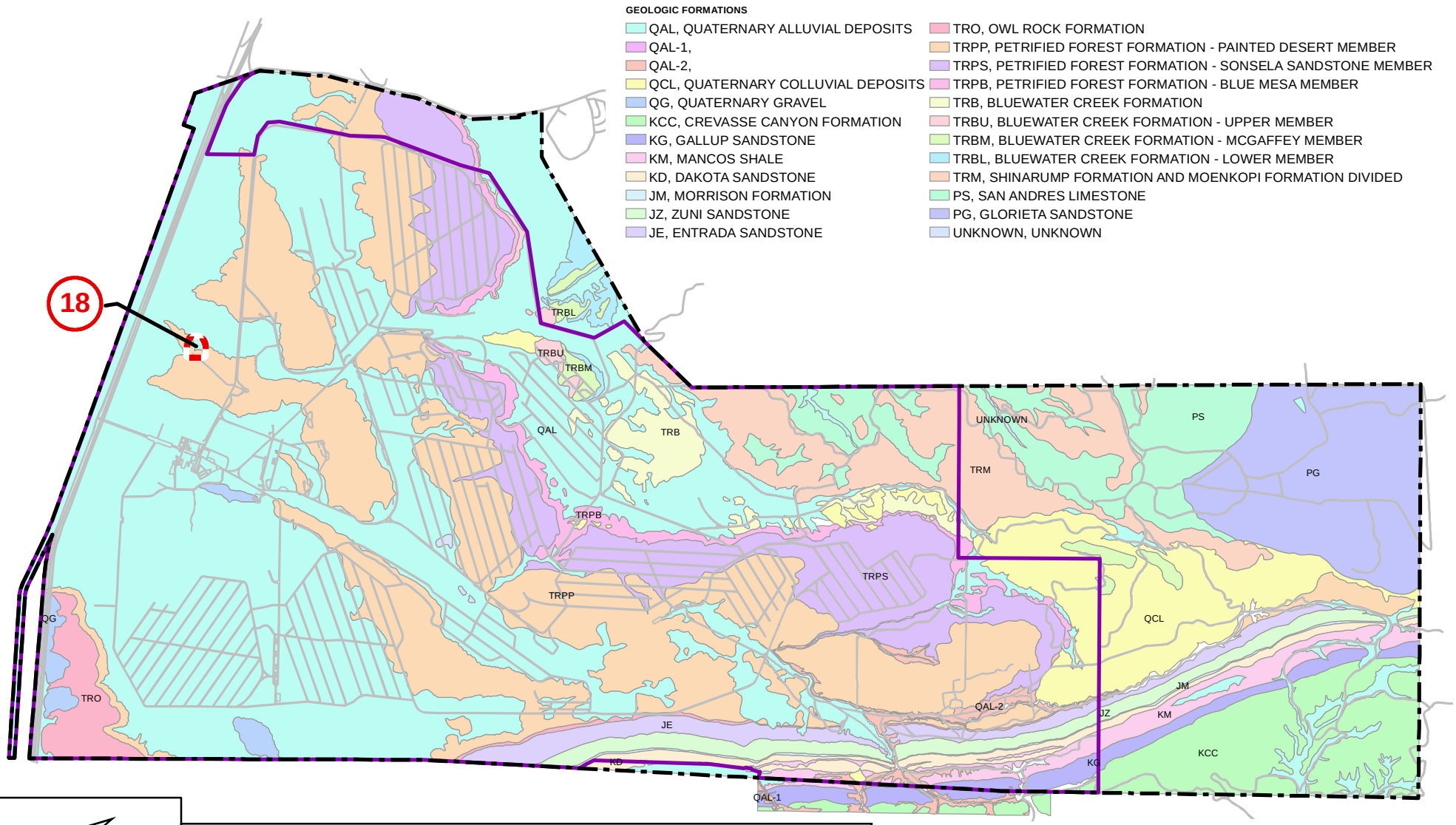
| | |
|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:63,360 |

# FORT WINGATE DEPOT ACTIVITY
# PARCEL 18 IR WORK PLAN

## FACILITY-WIDE SOILS MAP

DATE: FEBRUARY 2012
PROJECT NO.: 912640002.0002.01
FIGURE NO.: 2-3




N

1 in = 5,280 ft

**Legend**

- FWDA Boundary Pre 2002
- FWDA Boundary Feb 2002
- Parcel Boundary
- 18 Parcel Number
- FWDA Roads

Source: U.S. Geological Survey (USGS)

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**FORT WORTH DISTRICT**

**AMEC**
**Environment & Infrastructure, Inc.**

| | |
|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:63,360 |

# FORT WINGATE DEPOT ACTIVITY
# PARCEL 18 IR WORK PLAN

## FACILITY-WIDE GEOLOGIC MAP

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0002.01 |
| FIGURE NO.: | 2-4 |

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# 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;
- 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.

- The Permittee shall propose a soil cleanup level for PCBs based on NMED's Position Paper Risk-Based Remediation of Polychlorinated Biphenyls at RCRA Corrective Action Sites (March 2000 as updated).

- 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 $10^{-5}$).

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 Technical Background Document for Development of Soil Screening Levels, Revision 5.0 (NMED, 2009). 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. As FWDA has not yet proposed a site specific soil cleanup level for PCBs, the remediation goal for total PCBs will be 1 milligram per kilogram (mg/kg) and individual congeners will be evaluated based on NMED SSLs. The remediation goal for asbestos will be 1% asbestos as determined by Polarized Light Microscopy.

1 **Table 3-1. Summary of Soil Remediation Goals**

| Chemical | SSL for Residential (mg/kg)[1] | EPA Residential RSLs (mg/kg)[2] |
|---|---|---|
| **Volatile Organic Compounds[3]** | | |
| Acetone | 6.75E+04 | ------ |
| Benzene | 1.55E+01 | ------ |
| Bromodichloromethane | 5.25E+00 | ------ |
| Bromomethane | 2.23E+01 | ------ |
| 2-Butanone (Methyl ethyl ketone, MEK) | 3.96E+04 | ------ |
| tert-Butyl methyl ether (MTBE) | 8.62E+02 | ------ |
| Carbon disulfide | 1.94E+04 | ------ |
| Carbon tetrachloride | 4.38E+00 | ------ |
| Chlorobenzene | 5.08E+02 | ------ |
| Chloroform | 5.72E+00 | ------ |
| Chloromethane | 3.56E+01 | ------ |
| 1,2-Dibromo-3-chloropropane | 1.94E-01 | ------ |
| Dibromochloromethane | 1.19E+01 | ------ |
| 1,2-Dibromoethane (EDB) | 5.74E-01 | ------ |
| 1,2-Dichlorobenzene | 3.01E+03 | ------ |
| 1,4-Dichlorobenzene | 3.22E+01 | ------ |
| Dichlorodifluoromethane | 4.81E+02 | ------ |
| 1,1-Dichloroethane | 6.29E+01 | ------ |
| 1,2-Dichloroethane (EDC) | 7.74E+00 | ------ |
| cis-1,2-Dichloroethene | 7.82E+02 | ------ |
| trans-1,2-Dichloroethene | 2.73E+02 | ------ |
| 1,1-Dichloroethene (1,1-DCE) | 6.18E+02 | ------ |
| 1,2-Dichloropropane | 1.47E+02 | ------ |
| Ethylbenzene | 6.97E+01 | ------ |
| Hexachloro-1,3-butadiene | 6.11E+01 | ------ |
| Methylene chloride | 1.99E+02 | ------ |
| Naphthalene | 4.50E+01 | ------ |
| Styrene | 8.97E+03 | ------ |
| 1,1,1,2-Tetrachloroethane | 2.92E+01 | ------ |
| 1,1,2,2-Tetrachloroethane | 7.98E+00 | ------ |

| Chemical | SSL for Residential (mg/kg)[1] | EPA Residential RSLs (mg/kg)[2] |
|---|---|---|
| **Volatile Organic Compounds (continued)** | | |
| Tetrachloroethene (PCE) | 6.99E+00 | ------ |
| Toluene | 5.57E+03 | ------ |
| 1,2,4-Trichlorobenzene | 1.43E+02 | ------ |
| 1,1,1-Trichloroethane | 2.18E+04 | ------ |
| 1,1,2-Trichloroethane | 1.72E+01 | ------ |
| Trichloroethylene (TCE) | 4.57E+01 | ------ |
| Trichlorofluoromethane | 2.01E+03 | ------ |
| 1,2,3-Trichloropropane | 3.91E+02 | ------ |
| Vinyl chloride | 8.65E-01 | ------ |
| Xylenes | 1.09E+03 | ------ |
| **Semi-Volatile Organic Compounds[4]** | | |
| Benzyl alcohol | NS | 6.1E+03 |
| bis(2-Chloroethoxy)methane | NS | 1.8E+02 |
| bis(2-Chloroethyl)ether | 2.56E+00 | ------ |
| bis(2-Chloroisopropyl) ether | 9.15E+01 | ------ |
| bis(2-Ethylhexyl)phthalate | 3.47E+02 | ------ |
| Butyl benzyl phthalate | NS | 1.2E+04 |
| 2-Chloronaphthalene (b-Chloronaphthalene) | 6.26E+03 | ------ |
| 2-Chlorophenol | 3.91E+02 | ------ |
| Dibenzofuran | NS | 7.80.E+01 |
| Dibutyl phthalate (Di-n-butyl phthalate) | 6.11E+03 | ------ |
| 2,4-Dichlorophenol | 1.83E+02 | ------ |
| Diethyl phthalate | 4.89E+04 | ------ |
| Dimethyl phthalate | 6.11E+05 | ------ |
| 2,4-Dimethylphenol | 1.22E+03 | ------ |
| 4,6-Dinitro-2-methylphenol (4,6-Dinitro-o-cresol) | 6.11E+00 | ------ |
| 2,4-Dinitrophenol | 1.22E+02 | ------ |

| Chemical | SSL for Residential (mg/kg)[1] | EPA Residential RSLs (mg/kg)[2] |
|---|---|---|
| **Semi-Volatile Organic Compounds (continued)** | | |
| 2,4-Dinitrotoluene | 1.57E+01 | ------ |
| 2,6-Dinitrotoluene | 6.12E+01 | ------ |
| Hexachlorobenzene | 3.04E+00 | ------ |
| Hexachloroethane | 6.11E+01 | ------ |
| Isophorone | 5.12E+03 | ------ |
| 3- and 4-Methylphenol (o- and m-Cresol) | NS | 3.10.E+03 |
| 2-Methylphenol (p-Cresol) | NS | 3.10.E+02 |
| 2-Nitroaniline | NS | 6.10.E+02 |
| 4-Nitroaniline | NS | 2.40.E+02 |
| Nitrobenzene | 4.94E+01 | ------ |
| N-Nitrosodimethylamine | 9.54E-02 | ------ |
| N-Nitroso-di-N-propylamine | NS | 6.90E-01 |
| N-Nitrosodiphenylamine | 9.93E+02 | ------ |
| Pentachlorophenol | 2.98E+01 | ------ |
| Phenol | 1.83E+04 | ------ |
| 2,4,5-Trichlorophenol | 6.11E+03 | ------ |
| 2,4,6-Trichlorophenol | 6.11E+01 | ------ |
| **Polynuclear Aromatic Hydrocarbons[5]** | | |
| Acenaphthene | 3.44E+03 | ------ |
| Anthracene | 1.72E+04 | ------ |
| Benzo(a)anthracene | 6.21E+00 | ------ |
| Benzo(a)pyrene | 6.21E-01 | ------ |
| Benzo(b)fluoranthene | 6.21E+00 | ------ |
| Benzo(k)fluoranthene | 6.21E+01 | ------ |
| Chrysene | 6.21E+02 | ------ |
| Dibenz(a,h)anthracene | 6.21E-01 | ------ |
| Fluoranthene | 2.29E+03 | ------ |
| Fluorene | 2.29E+03 | ------ |
| Indeno(1,2,3-c,d)pyrene | 6.21E+00 | ------ |
| Naphthalene | 4.50E+01 | ------ |

| Chemical | SSL for Residential (mg/kg)[1] | EPA Residential RSLs (mg/kg)[2] |
|---|---|---|
| **Polynuclear Aromatic Hydrocarbons (continued)** | | |
| Phenanthrene | 1.83E+03 | ------ |
| Pyrene | 1.72E+03 | ------ |
| **Polychlorinated Biphenyls[6]** | | |
| Total PCBs | 1.00E+00 | |
| Aroclor 1016 | 3.93E+00 | ------ |
| Aroclor 1221 | 1.76E+00 | ------ |
| Aroclor 1232 | 1.76E+00 | ------ |
| Aroclor 1242 | 2.22E+00 | ------ |
| Aroclor 1248 | 2.22E+00 | ------ |
| Aroclor 1254 | 1.12E+00 | ------ |
| Aroclor 1260 | 2.22E+00 | ------ |
| **Explosives[7]** | | |
| 2-Amino-4,6-Dinitrotoluene | NS | 1.5E+02 |
| 4-Amino-2,6-Dinitrotoluene | NS | 1.5E+02 |
| 1,3-Dinitrobenzene | NS | 6.1E+00 |
| 2,4-Dinitrotoluene | 1.57E+01 | ------ |
| HMX | 3.06E+03 | ------ |
| Nitrobenzene | 4.94E+01 | ------ |
| m-Nitrotoluene | 1.56E+03 | ------ |
| o-Nitrotoluene | 2.91E+01 | ------ |
| p-Nitrotoluene | 2.44E+02 | ------ |
| RDX | 4.42E+01 | ------ |
| 1,3,5-Trinitrobenzene | NS | 2.2E+03 |
| Tetryl (Trinitrophenylmethylnitramine) | 2.44E+02 | ------ |
| 2,4,6-Trinitrotoluene | 3.59E+01 | ------ |
| **Chlorinated Pesticides[8]** | | |
| 4,4'-DDD | 2.03E+01 | ------ |
| 4,4'-DDE | 1.43E+01 | ------ |
| 4,4'-DDT | 1.72E+01 | ------ |
| Aldrin | 2.84E-01 | |

| Chemical | SSL for Residential (mg/kg)[1] | EPA Residential RSLs (mg/kg)[2] |
|---|---|---|
| **Chlorinated Pesticides (cont'd)** | | |
| Alpha-BHC | 7.72E-01 | ------ |
| Beta-BHC | 2.70E+00 | ------ |
| Gamma-BHC (Lindane) | 5.17E+00 | ------ |
| Chlordane | 1.62E+01 | ------ |
| Dieldrin | 3.04E-01 | ------ |
| Endosulfan | 3.67E+02 | ------ |
| Endrin | 1.83E+01 | ------ |
| Heptachlor | 1.08E+00 | ------ |
| Heptachlor Epoxide | NS | 7.9E-01 |
| Methoxychlor | NS | 3.1E+02 |
| Toxaphene | 4.42E+00 | ------ |
| **Organophosphorus Pesticides[9]** | | |
| Chlorpyrifos | NS | 6.1E+01 |
| Demeton, Total | NS | 2.4E+00 |
| Diazinon | NS | 4.3E+01 |
| Disulfoton | NS | 2.4E+02 |
| Ethion | NS | 3.1E+01 |
| Malathion | NS | 1.2E+03 |
| Methyl Parathion | NS | 1.5E+01 |
| Parathion | NS | 3.7E+02 |
| **Herbicides[10]** | | |
| 2,4-D | NS | 6.9E+02 |
| 2,4-DB | NS | 4.9E+02 |
| 2,4,5-T | NS | 6.1E+02 |
| 2,4,5-TP (Silvex) | NS | 4.9E+02 |
| Dicamba | NS | 1.8E+03 |
| Dichloroprop | NS | 4.9E+02 |
| Dinoseb | NS | 6.1E+01 |
| **Metals[11]** | | |
| Arsenic | 3.90E+00 | ------ |
| **Metals (continued)** | | |

| Chemical | SSL for Residential (mg/kg)[1] | EPA Residential RSLs (mg/kg)[2] |
|---|---|---|
| Barium | 1.56E+04 | ------ |
| Cadmium | 7.79E+01 | ------ |
| Chromium III | 1.13E+05 | |
| Chromium VI | 2.19E+02 | ------ |
| Lead | 4.00E+02 | ------ |
| Mercury (elemental) | 7.71E+00 | ------ |
| Selenium | 3.91E+02 | ------ |
| Silver | 3.91E+02 | ------ |

**Notes:**
1 = Soil Screening Levels from NMED 2009: Technical Background Document for Development of Soil Screening Levels, Revision 5.0
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

EPA = US Environmental Protection Agency
mg/kg = milligrams per kilogram
NS – Not Specified
NMED = New Mexico Environment Department

# 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 G. 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 Figure 4-1.

## 4.3 Pre-Excavation Grading and Waste Profile Sampling

Prior to initiating excavation activities, preliminary site grading and waste profile sampling activities will be conducted. 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.

During this initial mobilization, samples will also be collected for waste profiling purposes. 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 a maximum of 15,000 cubic yards of soil and debris will be excavated for landfill disposal. Therefore, a total of 15 waste profile samples will be collected for analysis. Approximate sample locations are illustrated in Figure 4-3. Samples from areas A-3, A-4, and A-5 will be collected from the surface. Samples from trenches A-8, A-9, and A-10 will be collected from within the landfill debris. Samples will be collected from each location and submitted for analysis of all COPCs listed in Section 3.2. Sample numbering will follow the protocol described in Section 5.4.

Additional trench excavation may be conducted at this time to determine the depth of debris in each of the identified landfill trenches. 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

The goal of the work reviewed 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. Excavation will be conducted utilizing a Cat 325 Excavator or equivalent. Overburden will be scraped from the surface of the landfill trenches and stockpiled for re-use during backfill operations. Landfill materials will be excavated and placed in temporary staging areas in stockpiles at the surface. Large pieces of metal debris will be segregated and transported for recycle as scrap steel. Remaining landfill material will be loaded into end-dump haul trucks utilizing a Cat 950 Loader (or equivalent). Landfill 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.

All excavations, stockpiles, 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 of the excavation. The Army proposes to conduct sampling approximately every 50 feet along the excavation floor as illustrated in Figure 4-6. Sample locations are approximate and will be biased toward any areas of stained or discolored soils, if present. 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.

Confirmation 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. 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. Sample numbering will follow the protocol described in Section 5.4.

## 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:

- Standard Proctor – American Society for Testing and Materials (ASTM) D698
- Gradation – ASTM C136
- Classification – ASTM D2487 and D4318

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. 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 document 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.

## 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.

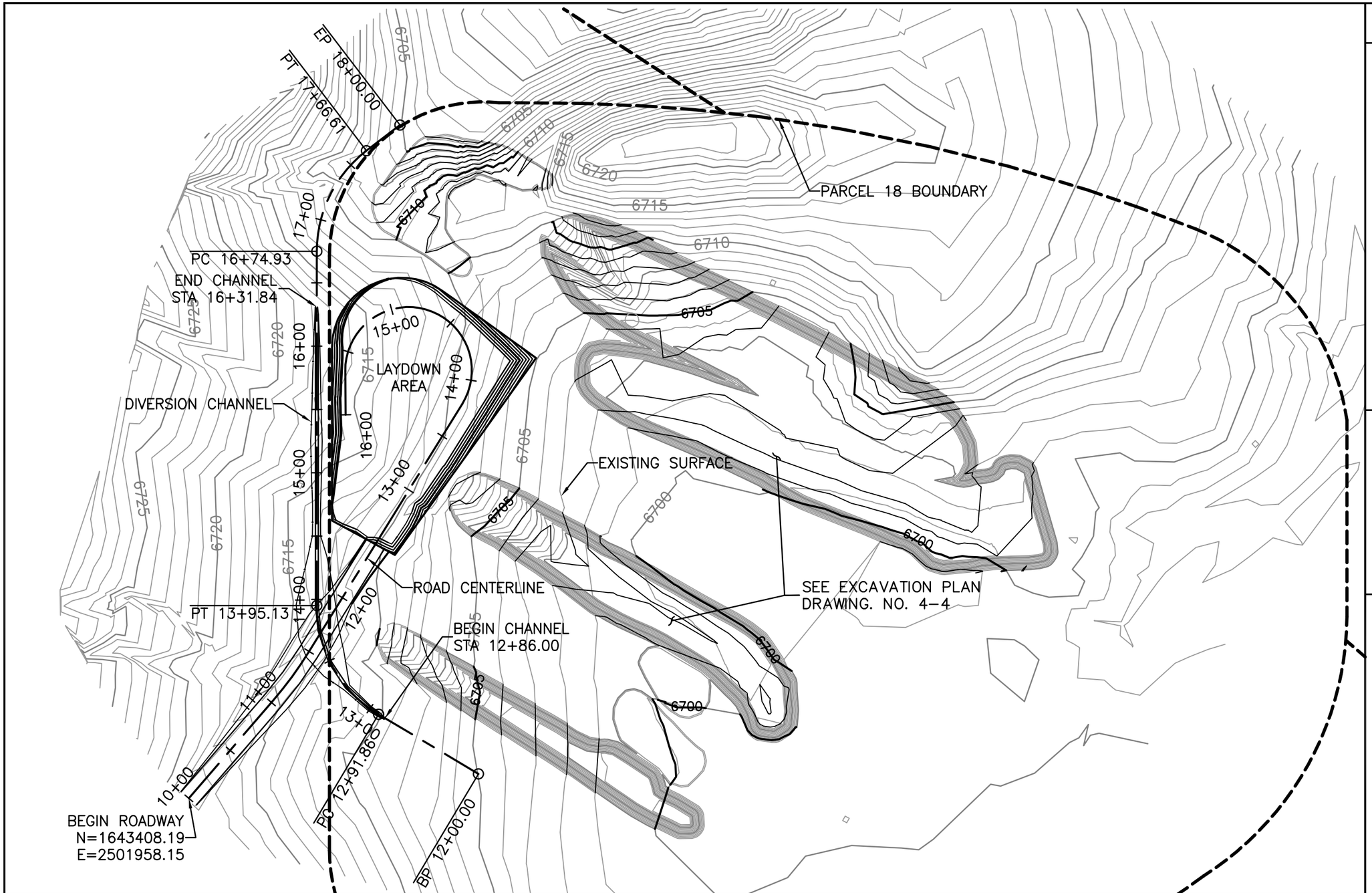
## 4.11 Project Schedule

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.

- 30 Days – Provide 30-day notice to NMED.
- 60 Days – Initial mobilization to conduct profile sampling and initial site grading.
- 105 Days – Mobilization to conduct excavation, disposal, confirmation sampling, backfill, and site restoration.
- 150 Days – Completion of field work.
- 180 Days – Submittal of Army Draft Final Report.
- 225 Days – Submittal of Tribal Draft Final Report.
- 315 Days – Receive Tribal comments on Final Report.
- 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.




## GENERAL NOTES

1. SURFACE DISTURBANCE WILL BE MINIMIZED AND LIMITED TO PREVENTING RUN-ON TO EXCAVATION AREAS.
2. SWALE LOCATION IS APPROXIMATE AND WILL BE LOCATED TO AVOID ANY POTENTIAL DISTURBANCE OF NEARBY ARCHAEOLOGICAL SITES.
3. GRADE TO DRAIN LAYDOWN AREA FROM EAST TO WEST AT 1% SLOPE.

N

0' 40' 80' 120'

1" = 80'

NOTE:

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC Environment & Infrastructure

| | |
|---|---|
| DWN BY: | SA |
| CHK'D BY: | SR |
| DATUM: | N/A |
| PROJECTION: | N/A |
| SCALE: | AS SHOWN |

PROJECT
FORT WINGATE DEPOT ACTIVITY
PARCEL 18, EASTERN LANDFILL

TITLE
EXISTING TOPOGRAPHIC SURFACE
AND INITIAL SITE GRADING

| | |
|---|---|
| DATE: | DEC 2011 |
| PROJECT NO: | 912640002.0002.01 |
| REV. NO.: | - |
| FIGURE NO. | 4-1 |

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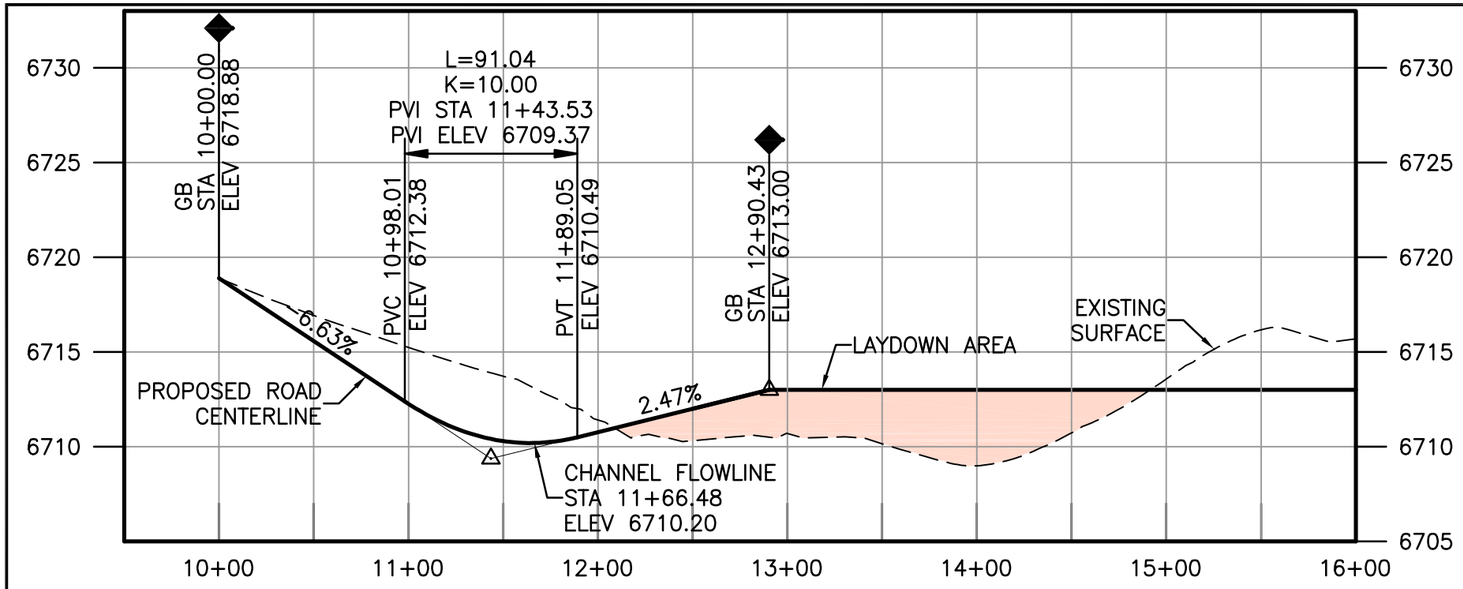
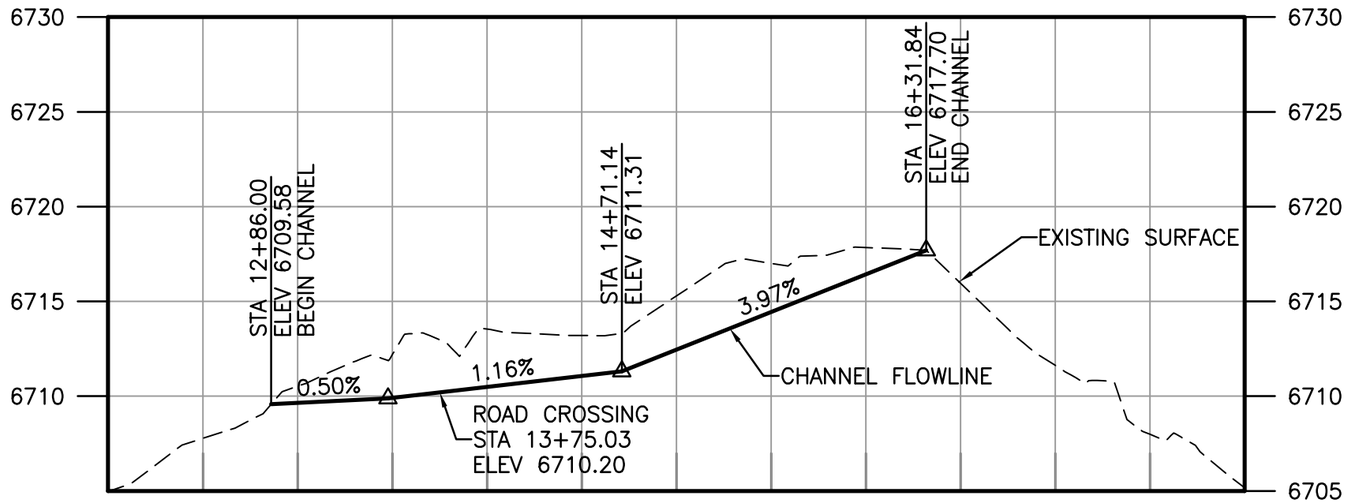
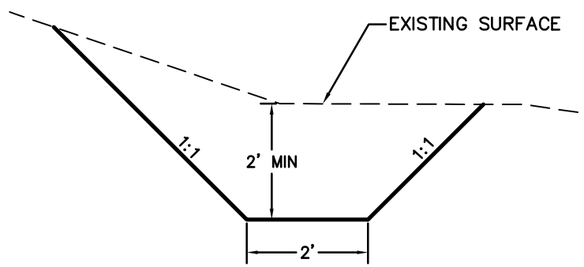



**Fort Wingate Road Profile**
**Vertical Exaggeration 10:1**
**SCALE 1"=80'**




**Diversion Channel Profile**
**Vertical Exaggeration 10:1**
**SCALE 1"=80'**




**Diversion Channel**
**Cross Section**
**N.T.S.**

## GENERAL NOTES

1. THE LIMITS AND DEPTHS OF COVER FILL SHOWN ARE ESTIMATED. SUFRACE DISTURBANCES WILL BE MINIMIZED TO THE EXTENT POSSIBLE AND LIMITED TO PREVENTING RUN-ON 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

NOTE:

**U.S. ARMY CORPS OF ENGINEERS**
**FORT WORTH DISTRICT**

**AMEC Environment & Infrastructure**

| | |
|---|---|
| DWN BY: | SA |
| CHK'D BY: | SR |
| DATUM: | N/A |
| PROJECTION: | N/A |
| SCALE: | AS SHOWN |

PROJECT
**FORT WINGATE DEPOT ACTIVITY**
**PARCEL 18, EASTERN LANDFILL**

TITLE
ROAD AND DIVERSION
CHANNEL PROFILES

| | |
|---|---|
| DATE: | DEC 2011 |
| PROJECT NO: | 912640002.0002.01 |
| REV. NO.: | - |
| FIGURE NO. | 4-2 |

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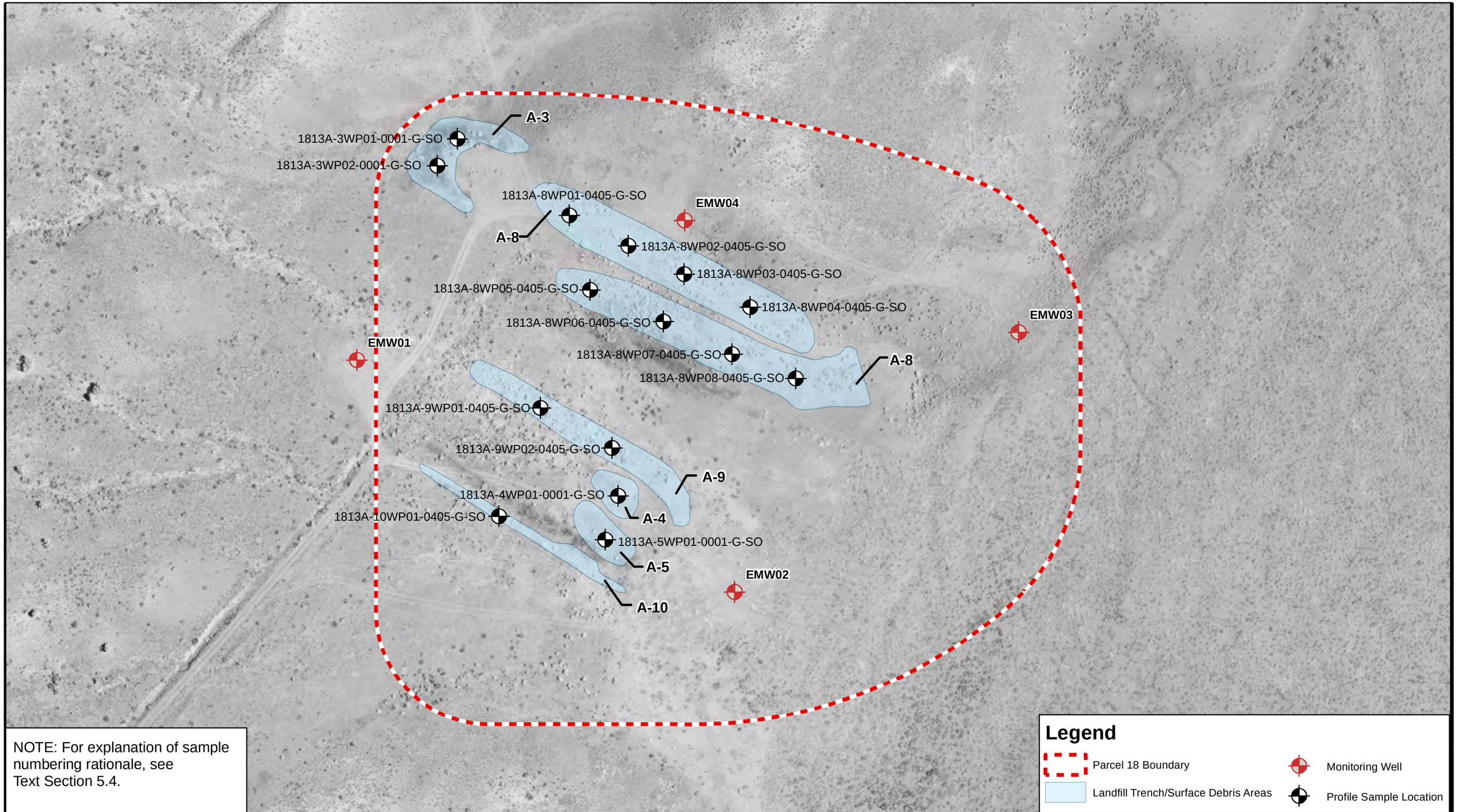



NOTE: For explanation of sample numbering rationale, see Text Section 5.4.

## Legend

- Parcel 18 Boundary
- Landfill Trench/Surface Debris Areas
- Monitoring Well
- Profile Sample Location

N

1 inch = 100 feet

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

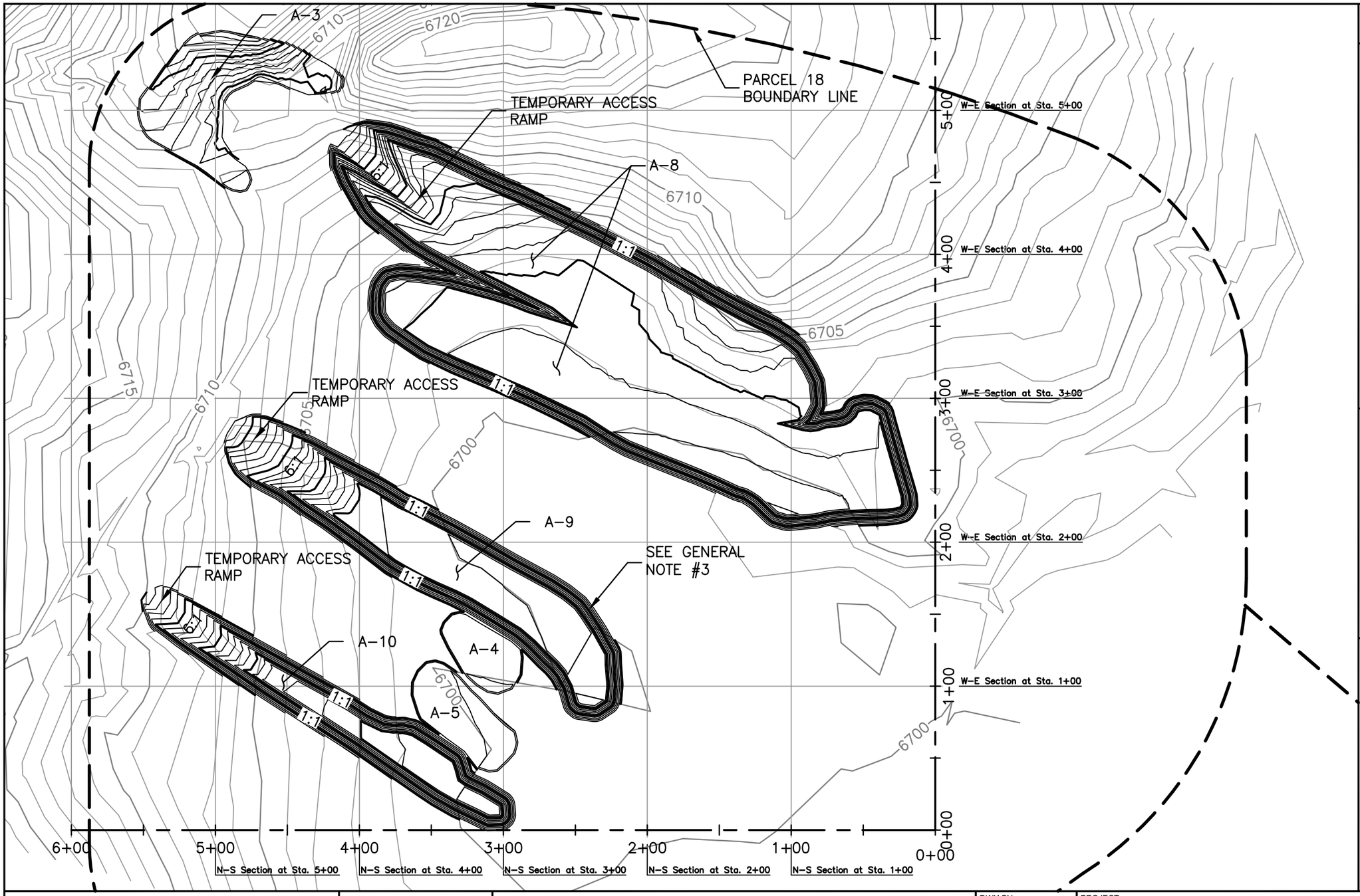
AMEC Environment & Infrastructure, Inc.

| | |
|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:1,200 |

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 IR WORK PLAN

APPROXIMATE PROFILE SAMPLE LOCATIONS

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0002.01 |
| FIGURE NO.: | 4-3 |




## GENERAL NOTES

1. EXCAVATION AREAS AND DEPTHS ARE ESTIMATED BASED ON AVAILABLE INFORMATION. ACTUAL EXCAVATION EXTENT WILL BE BASED ON VISUAL OBSERVATION AND CONFIRMATION SAMPLING RESULTS.
2. EXCAVATION AREAS WILL BE BERMED TO PREVENT RUN-ON.
3. BASED ON PREVIOUS SOIL BORING DATA, TYPE B SOILS AS DEFINED BY 29 CFR 1926 SUBPART P ARE ASSUMED. EM 385-1-1 ALLOWS A MAXIMUM 1:1 SLOPE FOR TYPE B SOILS. ADDITIONAL TESTING WILL BE PERFORMED ON SITE FOLLOWING THE PROCEDURES OUTLINED IN APPENDIX A OF 29 CFR 1926 SUBPART P PRIOR TO INITIATING EXCAVATION OPERATIONS TO CONFIRM THE APPROPRIATE SOIL TYPE; EXCAVATION SLOPES WILL BE ADJUSTED ACCORDINGLY.

## LEGEND

- 6700 — PROPOSED EXCAVATION MAJOR CONTOUR
- PROPOSED EXCAVATION MINOR CONTOUR
- PARCEL 18 BOUNDARY LINE
- A-3 — SURFACE DEBRIS/ TRENCH AREA DESIGNATION

N

0' 35' 70' 105'

1" = 70'

NOTE:

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC Environment & Infrastructure

| | |
|---|---|
| DWN BY: | SA |
| CHK'D BY: | SR |
| DATUM: | N/A |
| PROJECTION: | N/A |
| SCALE: | AS SHOWN |

PROJECT
FORT WINGATE DEPOT ACTIVITY
PARCEL 18, EASTERN LANDFILL

TITLE
EXCAVATION PLAN

| | |
|---|---|
| DATE: | DEC 2011 |
| PROJECT NO: | 912640002.0002.01 |
| REV. NO.: | - |
| FIGURE NO. | 4-4 |

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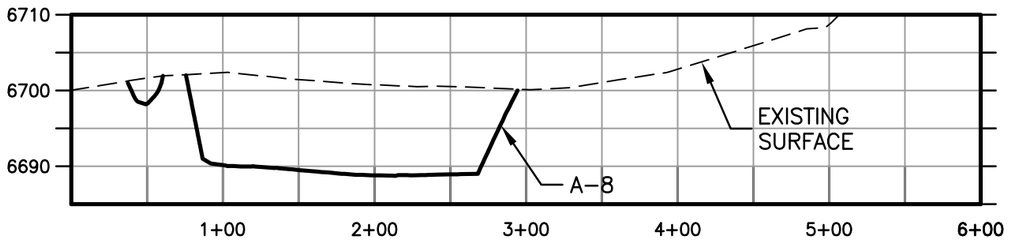
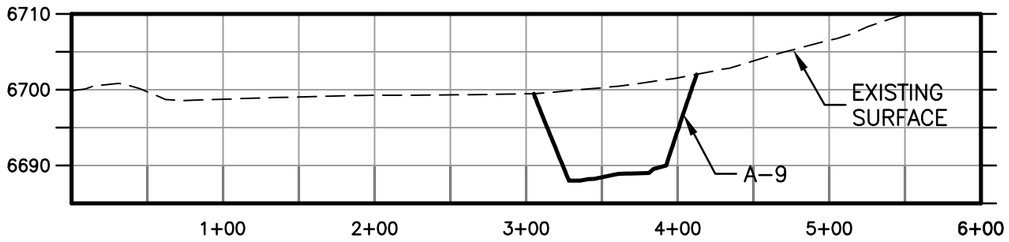
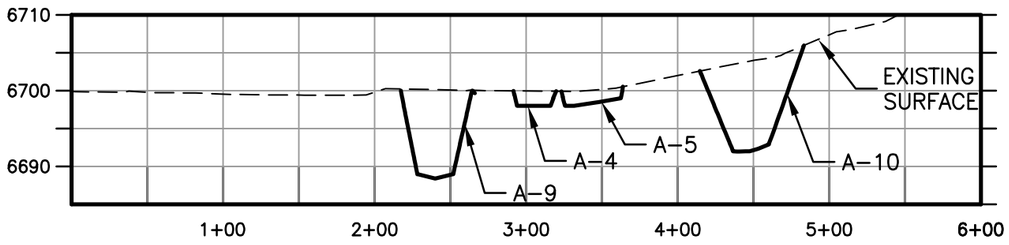


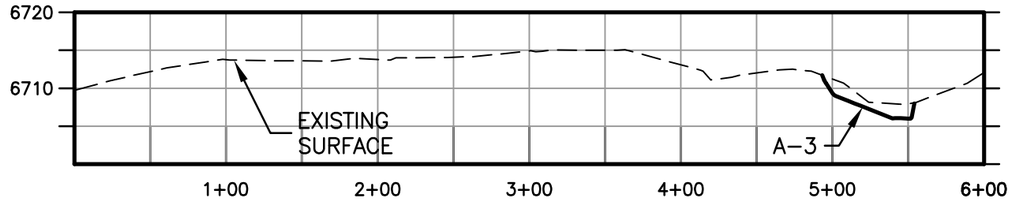

East–West Section at Sta. 3+00
Vertical Exaggeration 5:1
SCALE 1"=100'



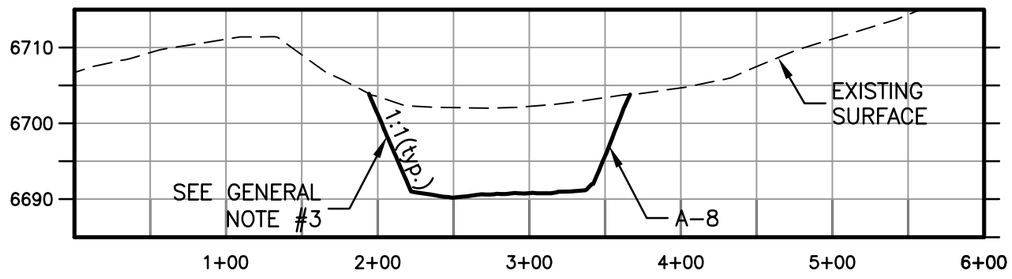

East–West Section at Sta. 2+00
Vertical Exaggeration 5:1
SCALE 1"=100'




East–West Section at Sta. 1+00
Vertical Exaggeration 5:1
SCALE 1"=100'




East–West Section at Sta. 5+00
Vertical Exaggeration 5:1
SCALE 1"=100'




East–West Section at Sta. 4+00
Vertical Exaggeration 5:1
SCALE 1"=100'

## GENERAL NOTES

1. EXCAVATION AREAS AND DEPTHS ARE ESTIMATED BASED ON AVAILABLE INFORMATION. ACTUAL EXCAVATION EXTENT WILL BE BASED ON VISUAL OBSERVATION AND CONFIRMATION SAMPLING RESULTS.
2. EXCAVATION AREAS WILL BE BERMED TO PREVENT RUN-ON.
3. BASED ON PREVIOUS SOIL BORING DATA, TYPE B SOILS AS DEFINED BY 29 CFR 1926 SUBPART P ARE ASSUMED. EM 385-1-1 ALLOWS A MAXIMUM 1:1 SLOPE FOR TYPE B SOILS. ADDITIONAL TESTING WILL BE PERFORMED ON SITE FOLLOWING THE PROCEDURES OUTLINED IN APPENDIX A OF 29 CFR 1926 SUBPART P PRIOR TO INITIATING EXCAVATION OPERATIONS TO CONFIRM THE APPROPRIATE SOIL TYPE; EXCAVATION SLOPES WILL BE ADJUSTED ACCORDINGLY.

## LEGEND

- EXISTING SURFACE
- PROPOSED TRENCH
- A–3 SURFACE DEBRIS/ TRENCH AREA DESIGNATION

NOTE:

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|---|---|
| DWN BY: | SA |
| CHK'D BY: | SR |
| DATUM: | N/A |
| PROJECTION: | N/A |
| SCALE: | AS SHOWN |

PROJECT: FORT WINGATE DEPOT ACTIVITY
PARCEL 18, EASTERN LANDFILL

TITLE: EXCAVATION PLAN
CROSS SECTIONS

| | |
|---|---|
| DATE: | DEC 2011 |
| PROJECT NO: | 912640002.0002.01 |
| REV. NO.: | - |
| FIGURE NO. | 4-5 |

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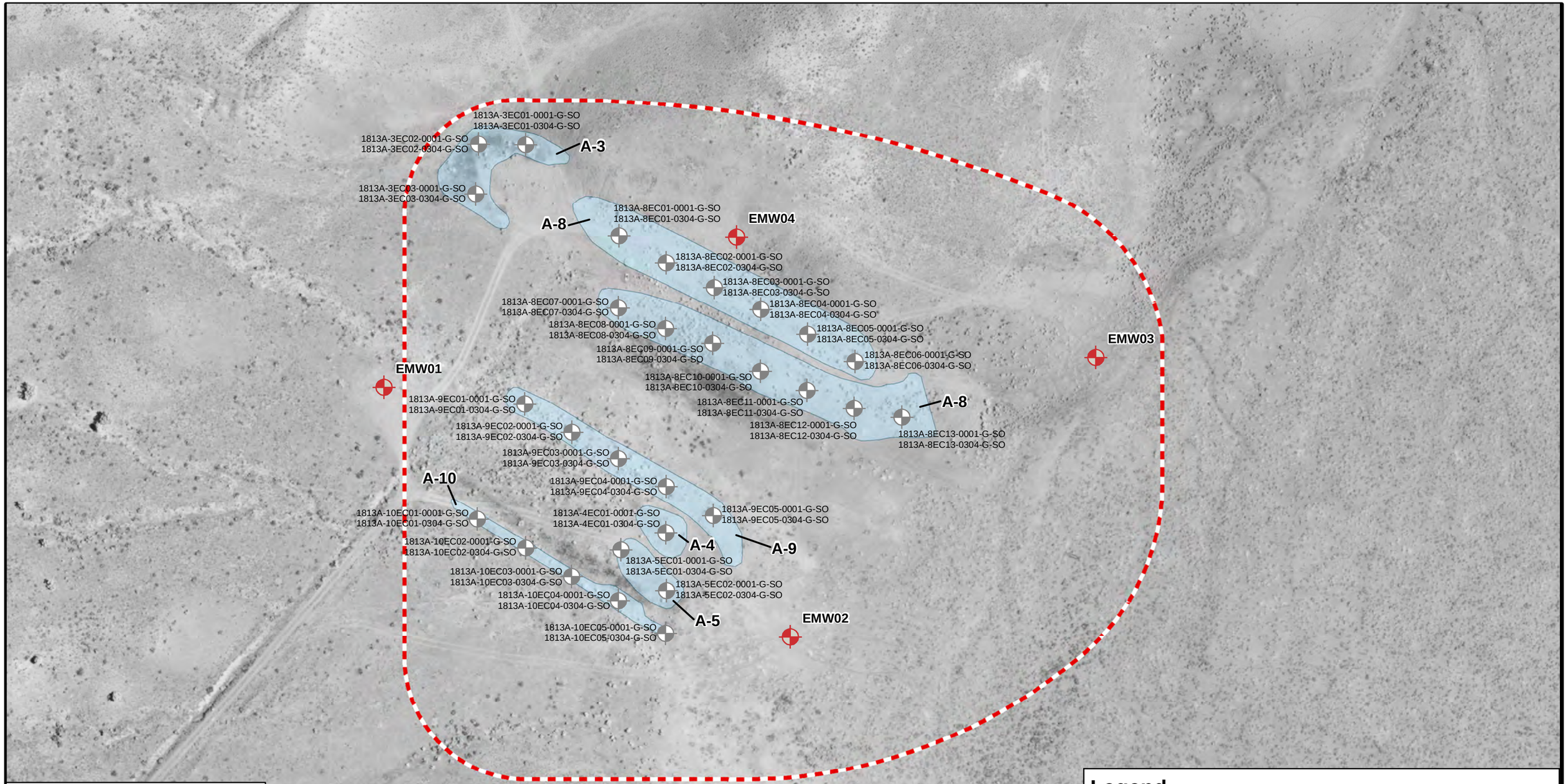


NOTE: For explanation of sample numbering rationale, see Text Section 5.4.

## Legend

- Parcel 18 Boundary
- Landfill Trench/Surface Debris Areas
- Monitoring Well
- Confirmation Sample Location

N

1 inch = 100 feet

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|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:1,200 |

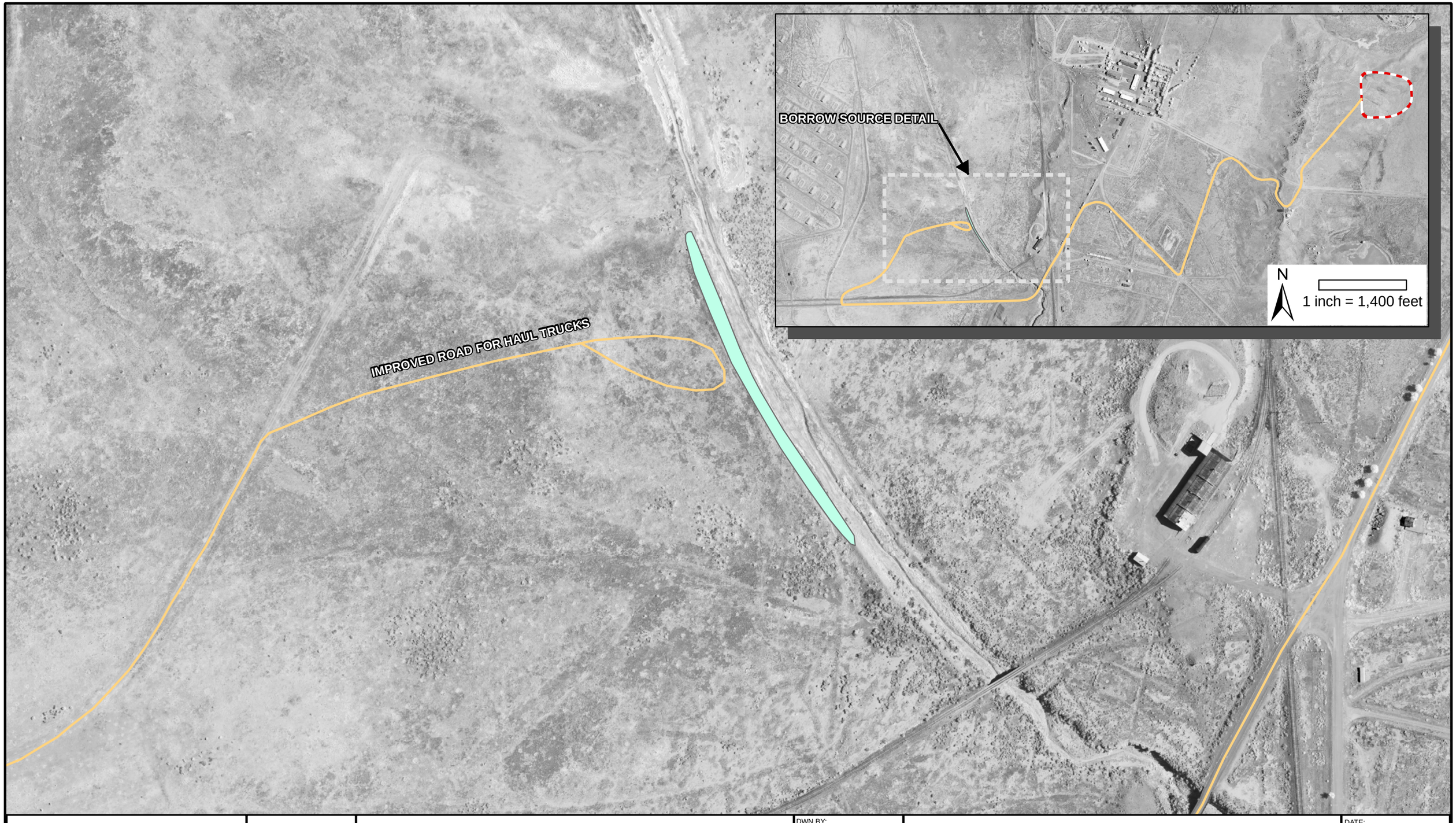
FORT WINGATE DEPOT ACTIVITY
PARCEL 18 IR WORK PLAN

APPROXIMATE CONFIRMATION SAMPLE LOCATIONS

DATE: FEBRUARY 2012

PROJECT NO.: 912640002.0002.01

FIGURE NO.: 4-6




N

1 inch = 200 feet

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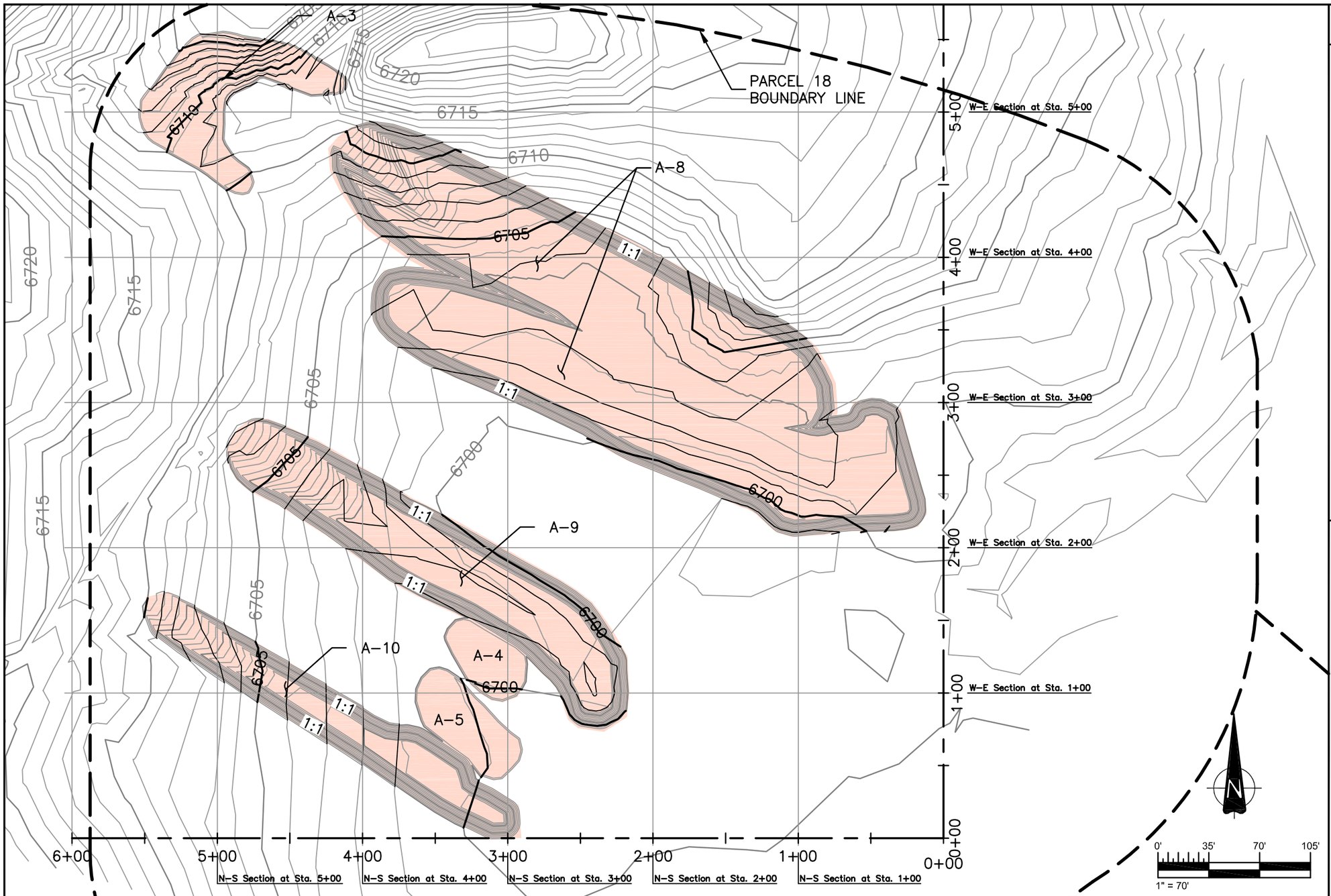
| | |
|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | |

**FORT WINGATE DEPOT ACTIVITY**
**PARCEL 18 IR WORK PLAN**

**BORROW SOURCE AND HAUL ROUTE**

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0002.01 |
| FIGURE NO.: | 4-7 |




## GENERAL NOTES

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 CONDITIONED AND COMPACTED TO OPTIMUM MOISTURE (±2%) 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 8- TO 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

- FILL AREA
- A-3 — SURFACE DEBRIS/ TRENCH AREA DESIGNATION
- 6700 — FINAL GRADING MAJOR CONTOUR
- FINAL GRADING MINOR CONTOUR
- PARCEL 18 BOUNDARY LINE

NOTE:

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| DWN BY: | SA |
| CHK'D BY: | SR |
| DATUM: | N/A |
| PROJECTION: | N/A |
| SCALE: | AS SHOWN |

PROJECT: FORT WINGATE DEPOT ACTIVITY
PARCEL 18, EASTERN LANDFILL

TITLE: BACKFILL AND FINAL GRADING PLAN

DATE: DEC 2011
PROJECT NO: 912640002.0002.01
REV. NO.: -
FIGURE NO. **4-8**

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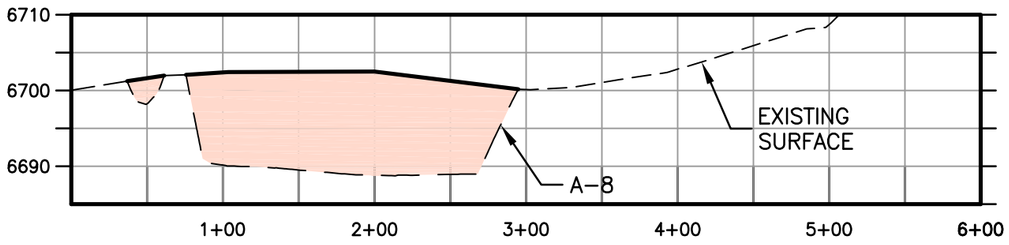
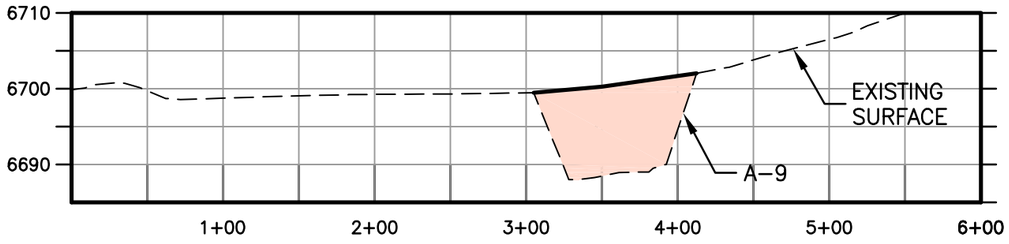
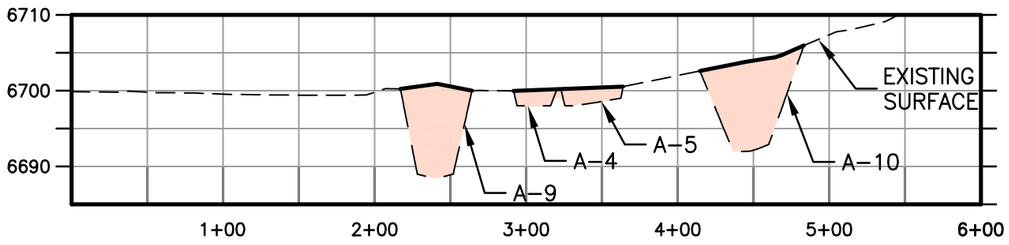


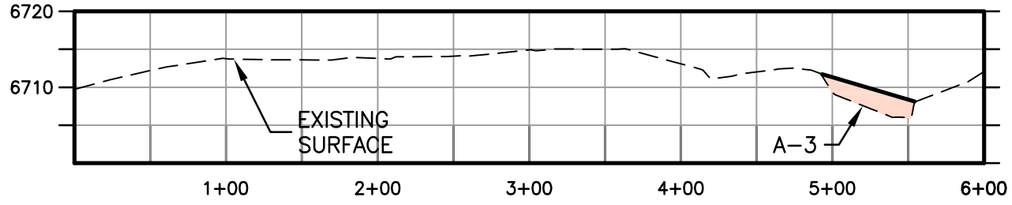

**East–West Section at Sta. 3+00**
**Vertical Exaggeration 5:1**
**SCALE 1"=100'**



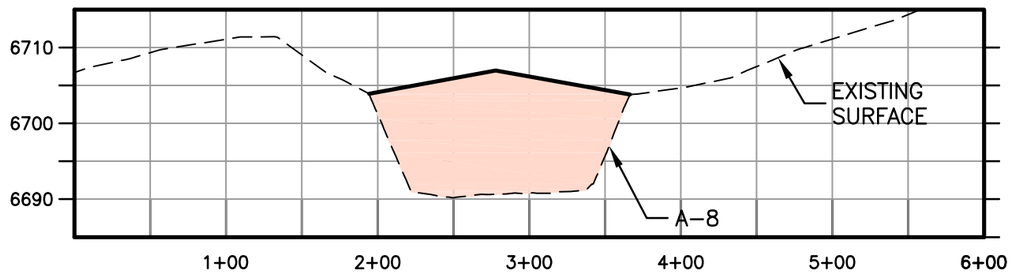

**East–West Section at Sta. 2+00**
**Vertical Exaggeration 5:1**
**SCALE 1"=100'**




**East–West Section at Sta. 1+00**
**Vertical Exaggeration 5:1**
**SCALE 1"=100'**




**East–West Section at Sta. 5+00**
**Vertical Exaggeration 5:1**
**SCALE 1"=100'**




**East–West Section at Sta. 4+00**
**Vertical Exaggeration 5:1**
**SCALE 1"=100'**

## GENERAL NOTES

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 12-INCH THICK LOOSELY PACKED LIFTS. EACH LIFT WILL BE CONDITIONED AND COMPACTED TO OPTIMUM MOISTURE (±2%) 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 8- TO 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
- A–3 — SURFACE DEBRIS/ TRENCH AREA DESIGNATION

NOTE:

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

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| DWN BY: | SA |
| CHK'D BY: | SR |
| DATUM: | N/A |
| PROJECTION: | N/A |
| SCALE: | AS SHOWN |

PROJECT: FORT WINGATE DEPOT ACTIVITY
PARCEL 18, EASTERN LANDFILL

TITLE: FILL PLAN
CROSS SECTIONS

| | |
|---|---|
| DATE: | DEC 2011 |
| PROJECT NO: | 912640002.0002.01 |
| REV. NO.: | - |
| FIGURE NO. | 4-9 |

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# 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:

$$\%RPD = \{(S - D)/[(S + D)/2]\} \times 100$$

where:

S = first sample value (original value)
D = second sample value (duplicate value)

The precision criteria for the duplicate samples will be ±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

$$\%R = (A/B) \times 100$$

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

$$\%Completeness = [(complete\ data\ obtained)/(total\ data\ planned)] \times 100$$

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-G-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: G (grab)

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-G-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.

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## Table 5-1. Summary of Analytical Methods, Sample Containers, Preservation, and Holding Times

| Target Analytes | Matrix | Analytical Method (EPA SW846) | Sample Volume/Container | Preservative | Holding Time |
|---|---|---|---|---|---|
| Volatile Organic Compounds | Soil | 8260B with methanol extraction | 40-ml VOA Vial | Cool to 4°C | 14 days |
| Semi-Volatile Organic Compounds | Soil | 8270C | 4-oz Glass Jar | Cool to 4°C | 14 days |
| Polynuclear Aromatic Hydrocarbons | Soil | 8310 | 4-oz Glass Jar | Cool to 4°C | 14 days |
| Polychlorinated biphenyls | Soil | 8082 | 8-oz Glass Jar | Cool to 4°C | 14 days |
| Explosives | Soil | 8330B | 8-oz Glass Jar | Cool to 4°C | 14 days |
| Chlorinated Pesticides | Soil | 8081 | 8-oz Glass Jar | Cool to 4°C | 14 days |
| Organophosphorus Pesticides | Soil | 8141 | 8-oz Glass Jar | Cool to 4°C | 14 days |
| Herbicides | Soil | 8151 | 8-oz Glass Jar | Cool to 4°C | 14 days |
| RCRA 8 Metals | Soil | 6010C/7471B | 4-oz Glass Jar | Cool to 4°C | 6 months (28 days for Hg) |
| Total Petroleum Hydrocarbons – Gasoline Range Organics | Soil | 8015 modified, with methanol extraction | 40-ml VOA Vial | Cool to 4°C | 14 days |
| Total Petroleum Hydrocarbons – Diesel Range Organics | Soil | 8015 modified, with methanol extraction | 40-ml VOA Vial | Cool to 4°C | 14 days |

Notes:
EPA = U.S. Environmental Protection Agency
Hg = mercury
ml = milliliter
oz = ounce
RCRA = *Resource Conservation and Recovery Act*

## Table 5-2. Quality Control Samples for Precision and Accuracy

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

Notes:
VOC = volatile organic compound

**Table 5-3. Data Validation Flags**

| Flag | Interpretation |
|---|---|
| R | 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. |
| NJ | The analysis indicates the presence of a constituent that has been tentatively identified and the associated numerical value represents its approximate concentration. |
| UJ | 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. |
| U | The constituent was analyzed for but was not detected above the reported sample quantification limit. |
| J | The constituent was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample. |
| | |

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

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# APPENDIX A

# NRCS SOIL SURVEY OF MCKINLEY COUNTY, NEW MEXICO

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United States Department of Agriculture

Natural Resources Conservation Service
In cooperation with

United States Department of Interior, Bureau of Land Management and Bureau of Indian Affairs; and the New Mexico Agricultural Experiment Station

# 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

*Typical Profile:*
A—0 to 2 inches; silt loam
C1—2 to 12 inches; silty clay loam
C2—12 to 18 inches; silt loam
C3—18 to 26 inches; silty clay loam
C4—26 to 65 inches; silt loam

**Minor Components**

Venadito 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:* Clayey Bottomland

## 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 porcelenite 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 mmhos/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
Bt—2 to 13 inches; sandy clay loam
Bk1—13 to 19 inches; sandy clay loam
Bk2—19 to 35 inches; sandy loam
2R—35 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
*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 0 SAR (nonsodic)
*Ecological site:* Shallow Sandstone
*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

*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

**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 10.7 inches (high)
*Shrink-swell potential:* About 4.5 LEP (moderate)
*Flooding hazard:* None
*Seasonal water table minimum depth:* Greater than 6 feet
*Runoff class:* Low
*Calcium carbonate maximum:* About 10 percent
*Gypsum maximum:* None
*Salinity maximum:* About 2 mmhos/cm (nonsaline)
*Sodicity maximum:* About 10 SAR (slightly sodic)
*Ecological site:* Loamy
*Present native vegetation:* blue grama, western wheatgrass, Indian ricegrass, galleta, bottlebrush squirreltail, fourwing saltbush, needleandthread, winterfat, sand dropseed, rabbitbrush, broom snakeweed (fig. 4)
*Land capability (irrigated):* 3e
*Land capability (nonirrigated):* 6c
*Conservation Tree/Shrub Group:* 8

*Typical Profile:*
A—0 to 2 inches; silt loam
Bk1—2 to 11 inches; silt loam
Bk2—11 to 17 inches; sandy clay loam
2Bk3—17 to 45 inches; silt loam
3Bk4—45 to 49 inches; sandy clay loam
3Bk5—49 to 65 inches; gravelly 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.

Bt—2 to 31 inches; clay, clay loam
2Btk1—31 to 45 inches; very gravelly sandy clay
2Btk2—45 to 50 inches; clay loam
2Btk3—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**

*Geomorphic 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
*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:* 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**

*Geomorphic 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
*Calcium 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

*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

**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 7 inches; clay
Bss1—7 to 22 inches; clay
Bss2—22 to 42 inches; clay

*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, oneseed juniper, sand sagebrush, little bluestem, rabbitbrush, twoneedle 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:* Somewhat excessively 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**

*Geomorphic 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, oneseed juniper, pingue hymenoxys, prairie junegrass, threeawn, twoneedle 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
2R—12 inches; sandstone bedrock

**Evpark soils**

*Geomorphic 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:* 6D

*Typical Profile:*
A—0 to 5 inches; loam
Bt1—5 to 10 inches; clay loam
Bt2—10 to 24 inches; sandy clay loam
R—24 inches; unweathered bedrock

**Bryway soils**

*Geomorphic position:* Sideslopes on hills and ridges, 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 3.3 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 5 percent
*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, Indian ricegrass, banana yucca, big sagebrush, blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, mountainmahogany, muttongrass, oneseed juniper, pingue hymenoxys, 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:* 5 to 20 inches to bedrock (lithic)
*Drainage class:* Somewhat excessively 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

*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, blue grama, galleta, spike muhly, mat muhly, sand dropseed, 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 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 2 inches; clay
BCss1—2 to 9 inches; clay
BCss2—9 to 11 inches; silty clay
BCss3—11 to 65 inches; clay

**Minor Components**

Hawaikuh 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 (lithic)
*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, mountainmahogany, 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 (lithic)
*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)
*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:* 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, mountainmahogany, 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

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

*Typical Profile:*
A—0 to 3 inches; loamy fine sand
C—3 to 65 inches; loamy fine sand

**Minor Components**

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

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:* 1 to 5 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

*Typical Profile:*
A—0 to 2 inches; fine sandy loam
Ck1—2 to 6 inches; fine sandy loam
Ck2—6 to 15 inches; fine sandy loam
R—15 to 20 inches; sandstone bedrock

#### Rock outcrop

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

#### Minor Components

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

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 alluviim 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
*Land capability (nonirrigated):* 7s
*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 5.3 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 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
2Ck—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:* Ponderosa Pine Forest

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).

**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 2.6 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: alligator juniper, Rocky Mountain juniper, Gambel oak, twoneedle pinyon, ponderosa pine, Douglas-fir
Other plants: Arizona fescue, Gambel oak, blue grama, bottlebrush squirreltail, buckwheat, mountainmahogany, mountain muhly, muttongrass, rabbitbrush
*Land capability subclass (nonirrigated):* 8

*Typical Profile:*
A—0 to 5 inches; channery clay loam
C1—5 to 8 inches; clay
C2—8 to 17 inches; clay
2R—17 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, pine dropseed, prairie junegrass, twoneedle pinyon
*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

*Typical Profile:*
A—0 to 1 inches; very gravelly loam
Btk1—1 to 6 inches; very cobbly loam
Btk2—6 to 13 inches; very cobbly loam
R—13 inches; limestone 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.

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

*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

*Geomorphic 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:*
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

*Geomorphic 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—1 to 8 inches; loamy fine sand
Bt1—8 to 29 inches; fine sandy loam
Bt2—29 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:* Clayey

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

*Typical Profile:*
Oi—0 to 1 inches; slightly decomposed plant material
A—1 to 3 inches; very gravelly fine sandy loam
Bt1—3 to 5 inches; fine sandy loam
Bt2—5 to 16 inches; clay loam
R—16 inches; sandstone bedrock

**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
*Slowest permeability:* About 0.06 in/hr (slow)
*Available water capacity:* About 2.6 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:* 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

*Typical Profile:*
A—0 to 2 inches; very gravelly clay loam
Bt1—2 to 6 inches; clay
Bt2—6 to 18 inches; clay
R—18 inches; shale

**Minor Components**

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

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

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
*Slowest permeability:* About 0.06 in/hr (slow)
*Available water capacity:* About 3.8 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

*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 7.5 LEP (high)
*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 0 mmhos/cm (nonsaline)
*Sodicity maximum:* About 0 SAR (nonsodic)
*Ecological site:* Pinyon-Juniper Forest
*Present native vegetation:* Gambel's oak, Indian ricegrass, banana yucca, big sagebrush, blue grama, bottlebrush squirreltail, broom snakeweed, buckwheat, mountainmahogany, muttongrass, oneseed juniper, pingue hymenoxys, prairie junegrass, twoneedle pinyon, western wheatgrass
*Land capability (irrigated):* 4e
*Land capability (nonirrigated):* 6c
*Conservation Tree/Shrub Group:* 4C

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

#### 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
*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:* 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

#### 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 4 percent
*Slope:* 2 to 8 percent
*Depth to restrictive feature:* None within 60 inches
*Drainage class:* Well drained
*Ecological site:* Pinyon-Juniper Forest

## 555—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, muttongrass, 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, muttongrass, 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

*Typical Profile:*
A—0 to 3 inches; fine sandy loam
Bt—3 to 35 inches; sandy clay loam
Bk—35 to 65 inches; fine sandy loam

**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, threeawn, 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

*Typical Profile:*
A—0 to 3 inches; sandy loam
Bk1—3 to 24 inches; sandy loam
Bk2—24 to 36 inches; loamy sand
Bk3—36 to 65 inches; fine sandy loam

**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

*Slope:* 5 to 10 percent
*Depth to restrictive feature:* 5 to 20 inches 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

*Typical Profile:*
A—0 to 2 inches; extremely gravelly sandy loam
Ck1—2 to 8 inches; gravelly sandy loam
Ck2—8 to 30 inches; extremely gravelly coarse sand
Ck3—30 to 63 inches; very cobbly coarse sand

#### 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 B

# EXCERPTS FROM FINAL REMEDIAL INVESTIGATION/FEASIBILITY STUDY & RCRA CORRECTIVE ACTION PROGRAM DOCUMENT (ERM, 1997)

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FW 97-8

**Administrative Record**

FORT WINGATE DEPOT ACTIVITY, GALLUP, NEW MEXICO

# Document No. 97-5

## *Fort Wingate Depot Activity, Gallup, New Mexico, Final Remedial Investigation/Feasibility Study & RCRA Corrective Action Program Document*

ERM Program Management Company

**November 1997**

INQUIRIES REGARDING THIS DOCUMENT AND/OR THE ADMINISTRATIVE RECORD FOR FORT WINGATE DEPOT ACTIVITY SHOULD BE MADE TO:
COMMANDER, TOOELE ARMY DEPOT, TOOELE, UTAH 84074

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 landfilling 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 landfilling 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).

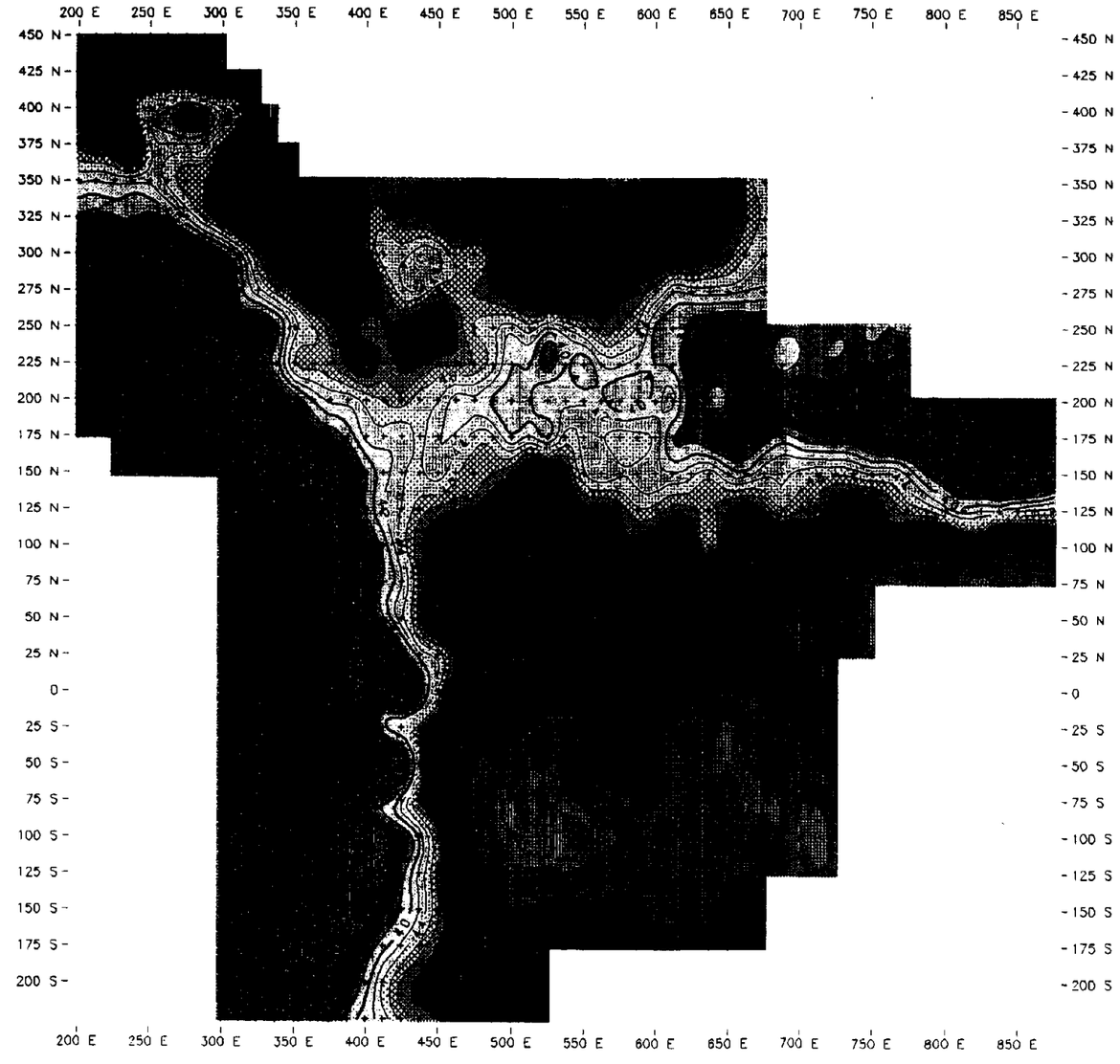
*Electromagnetic Conductivity Data*

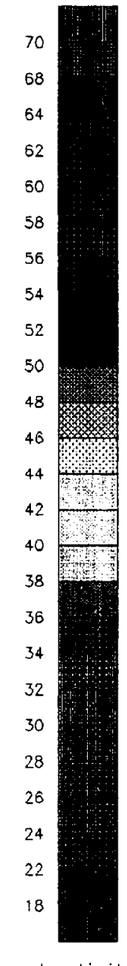
Plan contour maps of the apparent conductivity and in-phase EM data collected at the Old Landfill are presented in Figures 7-67 and 7-68, respectively. The terrain conductivity data range from -10.4 to 72.6 mS/m and the in-phase data range from -2.01 to 8.75 ppt. As was noted in the Current Landfill 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 7-67
# Terrain Conductivity Map
## Old Landfill
## Fort Wingate Depot Activity
## Gallup, New Mexico




Conductivity (mS/m)

Scale 1:1200

50 0 50 100 150 200 250

(feet)

DEVELOPED BY:

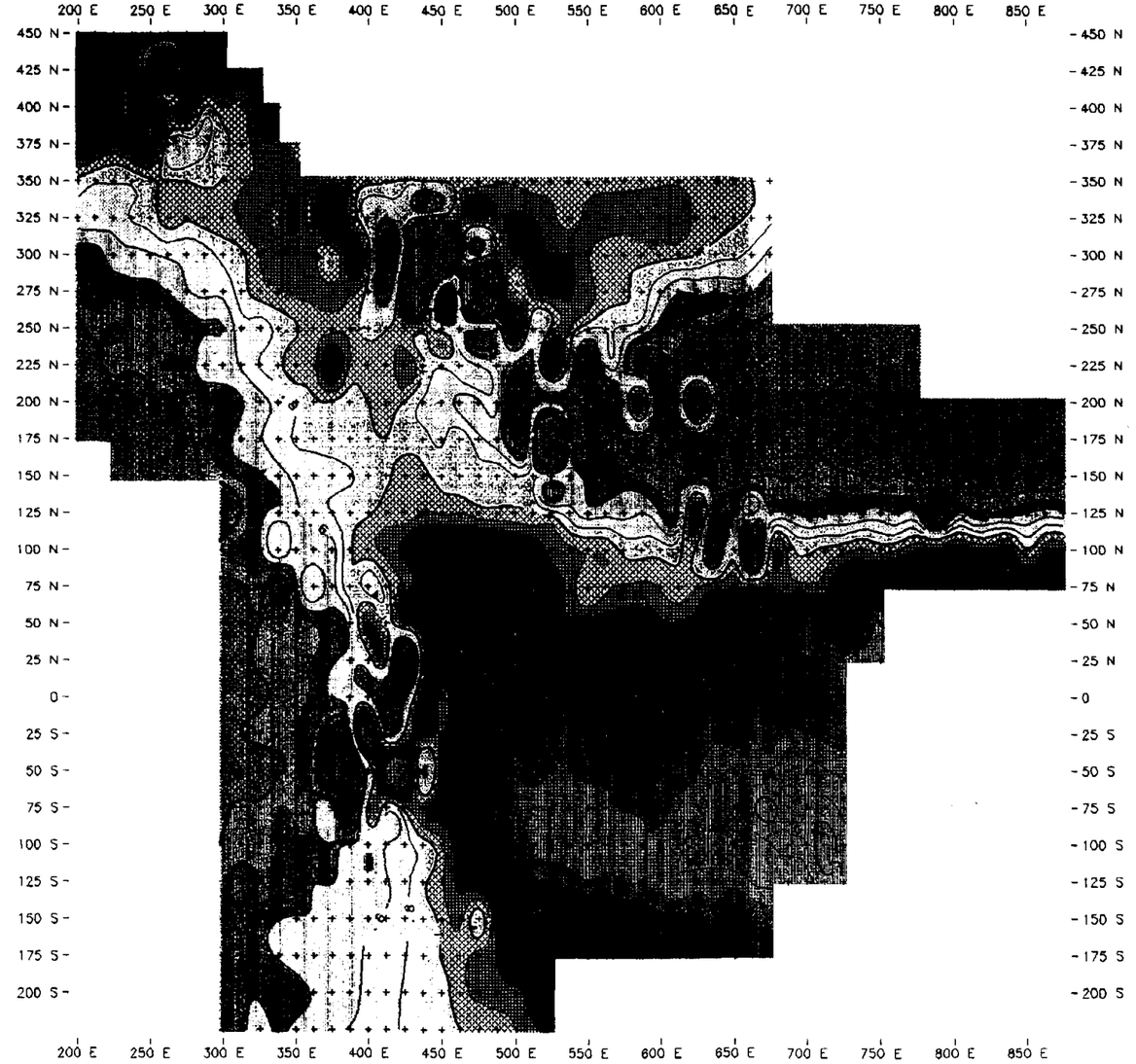
CHECKED BY:

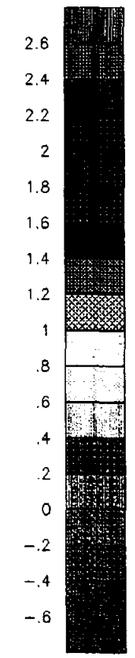
DATE: 11/15/97

ERM PMC

PM306.80.01/EK/6.18.93 REV/10.22.97

# Figure 7-68
# In-Phase EM Map
## Old Landfill
## Fort Wingate Depot Activity
## Gallup, New Mexico




In−Phase
(ppt)

Scale 1:1200

50 0 50 100 150 200 250

(feet)

DEVELOPED BY:

CHECKED BY: DATE:

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.

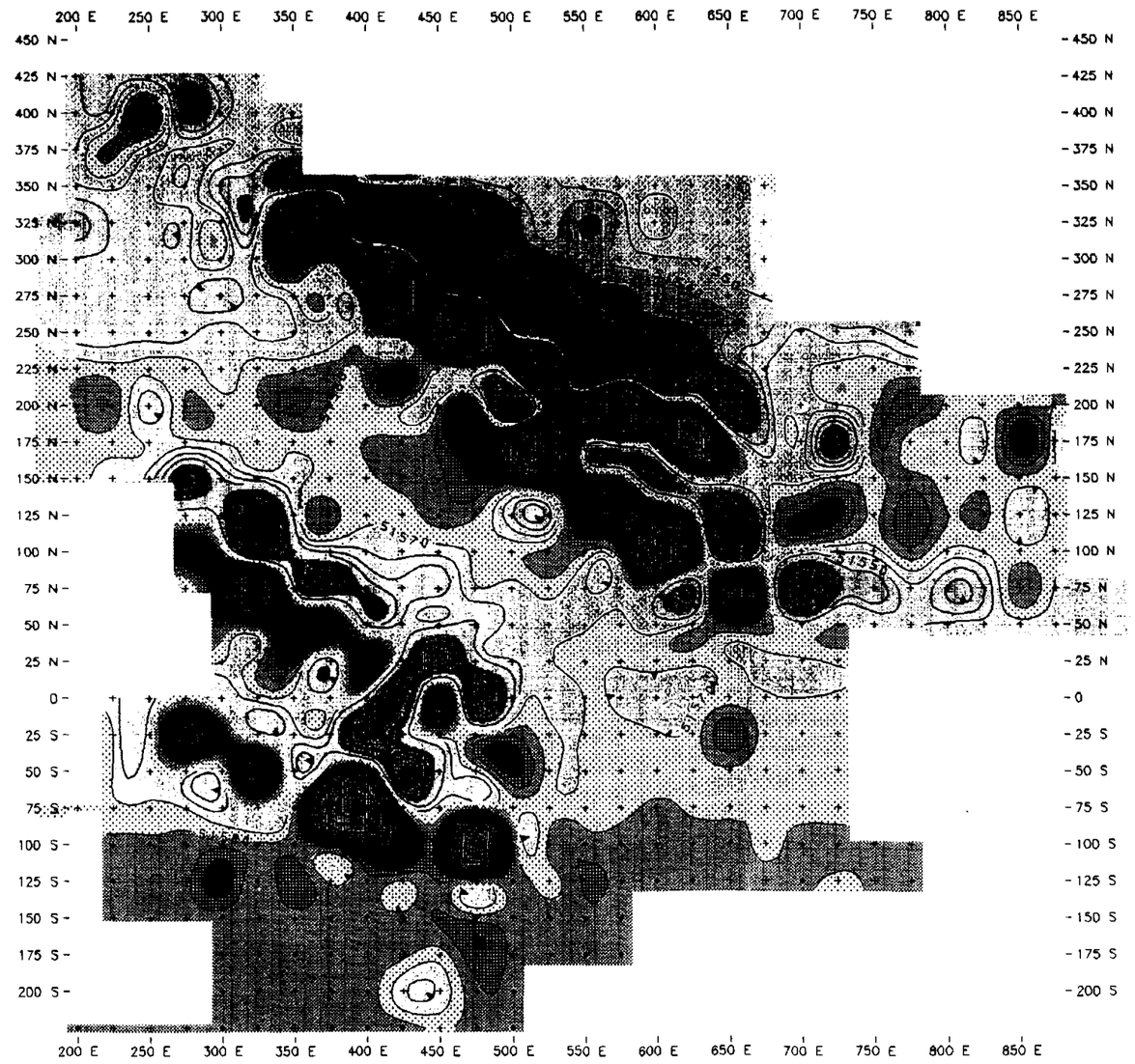
*Subsurface Soil Sample TCL SVOC Results*

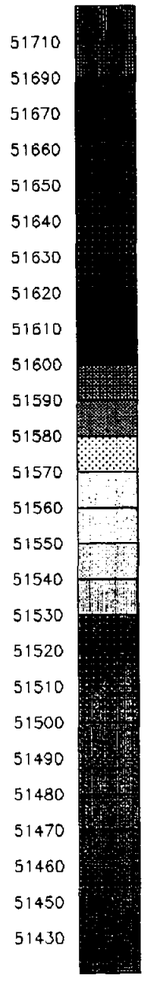
No SVOCs were detected in the subsurface soil samples.

*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




Total Field
(gammas)

Scale 1:1200

50 0 50 100 150 200 250

(feet)

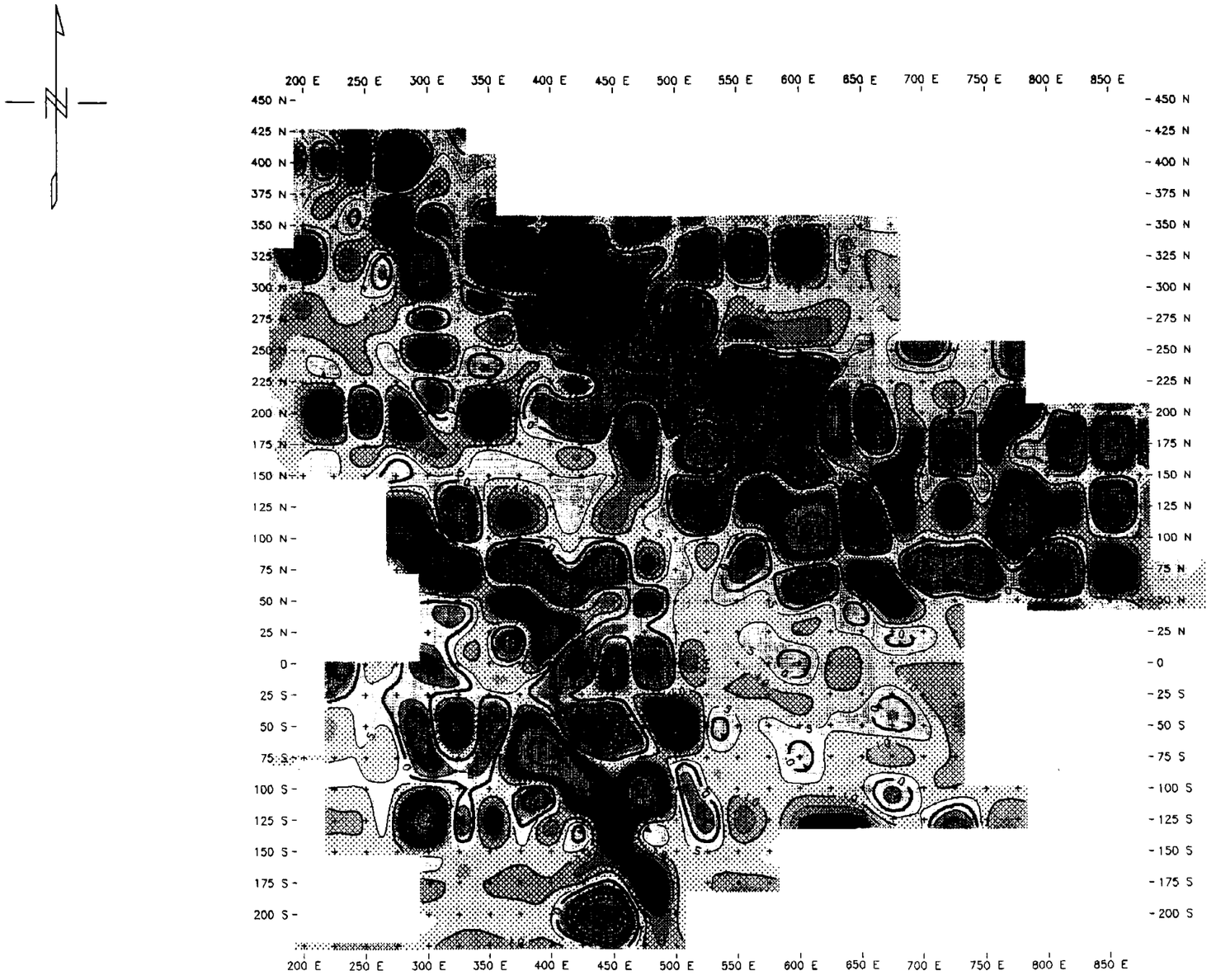
DEVELOPED BY: MJ Jr.

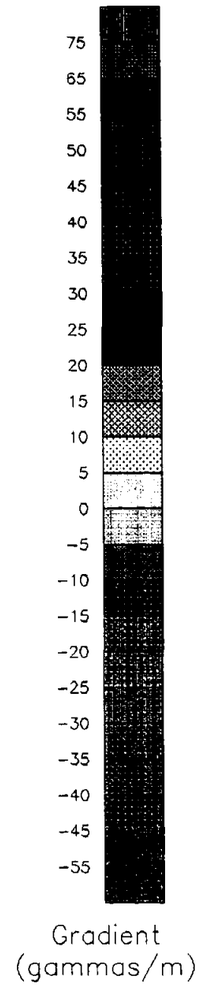
CHECKED BY: SVE DATE: 11/5/97

ERM PMC

PM306.80.01/EK/6.18.93 REV/10.22.97

# Figure 7-70
# Vertical Magnetic Gradient Map
## Old Landfill
## Fort Wingate Depot Activity
## Gallup, New Mexico




Scale 1:1200

50 0 50 100 150 200 250

(feet)

DEVELOPED BY: MJ

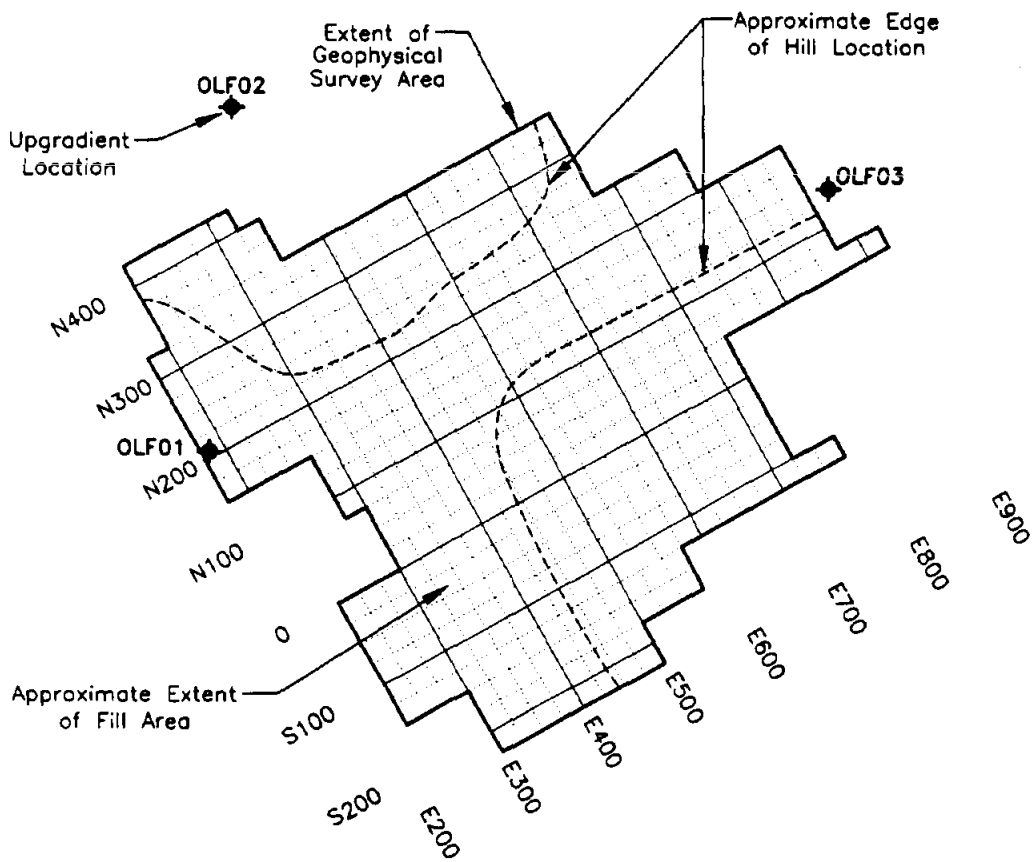
CHECKED BY: SJE DATE: 11/15/97

*Table 7-69*
*Soil Gas Survey Results*
*Old Landfill*
*Fort Wingate Depot Activity*
*Gallup, New Mexico*

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

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

200 100 0 200

Scale in Feet

N

DEVELOPED BY: M.J.S.

CHECKED BY: S.J.E. DATE: 1/24/94

ERM PMC

PM306.80.01/07.06.93-MKB/10.17.97-DST/I121-1A

*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**

| Parameter<br>Sample ID<br>Sample Type<br>Sample Depth (feet)<br>Sample Date | Units | Method/ Lab | CRL or [CRQL] | OLF01-1 SUBSURFACE SOIL 1.0 05/17/93 | OLF01-10 SUBSURFACE SOIL 10.0 05/17/93 | OLF01-20 SUBSURFACE SOIL 20.0 05/17/93 | OLF02-1 SUBSURFACE SOIL 1.0 05/17/93 | LEVELS: BACKGROUND/ SCREENING |
|---|---|---|---|---|---|---|---|---|
| **TAL METALS** | | | | | | | | |
| Manganese | UGG | JS12 | 9.87 | | | | 1020. | 968.0 |
| MN | | UB | | | | | | 12690.0 |
| Mercury | UGG | Y9 | 0.05 | 0.108 | 0.0862 | 0.0578 | 0.0909 | 0.05 |
| HG | | UB | | | | | | 81.0 |

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**

| Parameter<br>Sample ID<br>Sample Type<br>Sample Depth (feet)<br>Sample Date | Units | Method/ Lab | CRL or (CRQL) | OLF02-10<br>SUBSURFACE SOIL<br>10.0<br>05/17/93 | OLF03-1<br>SUBSURFACE SOIL<br>1.0<br>05/17/93 | LEVELS:<br><br>BACKGROUND/<br>SCREENING |
|---|---|---|---|---|---|---|
| **TAL METALS** | | | | | | |
| Lead | UGG | JD21 | 0.467 | | 17.1 | 16.4 |
| PB | | UB | | | | |
| Barium | UGG | JS12 | 3.29 | 542. | | 484.0 |
| BA | | UB | | | | 18900.0 |
| Mercury | UGG | Y9 | 0.05 | | 0.0828 | 0.05 |
| HG | | UB | | | | 81.0 |

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 7-71*
*Summary of Screening Evaluation*
*Old Landfill*
*Fort Wingate Depot Activity*
*Gallup, New Mexico*

| Compound Name | Media Type | Number of Samples | Number of Detections | Number of Hits Above Background | Number of Hits Above Screening Level |
|---|---|---|---|---|---|
| Barium | Soil | 9 | 9 | 1 | 0 |
| Lead | Soil | 9 | 9 | 1 | 1 |
| Manganese | Soil | 9 | 9 | 1 | 0 |
| Mercury | Soil | 9 | 5 | 5 | 0 |

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

# APPENDIX C

# EXCERPTS FROM EASTERN LANDFILL DELINEATION RELEASE ASSESSMENTS PROJECT (TtNUS, 2000)

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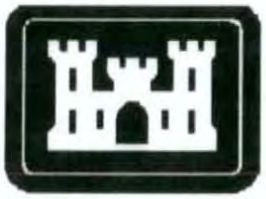
*Final*
*November 2000*

# 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**

MC-23

# 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.

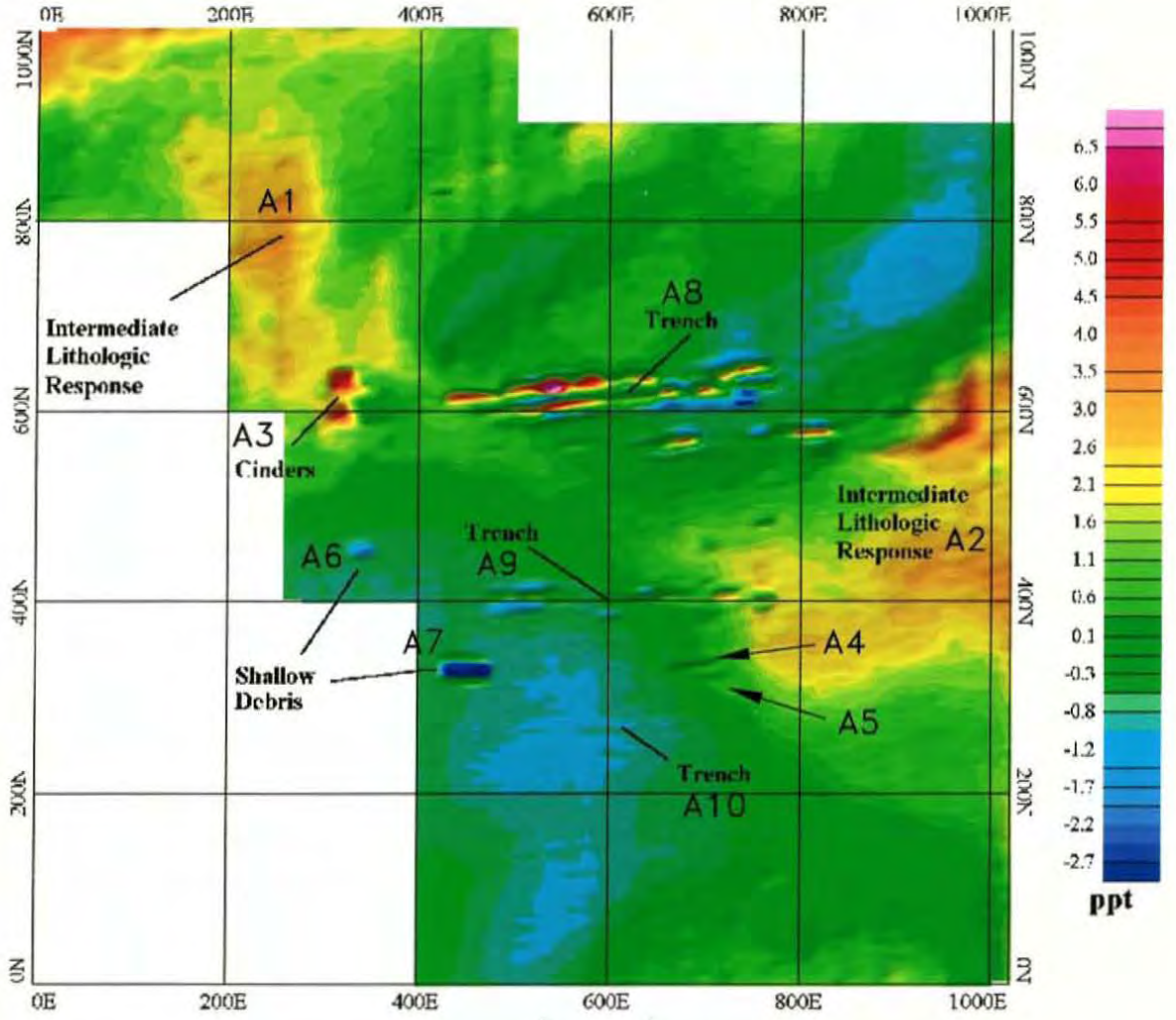
## 4.3 Identification and Delineation of the Eastern Landfill

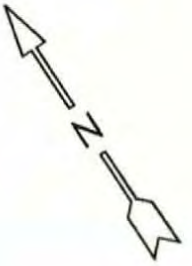
The physical identification of the edge of the landfill was matched with geophysical anomalies and from the result, Figure 4.3-1 was prepared, which identifies the Eastern Landfill consisting of several trenches or cells. The Eastern Landfill cells are outlined along with other collections of burned 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**

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

Note:
NA = Not Applicable
See Figure 4.1-4 for corresponding excavation locations.




0 200

Scale in Feet

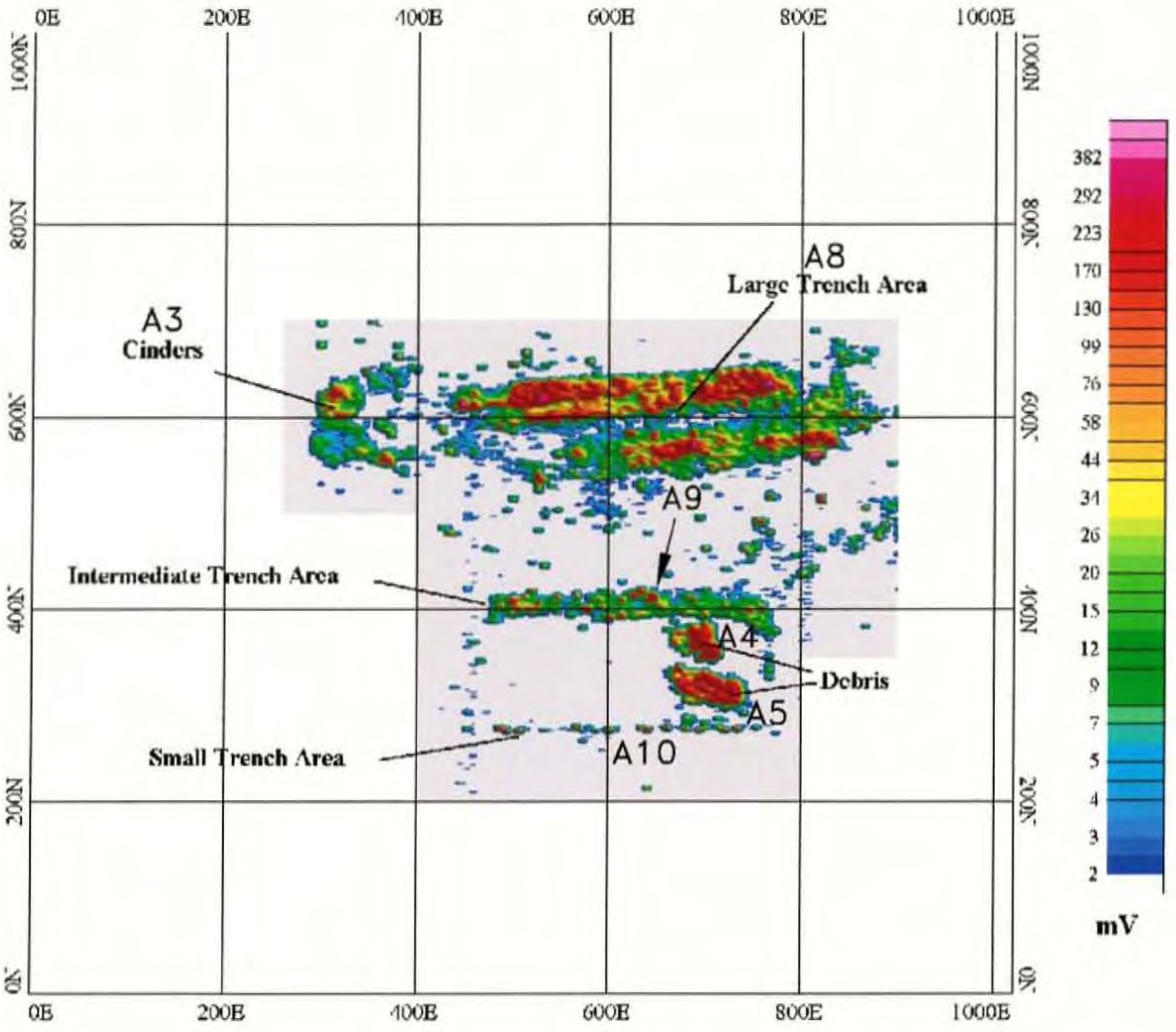
| | |
|---|---|
| SITE MANAGER: K. BELL | |
| CHECKED BY: K. BELL | |
| DRAWN BY: J. FLESCH | |
| DATE: 11-17-00 | SCALE: 1"=200' |
| CAD DWG. NO.: 158C_3 | PROJ. NO.: N7551.158C |

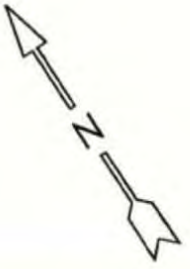
TETRA TECH NUS, INC.
Houston, Texas

FIGURE 4.1-1

EASTERN LANDFILL DELINEATION
EM-31 IN-PHASE RESPONSE

FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO

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Scale in Feet

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|---|---|
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| DATE: 11-17-00 | SCALE: 1"=200' |
| CAD DWG. NO.: 158C_4 | PROJ. NO.: N7551.158C |

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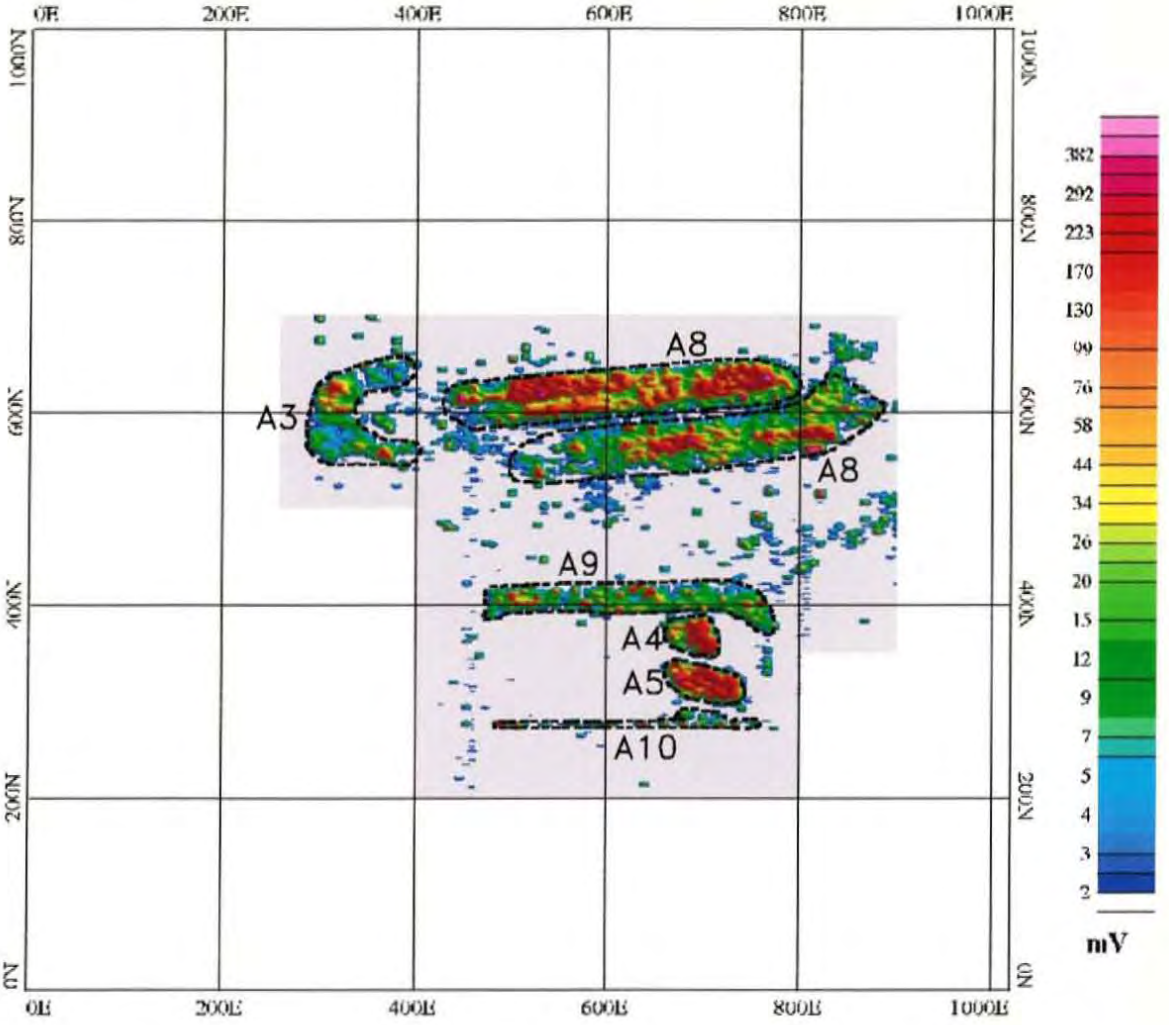
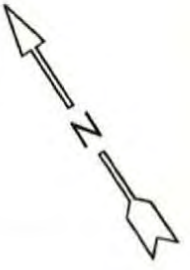
FIGURE 4.1-2
EASTERN LANDFILL DELINEATION
EM-61 RESPONSE
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO




0 200

Scale in Feet

| | |
|---|---|
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| CHECKED BY: K. BELL | |
| DRAWN BY: J. FLESCH | |
| DATE: 11-17-00 | SCALE: 1"=200' |
| CAD DWG. NO.: 158C_7 | PROJ. NO.: N7551.158C |

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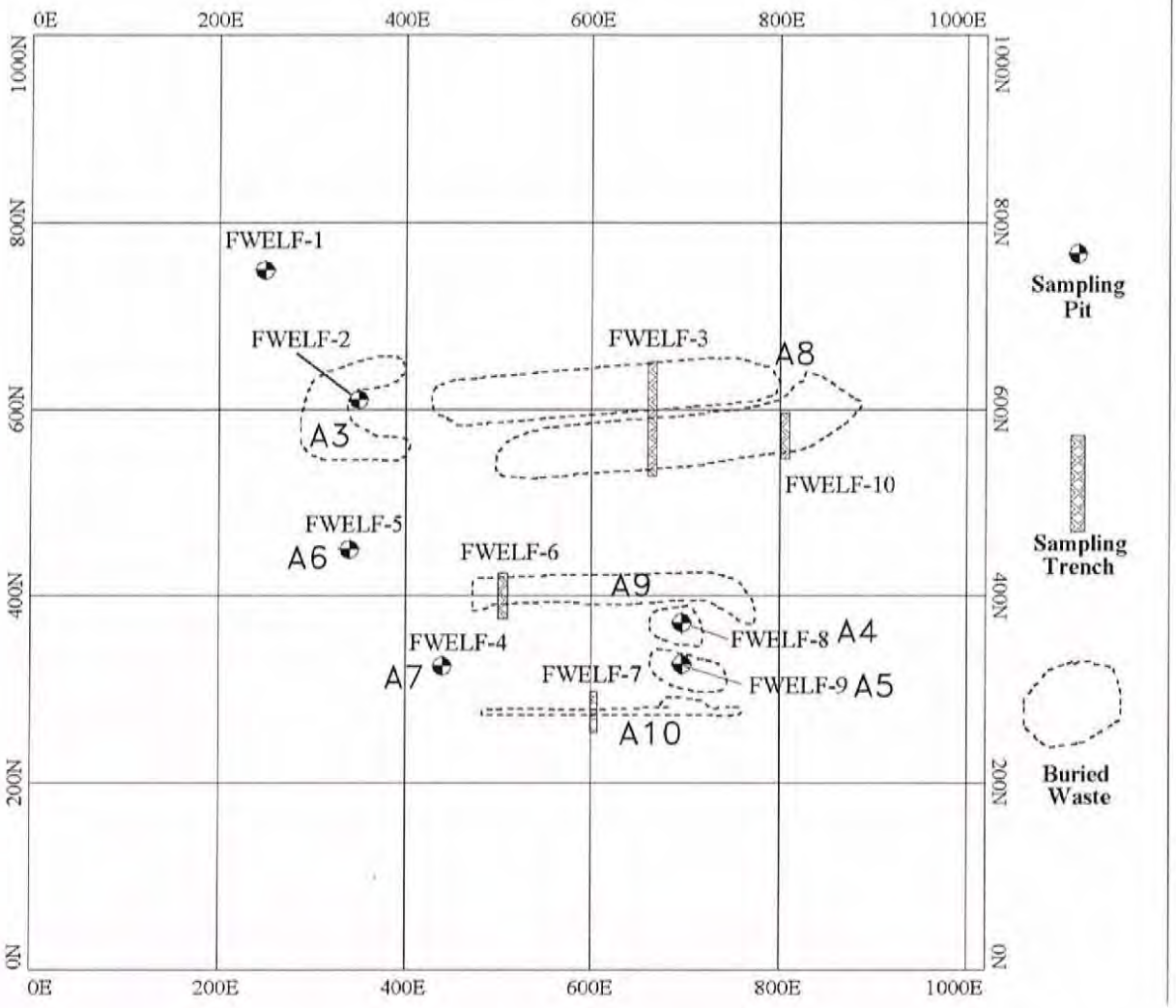
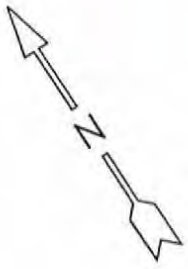
Houston, Texas

FIGURE 4.1-3

EASTERN LANDFILL DELINEATION
EM-61 BOUNDARY INTERPRETATIONS

FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO





| | |
|---|---|
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| CHECKED BY: K. BELL | |
| DRAWN BY: J. FLESCH | |
| DATE: 11-17-00 | SCALE: 1"=200' |
| CAD DWG. NO.: 158C_B | PROJ. NO.: N7551.158C |

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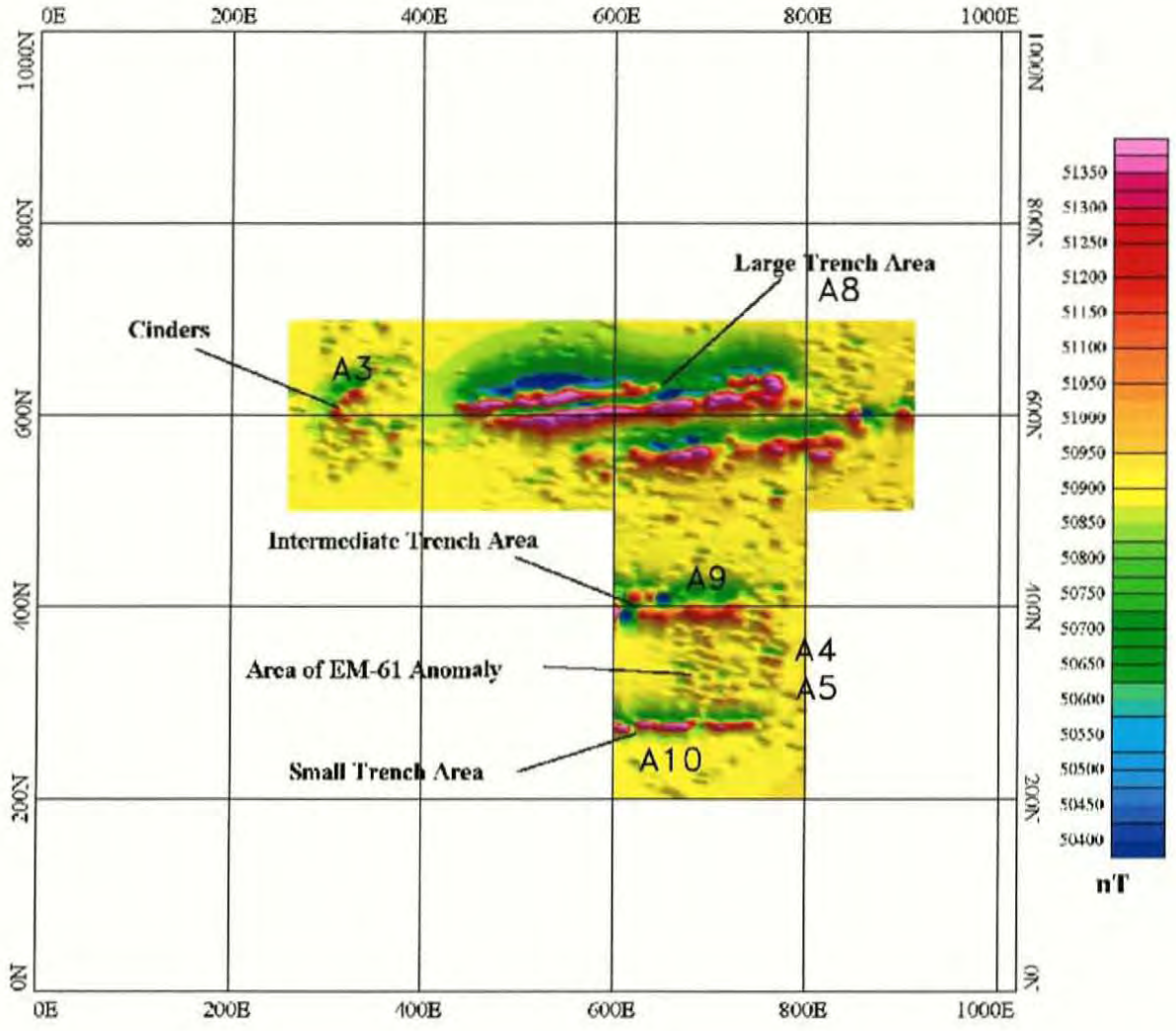
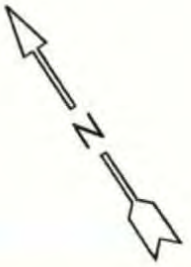
FIGURE 4.1-4
EASTERN LANDFILL DELINEATION
GEOPHYSICAL INTERPRETATIONS
AND SAMPLING LOCATIONS
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO




0 200

Scale in Feet

| | |
|---|---|
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| CHECKED BY: K. BELL | |
| DRAWN BY: J. FLESCH | |
| DATE: 11-17-00 | SCALE: 1"=200' |
| CAD DWG. NO.: 158C_5 | PROJ. NO.: N7551.158C |

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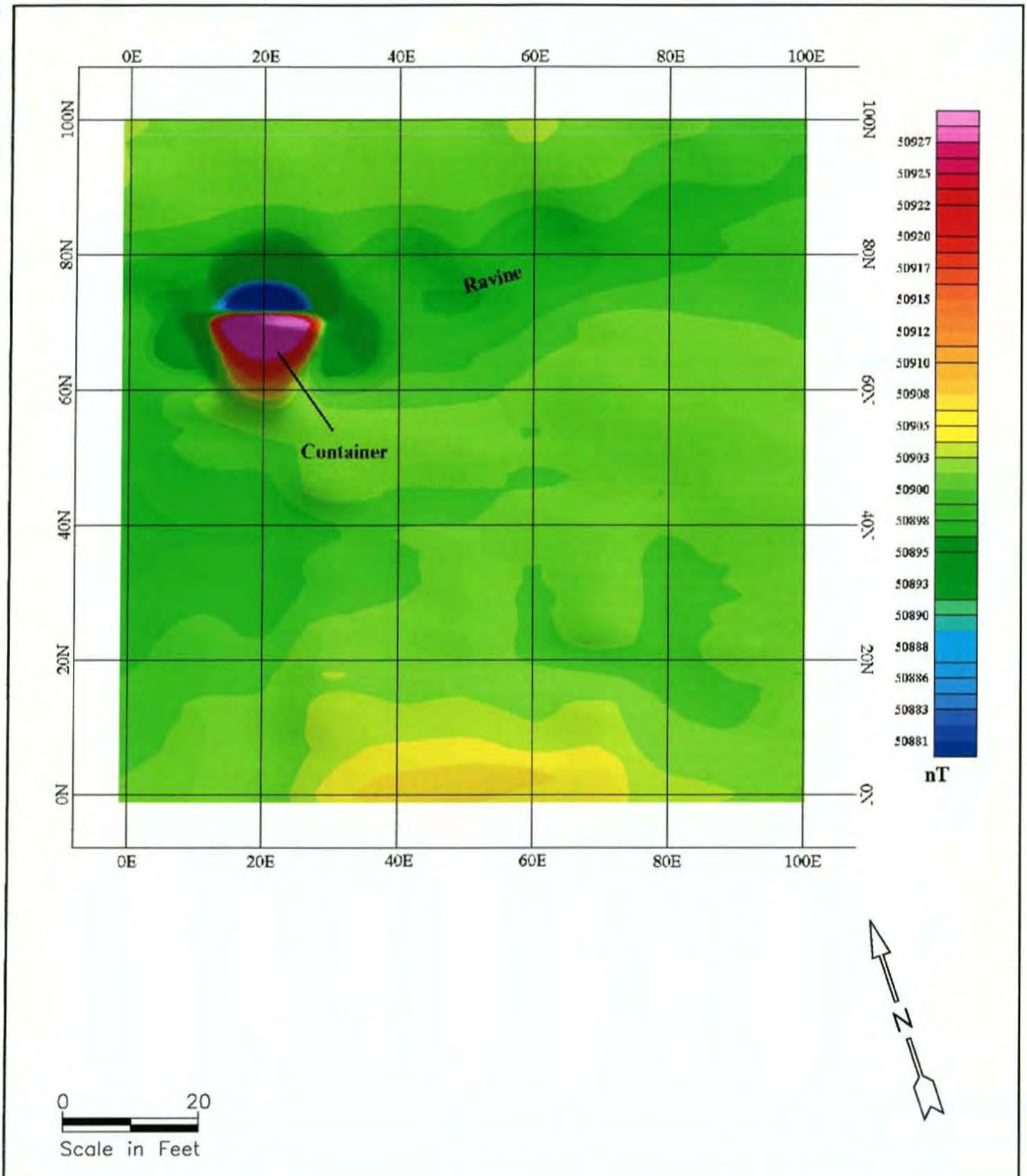
FIGURE 4.1-5
EASTERN LANDFILL DELINEATION
EASTERN LANDFILL MAGNETIC DATA
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO

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|---|---|
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| DRAWN BY: J. FLESCH | |
| DATE: 11-17-00 | SCALE: 1"=20' |
| CAD DWG. NO.: 158C_6 | PROJ. NO.: N7551.158C |

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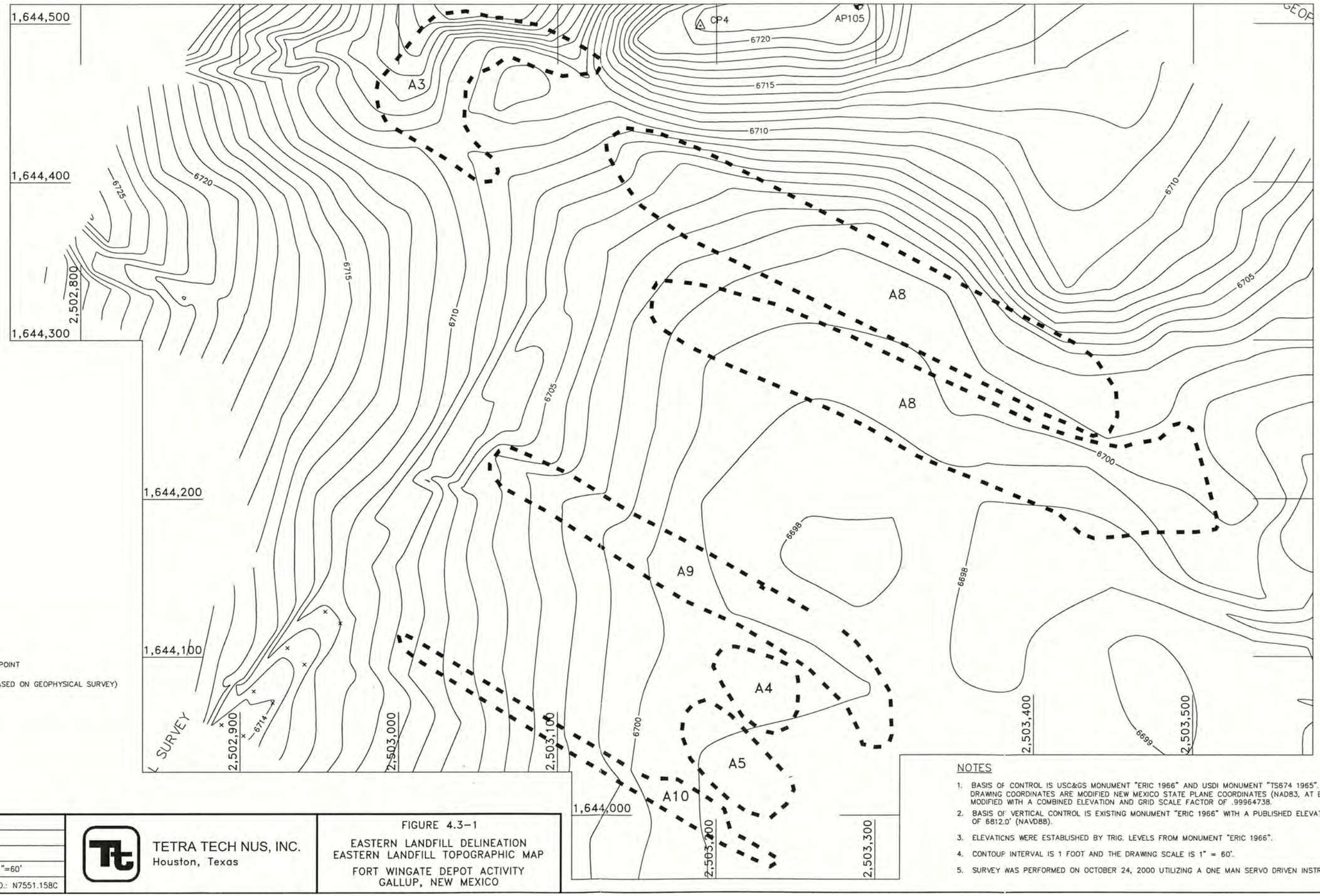
FIGURE 4.1-6
EASTERN LANDFILL DELINEATION
HILLSIDE MAGNETIC DATA
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO




LEGEND

SURVEY CONTROL POINT

CELL BOUNDARY (BASED ON GEOPHYSICAL SURVEY)

0 60

Scale in Feet

NOTES

1. BASIS OF CONTROL IS USC&GS MONUMENT "ERIC 1966" AND USDI MONUMENT "TS674 1965". DRAWING COORDINATES ARE MODIFIED NEW MEXICO STATE PLANE COORDINATES (NAD83, AT ELEVATION) MODIFIED WITH A COMBINED ELEVATION AND GRID SCALE FACTOR OF .99964738.
2. BASIS OF VERTICAL CONTROL IS EXISTING MONUMENT "ERIC 1966" WITH A PUBLISHED ELEVATION OF 6812.0' (NAVD88).
3. ELEVATICNS WERE ESTABLISHED BY TRIG. LEVELS FROM MONUMENT "ERIC 1966".
4. CONTOUR 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.

ORIGINAL PREPARED BY ASTS, INC., 500 COPPER AVE. NW, ALBUQUERQUE, NM 87102. MODIFIED 11-22-00 BY TTNUS.

| | |
|---|---|
| SITE MANAGER: K. BELL | |
| CHECKED BY: K. BELL | |
| DRAWN BY: J. FLESCH | |
| DATE: 11-22-00 | SCALE: 1"=60' |
| CAD DWG. NO.: 158C_SRFC | PROJ. NO.: N7551.158C |

TETRA TECH NUS, INC.
Houston, Texas

FIGURE 4.3-1
EASTERN LANDFILL DELINEATION
EASTERN LANDFILL TOPOGRAPHIC MAP
FORT WINGATE DEPOT ACTIVITY
GALLUP, NEW MEXICO

# APPENDIX A

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

SUNBELT GEOPHYSICS P.O. Box 36404 • Albuquerque, New Mexico 87176 • (505) 922-1140

# 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.

Average 7' depth

Depth

400'x60'x7'= 168,000 CF

300'x30'x7' = 63,000CF

Depth

280'x6'x7'≈ 12,000 CF

TOTAL = 243,000 CF = 9000 CY

### *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 D

# EXCERPTS FROM GROUNDWATER INVESTIGATION REPORT, EASTERN LANDFILL (TtNUS, 2005)

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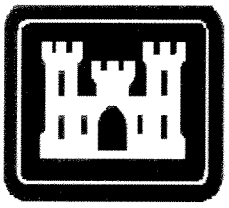
*Final*
*April 2005*

# 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**

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

**Table 5.1.2-2**

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

| Metals | Appendxi IX VOCs (8260B) | Appendix IX SVOCs (8270) | | Explosives (8330 Mod) | Appendix IX PCBs (8082) | Appendix IX Herbicides (8151) | Appendix IX Pesticides (8081) | Appendix IX OP Pesticides (8141) | Appendix IX PCDDs and PCDFs (8290) | Other Constituents | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | |
| Aluminum | 1,1,1,2-Tetrachloroethane | | Fluoranthene | **Standard 14 compounds:** | Aroclor 1016 | 2,4-D | 4,4-DDD | Disulfoton | 2,3,7,8-TCDD | **Method 9012** | **EPA 300.0** | **EPA 353.2** |
| Antimony | 1,1,1-Trichloroethane | 1,2,4,5-Tetrachlorobenzene | Fluorene | HMX | Aroclor 1221 | 2,4,5-T | 4,4-DDE | Famphur | 1,2,3,7,8-PeCDD | Cyanide | **Anions:** | Nitrate/Nitrite Nonspecific |
| Arsenic | 1,1,2,2-Tetrachloroethane | 1,4-Naphthoquinone | Hexachlorobenzene | RDX | Aroclor 1232 | 2,4,5-TP (Silvex) | 4,4-DDT | Phorate | 1,2,3,6,7,8-HxCDD | | Nitrate as Nitrogen | |
| Barium | 1,1,2-Trichloroethane | 1-Naphthylamine | Hexachlorobutadiene | 1,3,5-Trinitrobenzene | Aroclor 1242 | | Aldrin | Sulfotepp | 1,2,3,4,7,8-HxCDD | | Chloride | |
| Beryllium | 1,1-Dichloroethane | 2,3,4,6-Tetrachlorophenol | Hexachlorocyclopentadiene | 1,3-Dinitrobenzene | Aroclor 1248 | | alpha-BHC | Dimethoate | 1,2,3,7,8,9-HxCDD | | Fluoride | |
| Cadmium | 1,1-Dichloroethene | 2-AAF | Hexachloroethane | Nitrobenzene | Aroclor 1254 | | beta-BHC | | 1,2,3,4,6,7,8-HpCDD | | Sulfate | |
| Chromium | 1,2-Dibromo-3-Chloropropane | 2-Naphthylamine | Hexachlorophene | 2,4,6-TNT | Aroclor 1260 | | Chlordane | | 1,2,3,4,6,7,8,9-OCDD | | | |
| Cobalt | 1,2-Dibromoethane | 2-Picoline | Hexachloropropene | Tetryl | | | delta-BHC | | 2,3,7,8-TCDF | **EPA 150.1** | **EPA 376.1** | **EPA 160.1** |
| Copper | 1,2-Dichloroethane | 3,3-Dimethylbenzidine | Indeno(1,2,3-cd)pyrene | 2,4-Dinitrotoluene | 2-Chlorobiphenyl | | Dieldrin | | 1,2,3,7,8-PeCDF | | | |
| Cyanide | 1,2-Dichloropropane | 3-Methylcholanthrene | Isophorone | 2,6-Dinitrotoluene | 2,3-Dichlorobiphenyl | | Endosulfan sulfate | | 2,3,4,7,8-PeCDF | pH | Sulfide | Total Dissolved Solids |
| Iron | 1,4-Dioxane | 4,6-Dinitro-2-methylphenol | Isosafrole | 2-Amino-4,6-Dinitrotoluene | 2,2',5-Trichlorobiphenyl | | Endosulfan I | | 1,2,3,6,7,8-HxCDF | | | |
| Lead | 2-Hexanone | 4-Aminobiphenyl | Kepone | 4-Amino-2,6-Dinitrotoluene | 2,4',5-Trichlorobiphenyl | | Endosulfan II | | 1,2,3,7,8,9-HxCDF | | | |
| Manganese | 4-Methyl-2-Pentanone | 4-Chloro-3-methylphenol | m-Dinitrobenzene | 2-Nitrotoluene | 2,2',3,5'-Tetrachlorobiphenyl | | Endrin | | 1,2,3,4,7,8-HxCDF | | | |
| Mercury | Acetone | 4-Nitroquinoline-1-oxide | Methapyrilene | 4-Nitrotoluene | 2,2',5,5'-Tetrachlorobiphenyl | | Endrin aldehyde | | 2,3,4,6,7,8-HxCDF | | | |
| Nickel | Acetonitrile | 5-Nitro-o-toluidine | Methyl methanesulfonate | 3-Nitrotoluene | 2,3',4,4'-Tetrachlorobiphenyl | | gamma-BHC | | 1,2,3,4,6,7,8-HpCDF | | | |
| Selenium | Acrolein | 7,12-Dimethylbenz(a)anthracene | Methyl Parathion | | 2,2',3,4,5'-Pentachlorobiphenyl | | Heptachlor | | 1,2,3,4,6,7,8,9-OCDF | | | |
| Silver | Acrylonitrile | Acenaphthene | Methylnaphthalene,2- | | 2,2',4,5,5'-Pentachlorobiphenyl | | Heptachlor Epoxide | | | | | |
| Thallium | Allyl chloride | Acenaphthylene | Methylphenol,2- | **Most common additional compounds:** | 2,3,3',4',6'-Pentachlorobiphenyl | | Isodrin | | | | | |
| Tin | Benzene | Acetopnenone | Methylphenol,3- | 2,6-Diamino-4-nitrotoluene | 2,2',3,4,4',5'-Hexachlorobiphenyl | | Methoxychlor | | | | | |
| Vanadium | Bromodichloromethane | alpha,alpha-Dimethylphenethylamine | Methylphenol,4- | 2,4-Diamino-6-nitrotoluene | 2,2',3,4,5,5'-Hexachlorobiphenyl | | Toxaphene | | | | | |
| Zinc | Bromoform | Aniline | m-Nitroaniline | Picric acid | 2,2',3,5,5',6-Hexachlorobiphenyl | | | | | | | |
| | Bromomethane | Anthracene | Naphthalene | Nitroglycerin | 2,2',4,4',5,5'-Hexachlorobiphenyl | | | | | | | |
| | Carbon Disulfide | Aramite | Nitrobenzene | PETN | 2,2',3,3',4,4',5-Heptachlorobiphenyl | | | | | | | |
| | Carbon Tetrachloride | Benzo(a)anthracene | N-Nitrosodiethylamine | | 2,2',3,4,4',5,5'-Heptachlorobiphenyl | | | | | | | |
| | Chlorobenzene | Benzo(a)pyrene | N-Nitrosodimethylamine | **RDX Metabolites:** | 2,2',3,4,4',5',6-Heptachlorobiphenyl | | | | | | | |
| | Chloroethane | Benzo(b)fluoranthene | N-Nitrosodi-n-butylamine | TNX | 2,2',3,4',5,5',6-Heptachlorobiphenyl | | | | | | | |
| | Chloroform | Benzo(g,h,i)perylene | N-Nitrosodiphenylamine | DNX | 2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl | | | | | | | |
| | Chloromethane | Benzo(k)fluoranthene | N-Nitrosodipropylamine | MNX | | | | | | | | |
| | Chloroprene | Benzyl alcohol | N-Nitrosomethylethylamine | 2,2'-azoxy | | | | | | | | |
| | cis-1,3-Dichloropropene | Bis(2-chloroethoxy)methane | N-Nitrosomorpholine | 4,4'-azoxy | | | | | | | | |
| | Dibromochloromethane | Bis(2-chloroethyl)ether | N-Nitrosopiperidine | PYX | | | | | | | | |
| | Dibromomethane | Bis(2-chloroisopropyl)ether | N-Nitrosopyrrolidine | | | | | | | | | |
| | Dichlorodifluoromethane | Bis(2-ethylhexyl)phthalate | o,o,o-Triethyl phosphorothioate | | | | | | | | | |
| | Dichloromethane | Bromophenyl phenyl ether,4- | o-Nitroaniline | | | | | | | | | |
| | Ethyl methacrylate | Butyl benzyl phthalate | o-Nitrophenol | | | | | | | | | |
| | Ethylbenzene | Chlorobenzilate | o-Toluidine | | | | | | | | | |
| | Iodomethane | Chloronaphthalene, 2- | p-(Dimethylamino)azobenzene | | | | | | | | | |
| | MEK | Chlorophenol,2- | Parathion | | | | | | | | | |
| | methacrylonitrile | Chlorophenyl phenyl ether,4- | p-Chloroaniline | | | | | | | | | |
| | Methy methacrylate | Chrysene | Pentachlorobenzene | | | | | | | | | |
| | Methyl-tertbutyl-Ether (MTBE) | Diallate | Pentachloroethane | | | | | | | | | |
| | Propionitrile | Dibenzo(a,h)anthracene | Pentachlorophenol | | | | | | | | | |
| | Styrene | Dibenzofuran | Pentachloronitrobenzene | | | | | | | | | |
| | Tetrachloroethene | Dichlorobenzene, 1,2- | Phenacetin | | | | | | | | | |
| | Toluene | Dichlorobenzene, 1,3- | Phenanthrene | | | | | | | | | |
| | cis-1,2-Dichloroethene | Dichlorobenzene,1,4- | Phenol | | | | | | | | | |
| | trans-1,2-Dichloroethene | Dichlorobenzidine,3,3- | p-Nitroaniline | | | | | | | | | |
| | trans-1,3-Dichloropropene | Dichlorophenol,2,4- | p-Nitrophenol | | | | | | | | | |
| | trans-1,4-Dichloro-2-butene | Dichlorophenol,2,6- | p-Phenylenediamine | | | | | | | | | |
| | Trichloroethene | Diethyl phthalate | Pronamide | | | | | | | | | |
| | Trichlorofluoromethane | Dimethyl phthalate | Pyrene | | | | | | | | | |
| | Vinyl Acetate | Dimethylphenol,2,4- | Pyridine | | | | | | | | | |
| | Vinyl Chloride | Di-n-butylphthalate | Safrole | | | | | | | | | |
| | Xylene (Total) | Dinitrophenol,2,4- | sym-Trinitrobenzene | | | | | | | | | |
| | Isobutyl alcohol | Dinitrotoluene, 2,4- | Thionazin | | | | | | | | | |
| | 1,2,3-Trichloropropane | Dinitrotoluene, 2,6- | Trichlorobenzene, 1,2,4- | | | | | | | | | |
| | | Di-n-octylphthalate | Trichlorophenol,2,4,5- | | | | | | | | | |
| | | Dinoseb | Trichlorophenol,2,4,6- | | | | | | | | | |
| | | Diphenylamine | | | | | | | | | | |
| | | Ethyl methanesulfonate | | | | | | | | | | |

### 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 (8260B) | Screening Level | EMW02 | EMW03 | EMW03 DUP | EMW03 FTRP |
|---|---|---|---|---|---|
| | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| Acetone | 33 | | 0.0136 | 0.0133 | 0.011 |
| Toluene | 0.72 | | | | 0.00087 J |
| Xylene, Total | 0.2 | | | | 0.00065 J |
| MEK | 7.1 | | 0.00285 | 0.0029 | 0.0029 |

| Appendix IX SVOCs (8270) | | EMW02 | EMW03 | EMW03 DUP | EMW03 FTRP |
|---|---|---|---|---|---|
| | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| Bis(2-ethylhexyl)phthalate | 0.0048 | 0.00479 J | | **0.00682 J** | |
| Acetophenone | 3.7 | | | | 0.0016 J |
| Butylbenzylphthalate | 7.3 | | | | 0.00041 J |
| 2-Methylnaphthalene | (1) | | | | 0.00019 J |
| Naphthalene | 0.0062 | | | | 0.00024 J |
| Phenol | 11.0 | 0.0178 | | | 0.0032 J |

| Appendix IX Pesticides (8081 and 8141) | | EMW02 | EMW03 | EMW03 DUP | EMW03 FTRP |
|---|---|---|---|---|---|
| | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| Dieldrin | 0.0000042 | | | | **0.0000139 J** |
| Endosulfan II | (1) | | | | 0.0000138 J |
| Endrin Aldehyde | (1) | | | | 0.0000813 |
| gamma-BHC | (1) | | | | 0.0000112 J |
| Heptachlor Epoxide | 0.0000074 | | | | **0.0000587** |

| Appendix IX Herbicides (8151) | | EMW02 | EMW03 | EMW03 DUP | EMW03 FTRP |
|---|---|---|---|---|---|
| | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| All compounds were non detect | | | | | |

| Explosives (8330 Mod) | | EMW02 | EMW03 | EMW03 DUP | EMW03 FTRP |
|---|---|---|---|---|---|
| | (ug/L) | (ug/L) | (ug/L) | (ug/L) | (ug/L) |
| RDX | 0.61 | **2.9** | | | |
| Nitrobenzene | 3.4 | 0.22 J | | | |
| 2,4,6-TNT | 2.2 | 0.38 | 0.11 J | 0.11 J | |
| Nitroglycerin | (1) | 7.4 | 30 J | | |
| DNX | (1) | 3.4 J | 0.51 J | 0.53 J | |

| Appendix IX PCB and Conjoiners (8082) | | EMW02 | EMW03 | EMW03 DUP | EMW03 FTRP |
|---|---|---|---|---|---|
| | (ug/L) | (ug/L) | (ug/L) | (ug/L) | (ug/L) |
| 2-monochlorobiphenyl | (1) | 0.028 J | | | |

| Appendix IX PCDDs and PCDFs (8290) | | EMW02 | EMW03 | EMW03 DUP | EMW03 FTRP |
|---|---|---|---|---|---|
| | (pg/L) | (pg/L) | (pg/L) | (pg/L) | (pg/L) |
| All compounds were non detect | | | | | |

| Water Quality Parameters (Various) | | EMW02 | EMW03 | EMW03 DUP | EMW03 FTRP |
|---|---|---|---|---|---|
| | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| pH (pH units) | (1) | 11.47 | 11.63 | 11.55 | 11.5 |
| Nitrate as Nitrogen | 10 | 0.189 B | | 0.122 B | 0.274 |
| Chloride | (1) | 258 | 213 | 212 | 213 |
| Fluoride | 2.2 | 0.848 | 1.7 | **2.48** | **3.76** |
| Sulfate | (1) | 2550 | 2130 | 2110 | 2190 |
| Nitrate/Nitrite Nonspecific | 1.0 | 0.082 | 0.669 | 0.466 | 0.36 |
| Total Dissolved Solids | (1) | 4940 | 3920 | 4050 | 4110 |

Note:
1. 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.
B - analyte was found in the associated blank as well as the sample.
J - indicates estimated value.
mg/L - milligrams per liter
ug/L - micrograms per liter
pg/L - picograms per liter

## Table 5.2-2

## ANALYTICAL RESULTS - METALS

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

| Metals (6000/7000) | Screening Level | EMW02 (Dissolved) | EMW02 (Total) | EMW03 (Dissolved) | EMW03 (Total) | EMW03 DUP (Dissolved) | EMW03 DUP (Total) | EMW03 FTRP (Dissolved) | EMW03 FTRP (Total) |
|---|---|---|---|---|---|---|---|---|---|
| | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) | (mg/L) |
| Aluminum | 37 | 0.0427 | 1.14 | 1.6 | 1.46 | 1.99 | 1.75 | 1.5 | 1.75 |
| Antimony | 0.015 | | | | | | | 0.000393 | 0.000852 |
| Arsenic | 0.000045 | | | **0.00355** | | **0.005** | | **0.00725** | **0.00586** |
| Barium | 2.6 | 0.0641 | 0.06 | 0.107 | 0.113 | 0.0954 | 0.119 | 0.0978 | 0.131 |
| Beryllium | 0.073 | | | | | | | | 0.000182 |
| Cadmium | 0.018 | | | | | | | | 0.000168 |
| Chromium | 0.11 [(1)] | 0.00952 | 0.00985 | 0.103 | 0.0941 | **0.117** | 0.0882 | 0.0986 | 0.0898 |
| Cobalt | 0.73 | | 0.00125 | | 0.00082 | | 0.00092 | 0.000663 | 0.00108 |
| Copper | 1.4 | 0.00598 | 0.00597 | 0.0117 | 0.0122 | 0.0136 | 0.0116 | 0.0135 | 0.0123 |
| Iron | 11 | 0.148 | 0.473 | 0.0703 | 0.151 | 0.0969 | 0.169 | 0.075 | 0.225 |
| Lead | 0.015 | | | | | | | 0.000325 | 0.00069 |
| Manganese | 1.7 | 0.00218 | 0.0781 | 0.00144 | 0.00214 | 0.00276 | 0.004 | | 0.0056 |
| Mercury | 0.011 | | | | | 0.000031 | | | |
| Nickel | 0.73 | | | | | | | 0.00917 | 0.00929 |
| Selenium | 0.18 | | | | | | | 0.0131 | 0.00882 |
| Silver | 0.18 | | | | | | | | |
| Thallium | (2) | 0.00586 | | | 0.00509 | | 0.00511 | | 0.0000973 |
| Tin | 22 | | | | | 0.00331 | | 0.000753 | 0.000665 |
| Vanadium | 0.037 | | 0.00302 | **0.0859** | **0.0871** | **0.0936** | **0.081** | **0.0893** | **0.0865** |
| Zinc | 11 | 0.0244 | 0.00862 | 0.0132 | 0.00799 | | 0.0142 | 0.00297 | 0.00537 |

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, butylbenzlphthalate, 2-methylnapthalene, 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 [ug/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 EMW03 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 EMW02 and EMW03 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 exceeds 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

elevation measurements. Water level measurements were collected on July 30, 2004.

**Table 5.3-1**

**WATER LEVEL MEASUREMENTS FOR EXISTING MONITOR WELLS**

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

| Monitor Well | Depth to Water (feet) |
|---|---|
| TMW02 | 53.88 |
| TMW05 | 35.88 |
| TMW14A | 62.95 |
| TMW16 | 54.58 |
| TMW17 | 61.46 |
| TMW18 | 53.27 |
| TMW19 | 41.00 |
| TMW28 | 18.45 |
| FW35 | 14.50 |

Note:
1. Water level measurements collected between 1215 and 1340 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

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

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**

**SUMMARY OF AQUIFER TEST RESULTS**

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

| Monitor Well | Falling Head [(1)] (ft/sec) | Rising Head [(1)] (ft/sec) | Falling Head [(2)] (ft/sec) | Rising Head [(2)] (ft/sec) |
|---|---|---|---|---|
| EMW02 | $9.219 \times 10^{-6}$ | $5.925 \times 10^{-7}$ | $1.856 \times 10^{-5}$ | $1.183 \times 10^{-6}$ |
| EMW03 | $2.294 \times 10^{-7}$ | $1.196 \times 10^{-7}$ | $4.625 \times 10^{-7}$ | $1.879 \times 10^{-7}$ |

Note:
1. Bouwer-Rice Method.
2. Hvorslev Method.
ft/sec – feet second

# SOIL BORING LOGS

# Tetra Tech NUS, Inc.
Houston, Texas

## BOREHOLE No.: EMW01

NORTHING: **1643653.28**
EASTING: **2502047.57** GROUND ELEVATION: **6715.16 MSL**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| PROJECT: | **Eastern Landfill** | DRILLING CO.: | **Enviro-Drill** |
| SITE LOCATION: | **Fort Wingate Depot Activity** | DRILLER: | **Matt Cain** |
| JOB NO.: | **794A** | RIG TYPE: | **CME 75** |
| LOGGED BY: | **Larry Basilio** | METHOD OF DRILLING: | **Hollow Stem Auger / Air Rotary** |
| PROJECT MANAGER: | **Theresa Thompson** | SAMPLING METHODS: | **5 ft CME Barrel / Drill Cuttings** |
| DATE DRILLED: | **7/13/04 to 7/14/04** | TOTAL DEPTH: | **120 feet BGS** |

NOTES: Dry, Sparse Vegetation

▽ Initial Water Level
▼ Static Water Level

| DEPTH (FEET) | SOIL SYMBOL | USCS: SOIL DESCRIPTION | SAMPLE NUMBER/ INTERVAL | RECOVER/ ADVANCE (inches) | PID (ppm) | WELL DETAIL | WELL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | ML: SILT - red (2.5 YR 4/6), loose, poorly consolidated, dry, trace of < 1/2-inch gravel | No soil or groundwater samples were collected for laboratory analyses. | 48/60 | 0 | | 4 ft x 4 ft aboveground concrete surface completion |
| -5 | | | | 60/60 | 0 | | |
| -10 | | | | 12/60 | 0 | | |
| -15 | | SM: SAND - red (2.5 YR 4/8), very silty to very clayey in parts, dry, increasing clay content with depth | | 60/60 | 0 | | Borehole diameter 7 3/4" to 120 ft using hollow stem augers |
| -20 | | CL: CLAY - reddish brown (2.5 YR 4/4), very silty, partially indurated, broken, dry, sandy in parts, gray clay inclusions | | 60/60 | 0 | | |
| -25 | | ML: SILT - red (2.5 YR 4/6), very clayey, very stiff, broken to blocky, dry, gray clay inclusions | | 60/60 | 0 | | |
| -30 | | CL: CLAY - red (2.5 YR 4/8), very stiff to hard, broken to crumbly, very silty, non to very slightly plastic, dry, trace to abundant gray clay inclusions | | 60/60 | 0 | | 2" PVC riser with cement/bentonite grout |
| -35 | | ML: SILT - red (2.5 YR 5/6), very clayey, poor to fair induration, slightly sandy in parts, dry | | 60/60 | 0 | | |
| -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 | | 60/60 | 0 | | |
| -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 | | 60/60 | 0 | | |
| -50 | | CL: CLAY - reddish brown (2.5 YR 4/4), very stiff to hard, blocky, crumbly, silty, dry | | 60/60 | 0 | | |
| -55 | | CL: CLAY - red (2.5 YR 4/6), hard, dense, non plastic, slightly silty, dry | | 60/60 | 0 | | |
| -60 | | | | 60/60 | 0 | | |
| -65 | | | | 60/60 | 0 | | |
| -70 | | CL: CLAY - red (2.5 YR 4/6), some light gray | | | 0 | | |

**BOREHOLE No.: EMW01**



| DEPTH (FEET) | SOIL SYMBOLS | USCS: SOIL DESCRIPTION | SAMPLE NUMBER | ADVANCE/ RECOVER (feet) | PID ppm | BORING COMPLETION | WELL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| -75 | | mottle, very stiff to hard, non to very slightly plastic, silty, dry | | 60/60 | 0 | | |
| -80 | | CL: CLAY - red (2.5 YR 4/8), very stiff to hard, broken, silty, dry | | 60/60 | 0 | | |
| -85 | | | | 60/60 | 0 | | |
| -90 | | CL: CLAY - as above with increased sand content, very fine grained, dry to very slightly damp | | 60/60 | 0 | | |
| -95 | | 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 | | 60/60 | 0 | | Bentonite seal |
| -100 | | 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 | | 60/60 | 0 | | |
| -105 ▽ | | ML: SILT - hard, well indurated, fissile, dry | | 60/60 | 0 | | 0.010" slot 2" diameter PVC screen with 20/40 silica sand filter pack |
| -110 | | SM: SAND - gray, very fine grained, interbedded with siltstone and claystone, moderately friable, dry | | 60/60 | 0 | | |
| -115 | | | | | 0 | | |
| -120 | | Total Depth = 120.7 feet below ground surface | | | | | Bottom cap |

# Tetra Tech NUS, Inc.
Houston, Texas

## BOREHOLE No.: EMW02



NORTHING: **1643388.64**

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

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| PROJECT: | **Eastern Landfill** | DRILLING CO.: | **Enviro-Drill** |
| SITE LOCATION: | **Fort Wingate Depot Activity** | DRILLER: | **Matt Cain** |
| JOB NO.: | **794A** | RIG TYPE: | **CME 75** |
| LOGGED BY: | **Larry Basilio** | METHOD OF DRILLING: | **Hollow Stem Auger / Air Rotary** |
| PROJECT MANAGER: | **Theresa Thompson** | SAMPLING METHODS: | **5 ft CME Barrel / Drill Cuttings** |
| DATE DRILLED: | **7/15/04 to 7/19/04** | TOTAL DEPTH: | **120 feet BGS** |

NOTES: Dry, Sparse Vegetation

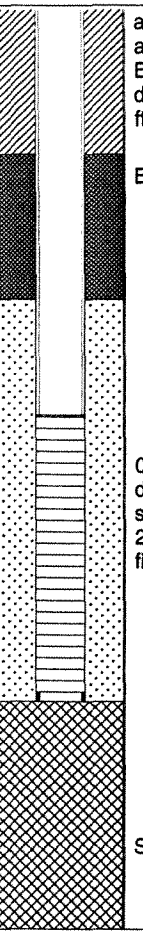
▽ Initial Water Level

▼ Static Water Level

| DEPTH (FEET) | SOIL SYMBOL | USCS: SOIL DESCRIPTION | SAMPLE NUMBER/ INTERVAL | RECOVER/ ADVANCE (inches) | PID (ppm) | WELL DETAIL | WELL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | CL: CLAY - dark reddish brown (2.5 YR 3/3), very stiff, slightly plastic, very silty, trace rootlets, trace caliche, homogenous, slightly damp | 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. | 48/60 | 0 | | 4 ft x 4 ft aboveground concrete surface completion |
| -5 | | | | | | | |
| -10 | | 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 | | 60/60 | 0 | | |
| -15 | | | | 60/60 | 0 | | Borehole diameter 7 3/4" to 67.5 ft using hollow stem augers |
| -20 | | 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 | | 60/60 | 0 | | |
| -25 | | 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 < 1/2-inch thick gray very fine grained sandstone, well cemented, dry, slightly to moderately friable | | 60/60 | 0 | | |
| -30 | | | | 60/60 | 0 | | 2" PVC riser with cement/bentonite grout |
| -35 | | 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 | | 60/60 | 0 | | |
| -40 | | | | 48/60 | 0 | | |
| -45 | | 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 | | 48/60 | 0 | | |
| -50 | | | | 36/60 | 0 | | |
| -55 | | CL: CLAY - very stiff to hard, non to very slightly plastic, broken to dense, slightly silty, trace sand, dry | | 60/60 | 0 | | |
| -60 | | SC: SAND - gray, hard, very fine grained, well to poorly indurated, interbedded with clays, hard drilling - drill rig is chattering | | 60/60 | 0 | | |
| -65 | | ML: SILT - reddish brown (2.5 YR 5/4), dense to brittle, crumbly, fair induration in parts, clayey, trace gray clay inclusion | | 50/60 | 0 | | |
| -70 | | ML: SILT - red (2.5 YR 5/8), some varigated colors, dense, blocky to crumbly, gray very fine grained sandstone scattered throughout, dry, | | | 0 | | Encounter refusal with HSA. Switch to |

**BOREHOLE No.: EMW02**



| DEPTH (FEET) | SOIL SYMBOLS | USCS: SOIL DESCRIPTION | SAMPLE NUMBER | ADVANCE/ RECOVER (feet) | PID ppm | BORING COMPLETION | WELL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| -75 | | hard drilling - drill rig is chattering | | | |  | air rotary drilling at 67.5 ft. Borehole diameter 6", 67.5 ft to 120 ft. |
| | | ML: SILT - reddish brown (2.5 YR 4/4), clayey, trace of fine grained sand, dry | | | 0 | | |
| -80 | | ML: SILT - red (2.5 YR 5/6), very clayey, crumbly, dry | | | 0 | | Bentonite Seal |
| -85 | | CL: CLAY - red (2.5 YR 5/6), silty, very stiff to hard, blocky, dry | | | 0 | | |
| -90 | | ML: SILT - reddish brown (2.5 YR 4/4), clayey, fair induration, dry | | | 0 | | |
| -95 | | | | | 0 | | 0.010" slot 2" diameter PVC screen with 20/40 silica sand filter pack |
| -100 | | CL: CLAY - reddish brown (2.5 YR 5/4), very stiff, broken, silty, moist at 103 ft bgs | | | 0 | | |
| -105 | | | | | 0 | | |
| -110 | | ML: SILT - very clayey, slightly plastic, loose, moist | | | 0 | | |
| -115 | | | | | 0 | | Slough |
| -120 | | Total Depth = 120 feet below ground surface | | | | | |

# Tetra Tech NUS, Inc.
**Houston, Texas**

## BOREHOLE No.: EMW03



NORTHING: **1643684.94**
EASTING: **2502802.90** GROUND ELEVATION: **6697.69 ft MSL**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| PROJECT: | **Eastern Landfill** | DRILLING CO.: | **Enviro-Drill** |
| SITE LOCATION: | **Fort Wingate Depot Activity** | DRILLER: | **Matt Cain** |
| JOB NO.: | **794A** | RIG TYPE: | **CME 75** |
| LOGGED BY: | **Larry Basilio** | METHOD OF DRILLING: | **Hollow Stem Auger / Air Rotary** |
| PROJECT MANAGER: | **Theresa Thompson** | SAMPLING METHODS: | **5 ft CME Barrel / Drill Cuttings** |
| DATE DRILLED: | **7/19/04 to 7/21/04** | TOTAL DEPTH: | **100 feet BGS** |

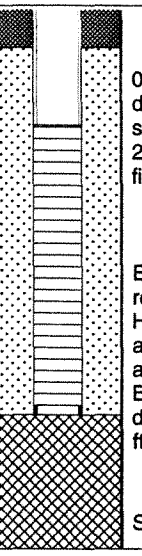
NOTES: Dry, Sparse Vegetation

▽ Initial Water Level
▼ Static Water Level

| DEPTH (FEET) | SOIL SYMBOL | USCS: SOIL DESCRIPTION | SAMPLE NUMBER/ INTERVAL | RECOVER/ ADVANCE (inches) | PID (ppm) | WELL DETAIL | WELL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | CL: CLAY - silty, very stiff, very slightly plastic, dry, fair dry strength, rootlets present | One groundwater sample (FW-EMW03) was collected for laboratory analyses. No soil samples were collected for laboratory analyses. | 48/60 | 0 | | 4 ft x 4 ft aboveground concrete surface completion |
| -5 | | | | | | | |
| -10 | | ML: SILT - light reddish brown (2.5 YR 6/4), very stiff to hard, non plastic, fair induration, clayey, dry | | 60/60 | 0 | | |
| -15 | | CL: CLAY - very stiff to hard, non plastic, silty, broken, abundant soft gray inclusions | | 60/60 | 0 | | Borehole diameter 7 3/4" to 85 ft using hollow stem augers |
| -20 | | ML: SILT - reddish brown (2.5 YR 5/4), clayey, crumbly, dry, low dry strength | | 60/60 | 0 | | |
| -25 | | | | 60/60 | 0 | | |
| -30 | | ML: SILT - hard, blocky, slightly clayey, laminated with gray sandstone, dry, less sandy with depth | | 60/60 | 0 | | 2" PVC riser with cement/bentonite grout |
| -35 | | | | 60/60 | 0 | | |
| -40 | | CL: CLAY - red (2.5 YR 4/6), silty, hard, non plastic, blocky, very silty in parts | | 60/60 | 0 | | |
| -45 ▽ | | | | 60/60 | 0 | | |
| -50 | | 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 | | 48/60 | 0 | | |
| -55 | | | | 40/60 | 0 | | |
| -60 | | ML: SILT - red (2.5 YR 5/6), crumbly, broken, clayey in parts, dry | | 60/60 | 0 | | |
| -65 | | | | 60/60 | 0 | | |
| -70 | | | | 60/60 | 0 | | Bentonite Seal |

**BOREHOLE No.: EMW03**



| DEPTH (FEET) | SOIL SYMBOLS | USCS: SOIL DESCRIPTION | SAMPLE NUMBER | ADVANCE/ RECOVER (feet) | PID ppm | BORING COMPLETION | WELL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| -75 | | 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 | | 60/60 | 0 |  | 0.010" slot 2" diameter PVC screen with 20/40 silica sand filter pack |
| -80 | | | | 48/60 | 0 | | |
| -85 | | ML: SILT - reddish brown (2.5 YR 4/4), hard, fair to good induration towards base, trace of gray sand, very fine grained, damp | | 60/60 | 0 | | Encounter refusal with HSA. Switch to air rotary drilling at 85 ft. Borehole diameter 6", 85 ft to 100 ft. |
| -90 | | ML: SILT - red (2.5 YR 4/8), powdery, clayey, to very slightly sandy, damp | | | 0 | | |
| -95 | | | | | 0 | | Slough |
| -100 | | Total Depth = 100 ft below ground surface | | | | | |

**Tetra Tech NUS, Inc.**
**Houston, Texas**

# BOREHOLE No.: EMW04



NORTHING: **1643812.62**
EASTING: **2502421.78** GROUND ELEVATION: **6704.84 MSL**

| PROJECT INFORMATION | | DRILLING INFORMATION | |
|---|---|---|---|
| PROJECT: | **Eastern Landfill** | DRILLING CO.: | **Enviro-Drill** |
| SITE LOCATION: | **Fort Wingate Depot Activity** | DRILLER: | **Matt Cain** |
| JOB NO.: | **794A** | RIG TYPE: | **CME 75** |
| LOGGED BY: | **Larry Basilio** | METHOD OF DRILLING: | **Hollow Stem Auger / Air Rotary** |
| PROJECT MANAGER: | **Theresa Thompson** | SAMPLING METHODS: | **5 ft CME Barrel / Drill Cuttings** |
| DATE DRILLED: | **7/21/04 to 7/23/04** | TOTAL DEPTH: | **120 feet bgs** |

NOTES: Dry, Sparse Vegetation

▽ Initial Water Level
▼ Static Water Level

| DEPTH (FEET) | SOIL SYMBOL | USCS: SOIL DESCRIPTION | SAMPLE NUMBER/ INTERVAL | RECOVER/ ADVANCE (inches) | PID (ppm) | WELL DETAIL | WELL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | | ML: SILT - reddish brown (2.5 YR 4/4), very clayey, broken to powdery, dry | No soil or groundwater samples were collected for laboratory analyses. | 36/60 | 0 | | 4 ft x 4 ft aboveground concrete surface completion |
| -5 | | 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 | | 60/60 | 0 | | |
| -10 | | ML: SILT - reddish bown (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 powedery with depth, less inclusions | | 60/60 | 0 | | Borehole diameter 7 3/4" to 42 ft using hollow stem augers |
| -15 | | | | 60/60 | 0 | | |
| -20 | | ML: SILT - reddish brown (2.5 YR 4/4), very clayey, fair induration, broken and powdery in parts, dry, trace gray clay inclusions | | 60/60 | 0 | | |
| -25 | | ML: SILT - red (2.5 YR 4/6), very clayey, increased clay content with depth, broken to crumbly, hard in parts, dry, trace gray clay inclusions | | 60/60 | 0 | | |
| -30 | | CL: CLAY - red (2.5 YR 5/6), hard, non to slightly plastic in parts, blocky to crumbly, dry | | 60/60 | 0 | | 2" PVC riser with cement/bentonite grout |
| -35 | | CL: CLAY - reddish brown (2.5 YR 5/4), hard, broken, blocky, silty to very silty in parts, fair to well indurated, dry | | 60/60 | 0 | | |
| -40 | | ML: SILT - reddish brown (2.5 YR 5/4), hard, blocky, clayey, slightly sandy, well indurated, dry | | 24/24 | 0 | | Encounter refusal with HSA. Switch to air rotary drilling at 42 ft. Borehole diameter 6", 42 ft to 120 ft |
| -45 | | ML: SILT - red (2.5 YR 5/6), clayey, powdery, dry | | | 0 | | |
| -50 | | | | | 0 | | |
| -55 | | ML: SILT - light red (2.5 YR 6/6), crumbly to powdery, dry | | | 0 | | |
| -60 | | | | | 0 | | |
| -65 | | | | | 0 | | |
| -70 | | | | | 0 | | |

**BOREHOLE No.: EMW04**



| DEPTH (FEET) | SOIL SYMBOLS | USCS: SOIL DESCRIPTION | SAMPLE NUMBER | ADVANCE/ RECOVER (feet) | PID ppm | BORING COMPLETION | WELL DESCRIPTION |
|---|---|---|---|---|---|---|---|
| -75 | | | | | 0 | | |
| -80 | | ML: SILT - as above, slightly damp | | | 0 | | |
| -85 | | ML: SILT - red (2.5 YR 4/6), loose, powdery, very clayey, dry to slightly damp | | | 0 | | |
| -90 | | CL: CLAY - light red (2.5 YR 6/4), powdery, slightly silty, dry | | | 0 | | Bentonite Seal |
| -95 | | | | | 0 | | |
| -100 | | | | | 0 | | 0.010" slot 2" diameter PVC screen with 20/40 silica sand filter pack |
| -105 | | | | | 0 | | |
| -110 | | | | | 0 | | |
| -115 ▽ | | | | | 0 | | Bottom cap |
| -120 | | Total Depth = 120 ft below ground surface | | | | | Slough |

# APPENDIX E

# AERIAL PHOTOGRAPHS

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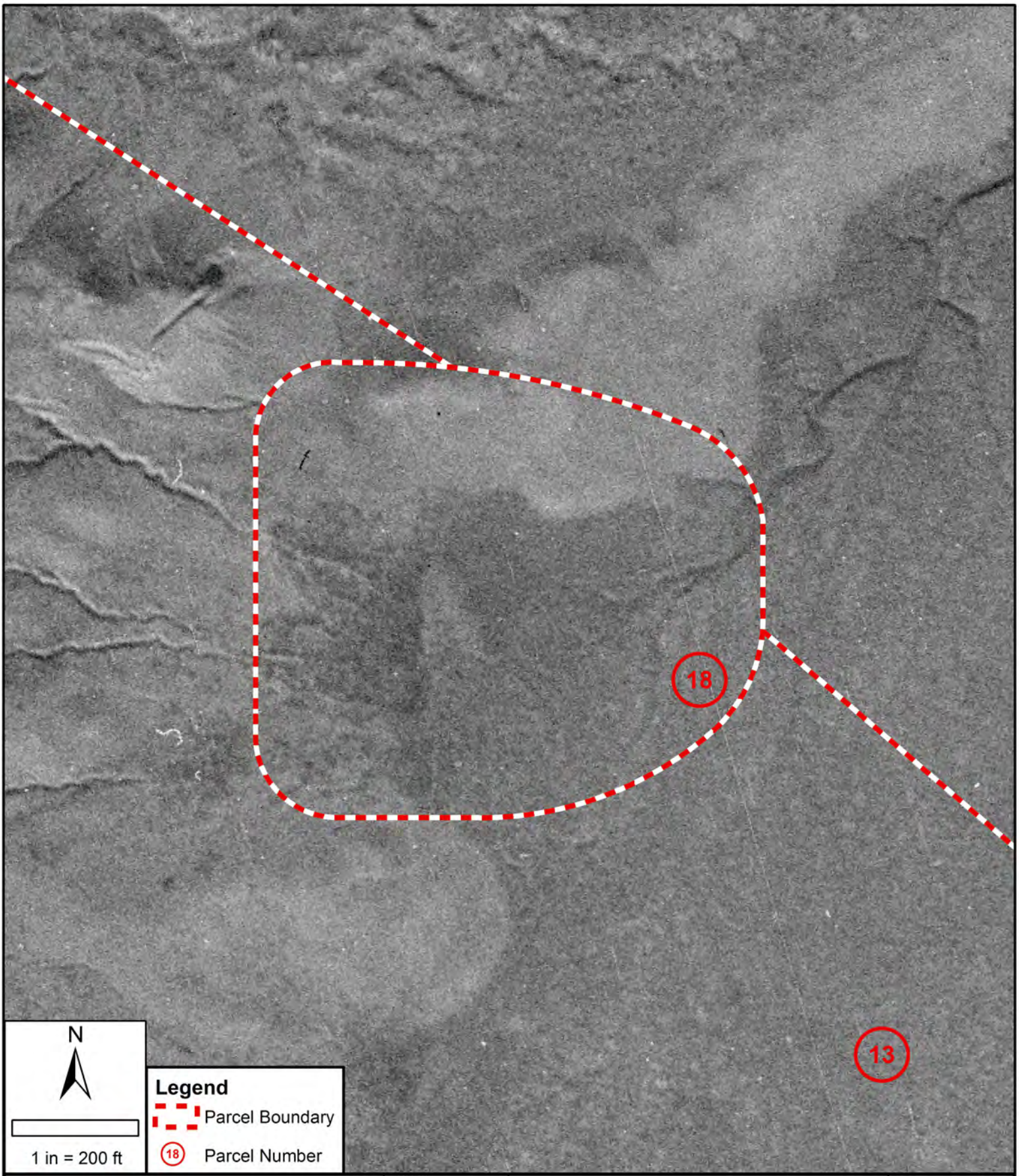
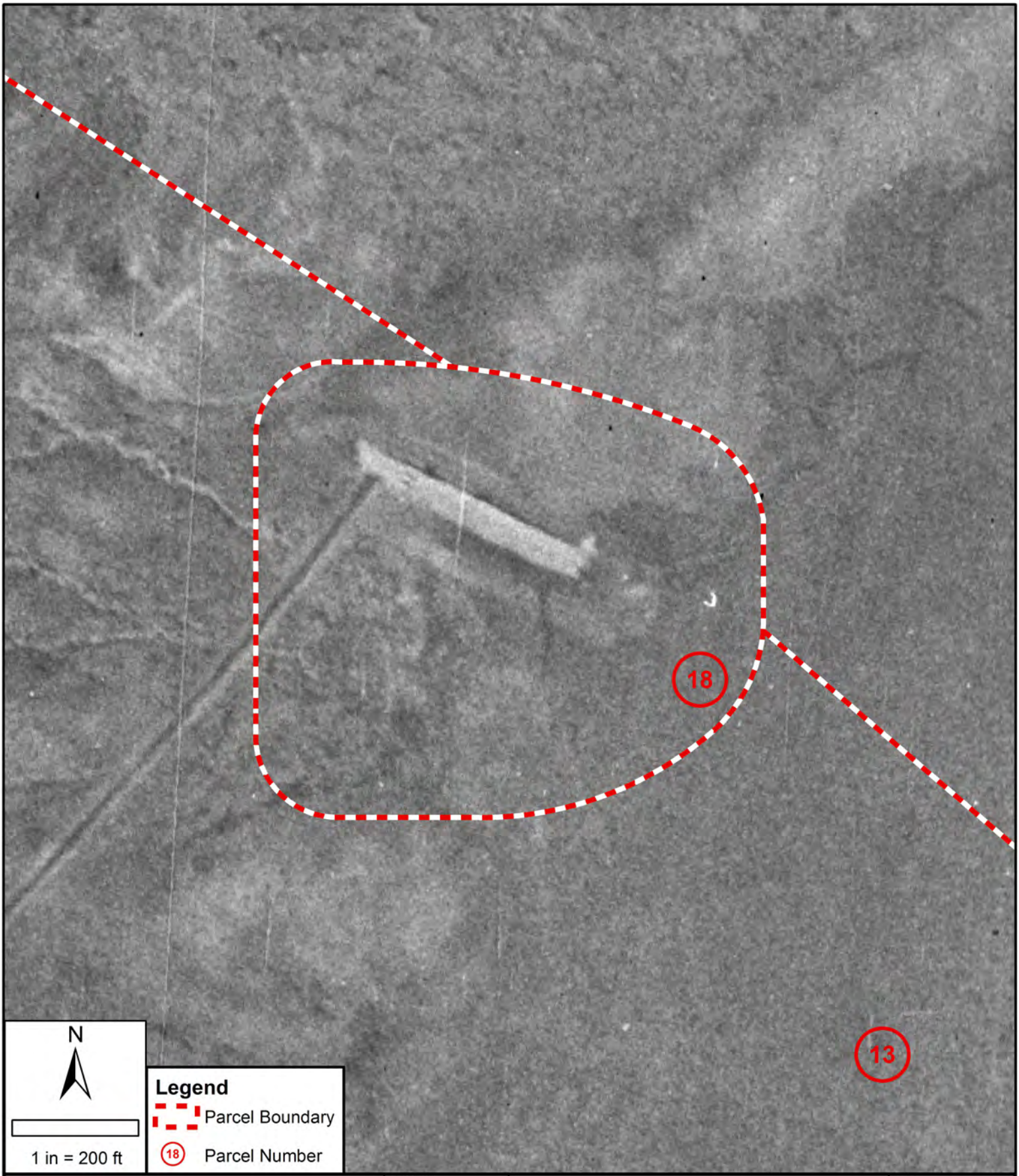



| | | | |
|---|---|---|---|
| U.S. ARMY CORPS OF ENGINEERS<br>FORT WORTH DISTRICT | DWN BY: SFW<br>CHK'D BY: CW<br>DATUM: NAD 1983<br>PROJECTION: NM STATE PLANE<br>SCALE: 1:2,400 | FORT WINGATE DEPOT ACTIVITY<br>PARCEL 18 RI WORK PLAN | DATE: FEBRUARY 2012<br>PROJECT NO.: 912640002.0001.01 |
| AMEC<br>ENVIRONMENT & INFRASTRUCTURE | | 1948 AERIAL PHOTOGRAPH | FIGURE NO.: E-1 |




U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

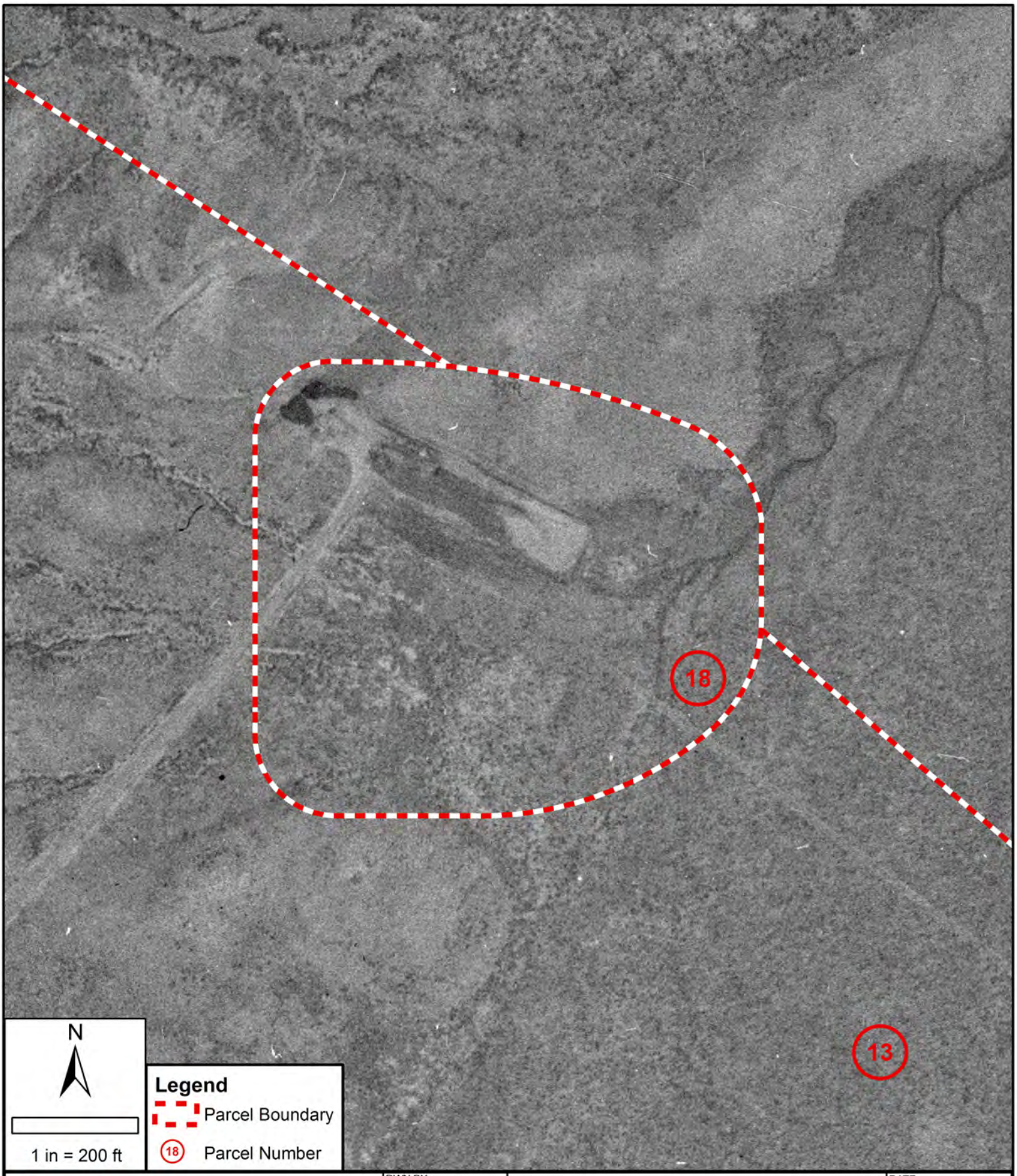
AMEC
ENVIRONMENT & INFRASTRUCTURE

| | |
|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:2,400 |

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 RI WORK PLAN

1952 AERIAL PHOTOGRAPH

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0001.01 |
| FIGURE NO.: | E-2 |




U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC
ENVIRONMENT & INFRASTRUCTURE

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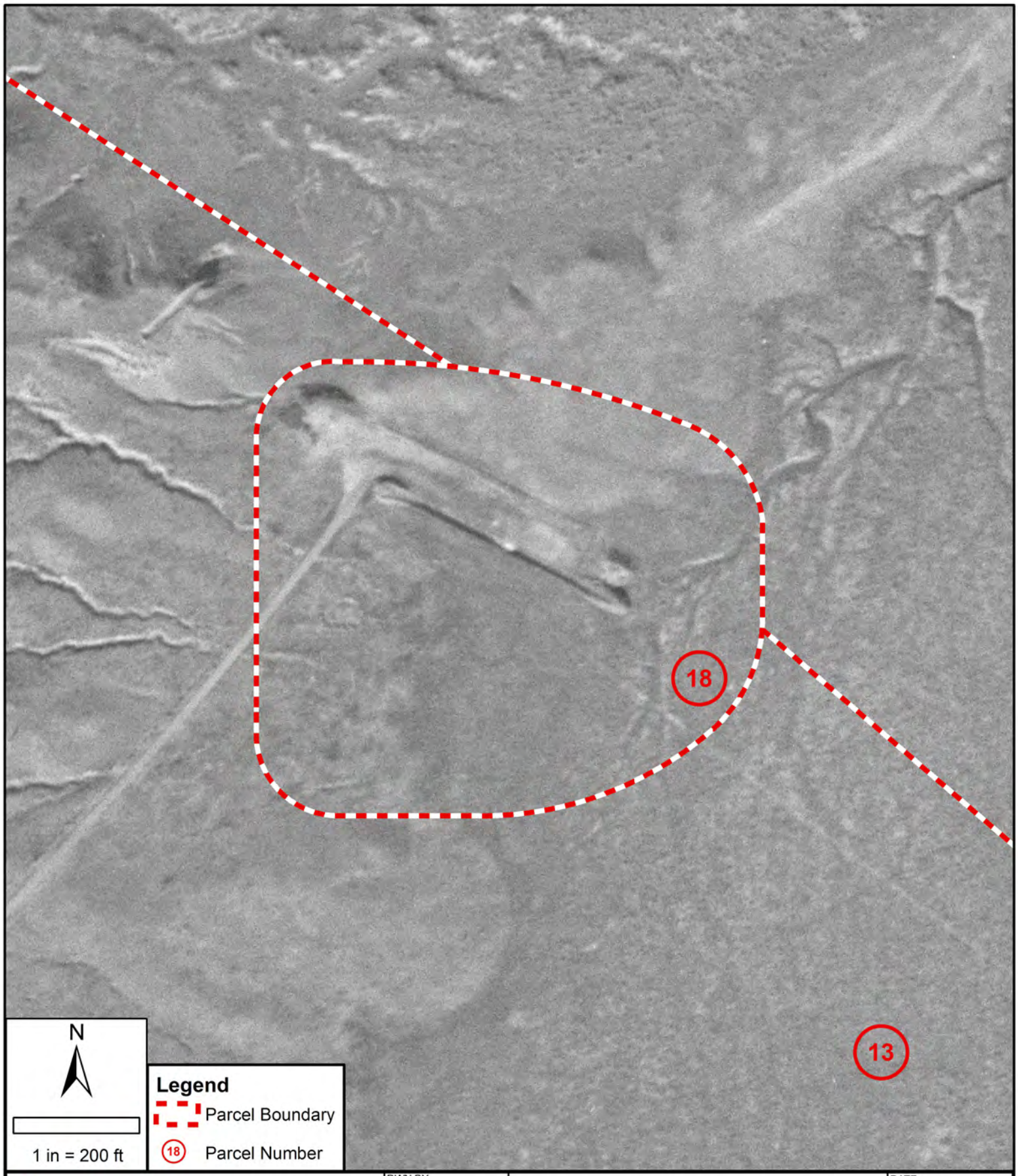
|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:2,400 |

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 RI WORK PLAN

1959 AERIAL PHOTOGRAPH

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0001.01 |
| FIGURE NO.: | E-3 |




U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC
ENVIRONMENT & INFRASTRUCTURE

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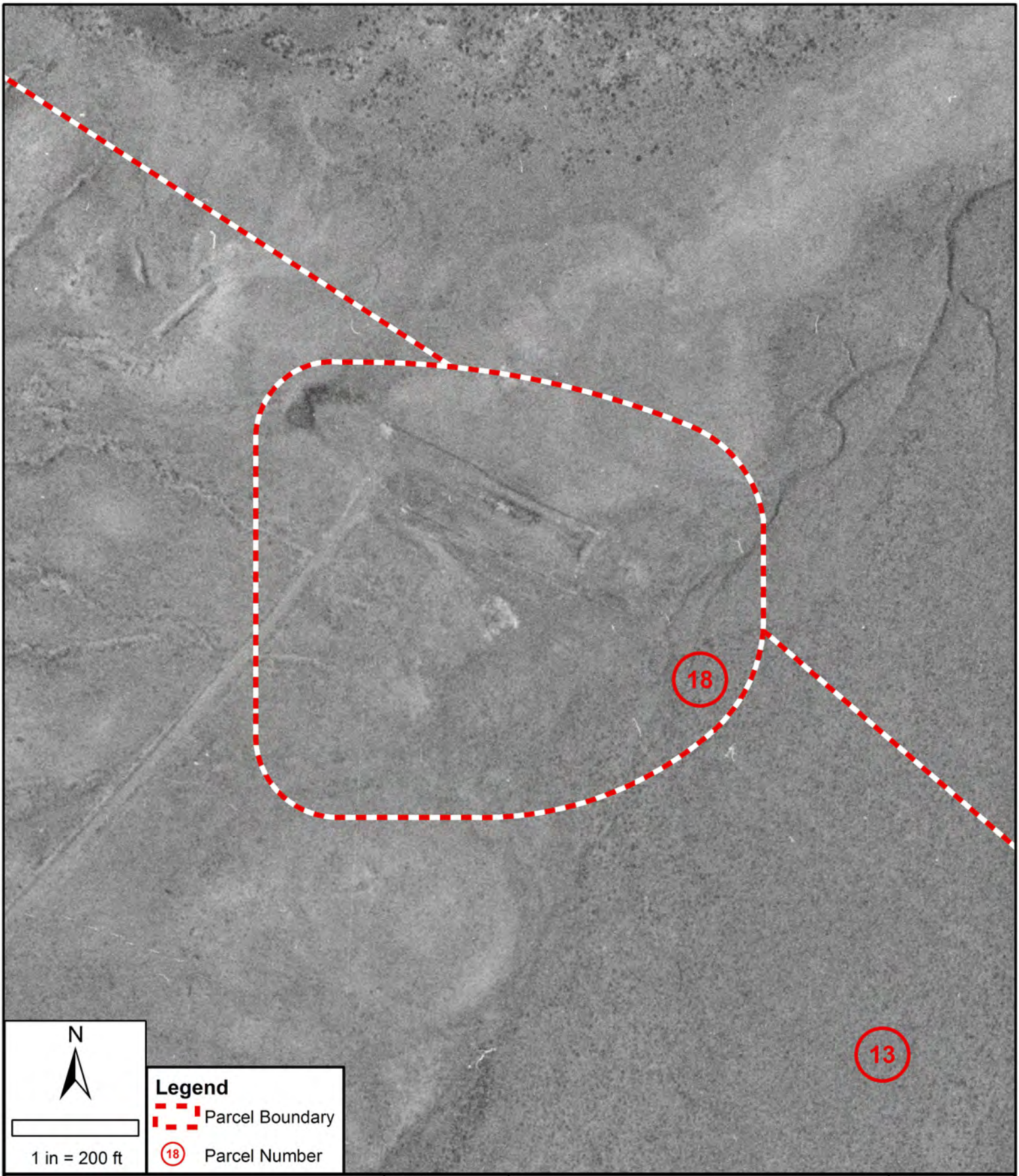
|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:2,400 |

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 RI WORK PLAN

1962 AERIAL PHOTOGRAPH

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0001.01 |
| FIGURE NO.: | E-4 |




U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

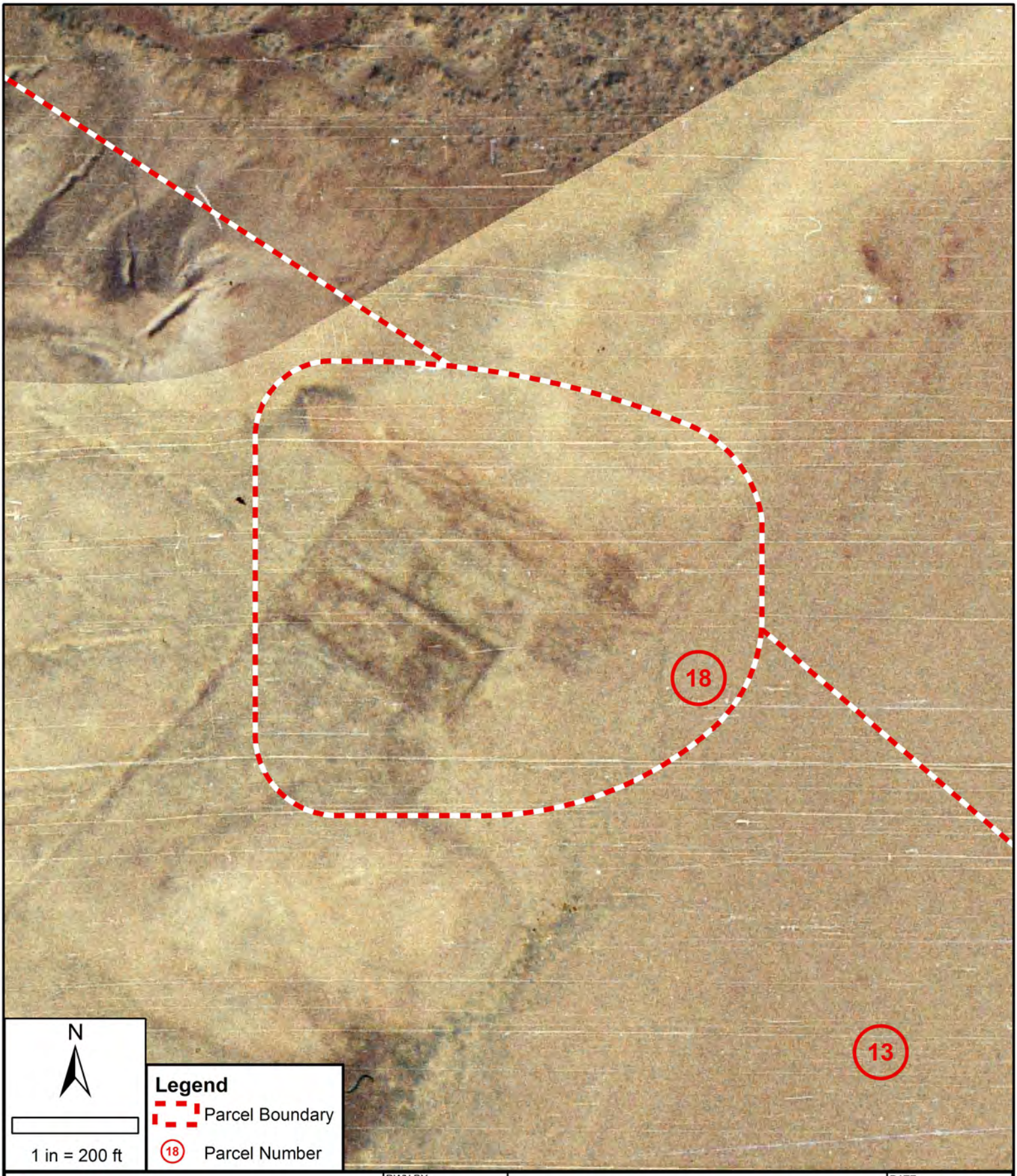
AMEC
ENVIRONMENT & INFRASTRUCTURE

DWN BY: SFW
CHK'D BY: CW
DATUM: NAD 1983
PROJECTION: NM STATE PLANE
SCALE: 1:2,400

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 RI WORK PLAN

1966 AERIAL PHOTOGRAPH

DATE: FEBRUARY 2012
PROJECT NO.: 912640002.0001.01
FIGURE NO.: E-5

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|---|---|---|---|
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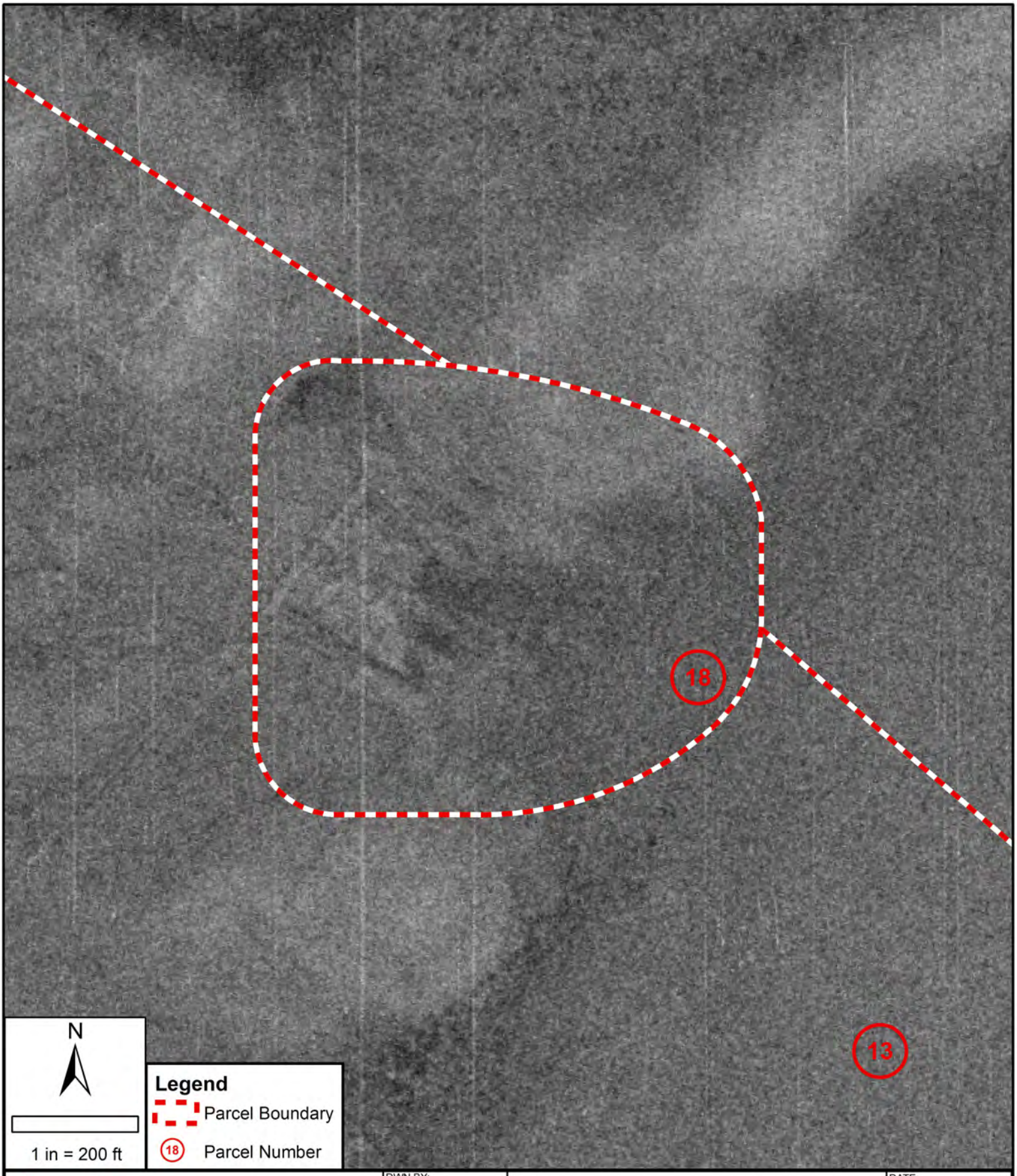
| AMEC<br>ENVIRONMENT & INFRASTRUCTURE | | 1973 AERIAL PHOTOGRAPH | FIGURE NO.: E-6 |




U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC
ENVIRONMENT & INFRASTRUCTURE

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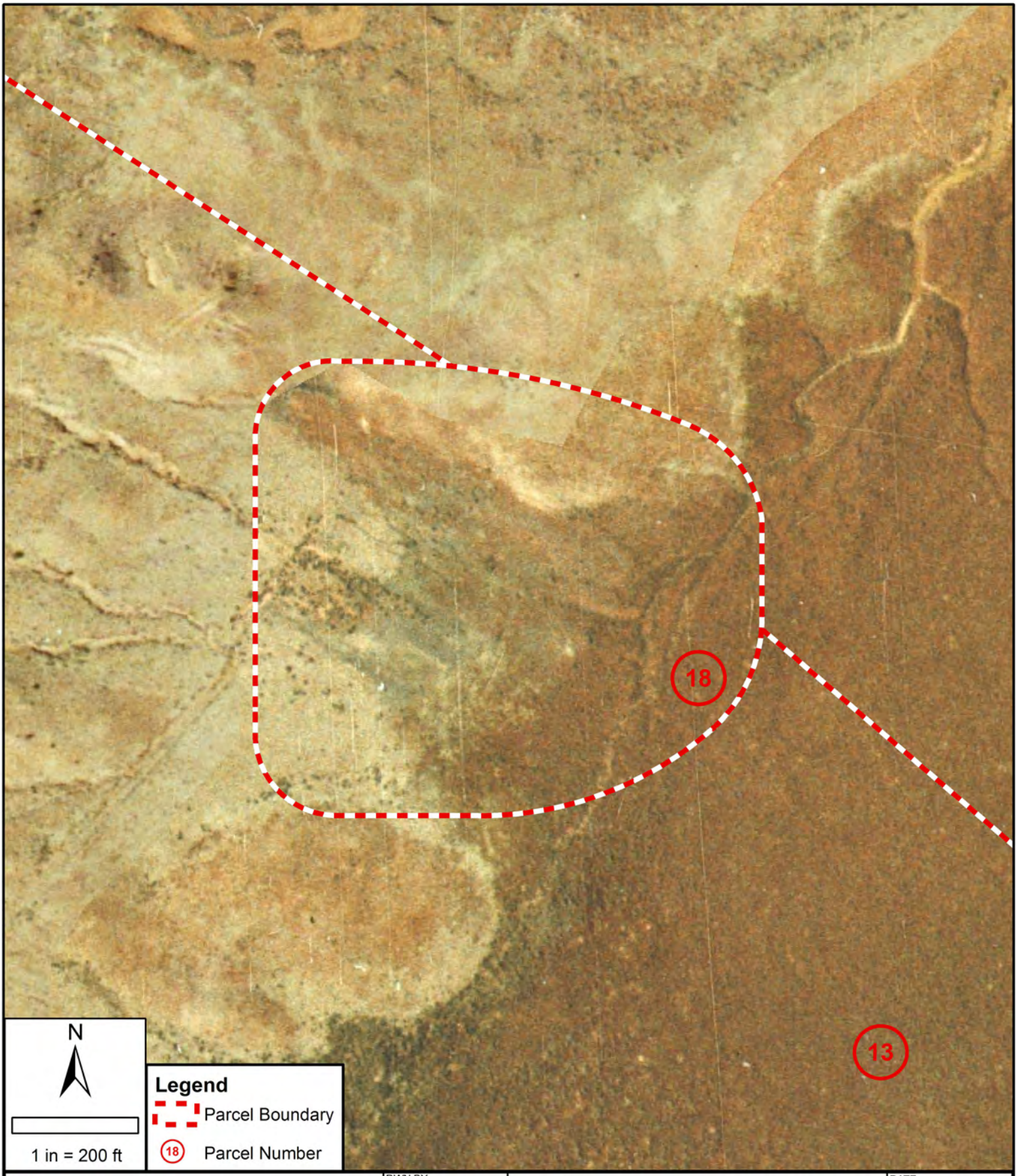
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:2,400 |

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 RI WORK PLAN

1978 AERIAL PHOTOGRAPH

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0001.01 |
| FIGURE NO.: | E-7 |




U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC
ENVIRONMENT & INFRASTRUCTURE

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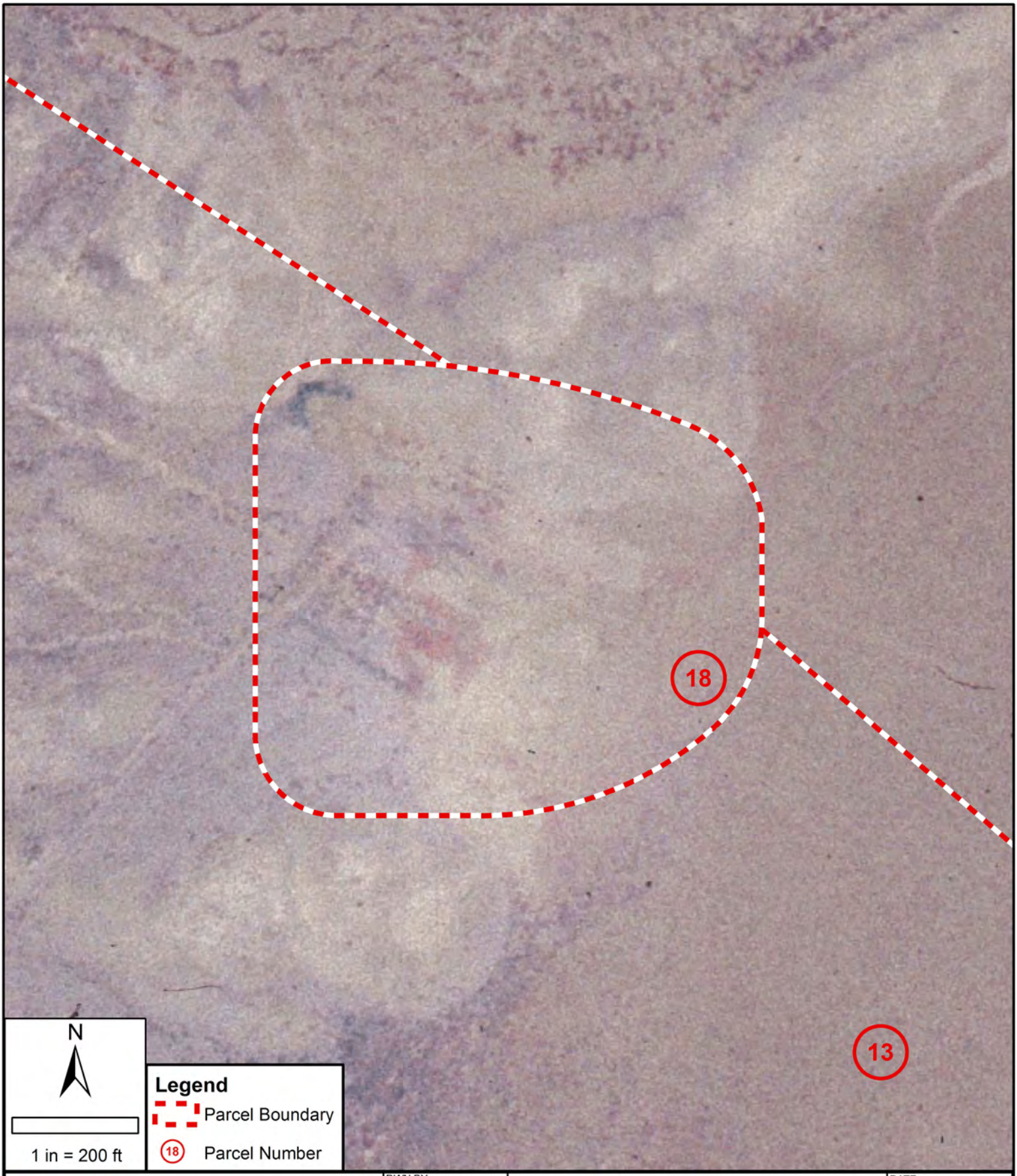
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:2,400 |

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 RI WORK PLAN

1985 AERIAL PHOTOGRAPH

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0001.01 |
| FIGURE NO.: | E-8 |




U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC
ENVIRONMENT & INFRASTRUCTURE

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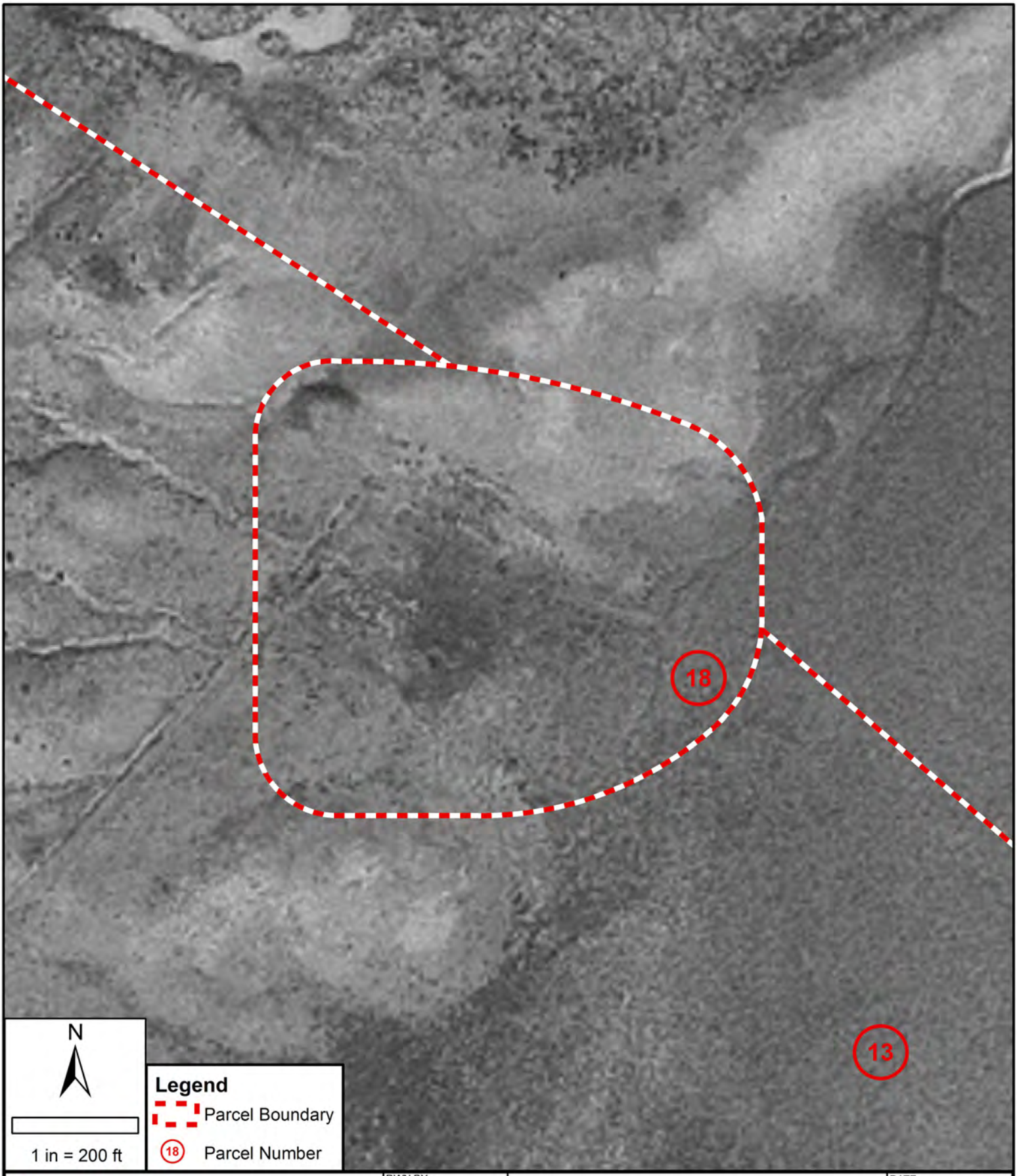
|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:2,400 |

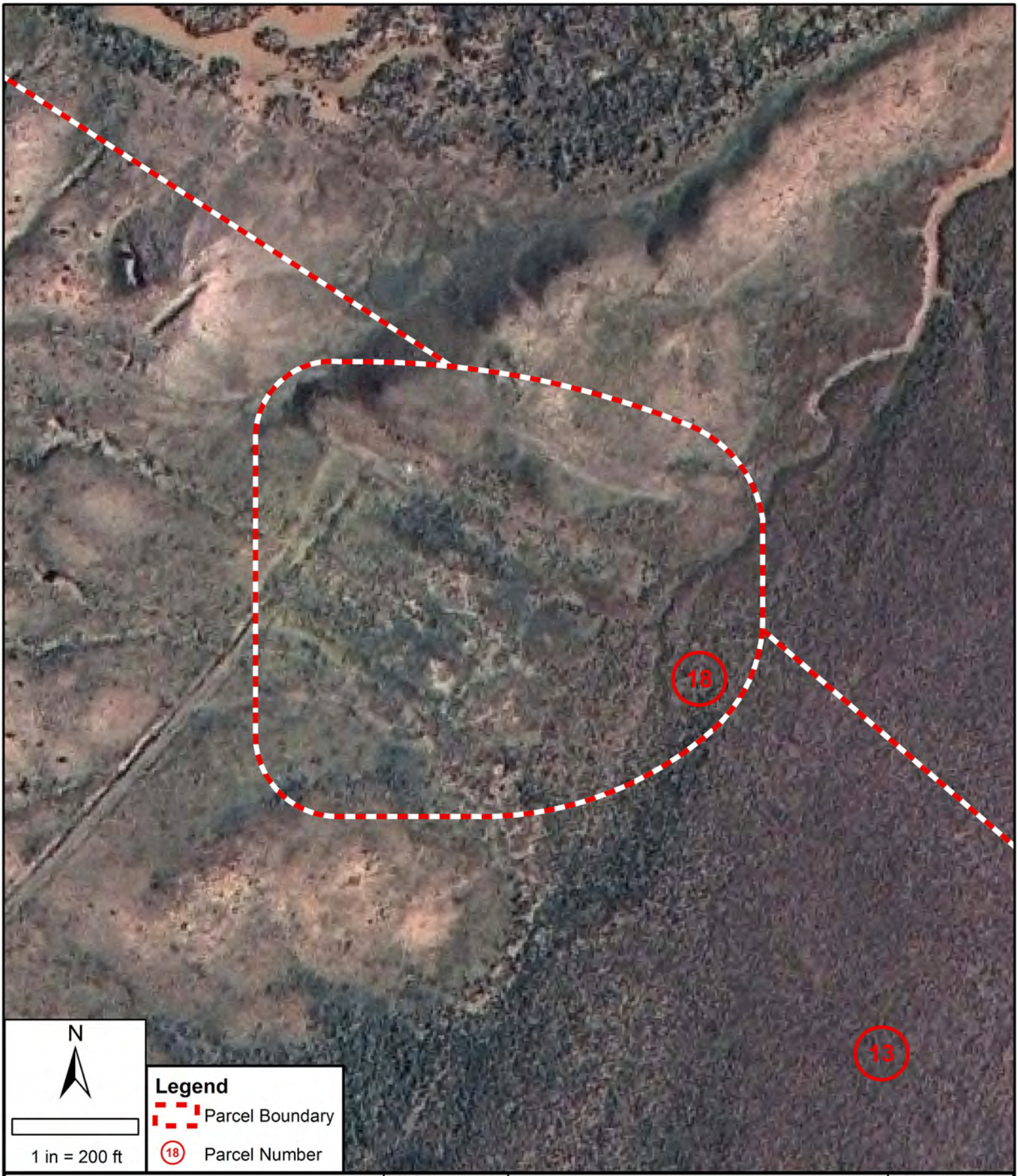
FORT WINGATE DEPOT ACTIVITY
PARCEL 18 RI WORK PLAN

1991 AERIAL PHOTOGRAPH

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0001.01 |
| FIGURE NO.: | E-9 |




| | | | |
|---|---|---|---|
| U.S. ARMY CORPS OF ENGINEERS<br>FORT WORTH DISTRICT | DWN BY: SFW<br>CHK'D BY: CW<br>DATUM: NAD 1983<br>PROJECTION: NM STATE PLANE<br>SCALE: 1:2,400 | FORT WINGATE DEPOT ACTIVITY<br>PARCEL 18 RI WORK PLAN | DATE: FEBRUARY 2012<br>PROJECT NO.: 912640002.0001.01 |
| AMEC<br>ENVIRONMENT & INFRASTRUCTURE | | 1997 AERIAL PHOTOGRAPH | FIGURE NO.: E-10 |




U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC
ENVIRONMENT & INFRASTRUCTURE

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|---|---|
| DWN BY: | SFW |
| CHK'D BY: | CW |
| DATUM: | NAD 1983 |
| PROJECTION: | NM STATE PLANE |
| SCALE: | 1:2,400 |

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 RI WORK PLAN

2005 AERIAL PHOTOGRAPH

| | |
|---|---|
| DATE: | FEBRUARY 2012 |
| PROJECT NO.: | 912640002.0001.01 |
| FIGURE NO.: | E-11 |

# APPENDIX F

# RESULTS OF BATTELLE AIRBORNE GEOPHYSICS SURVEY

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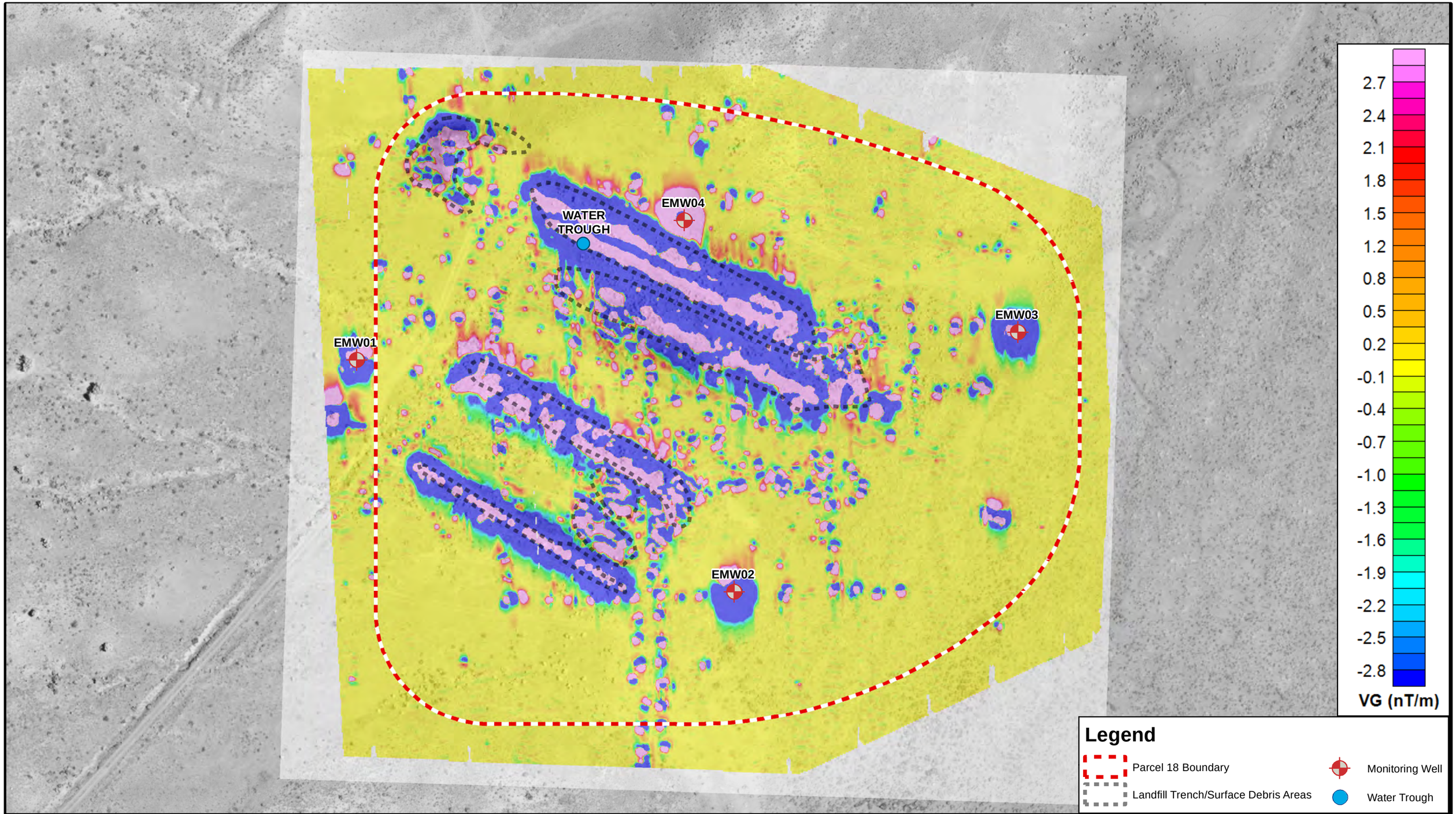



N

1 inch = 100 feet

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

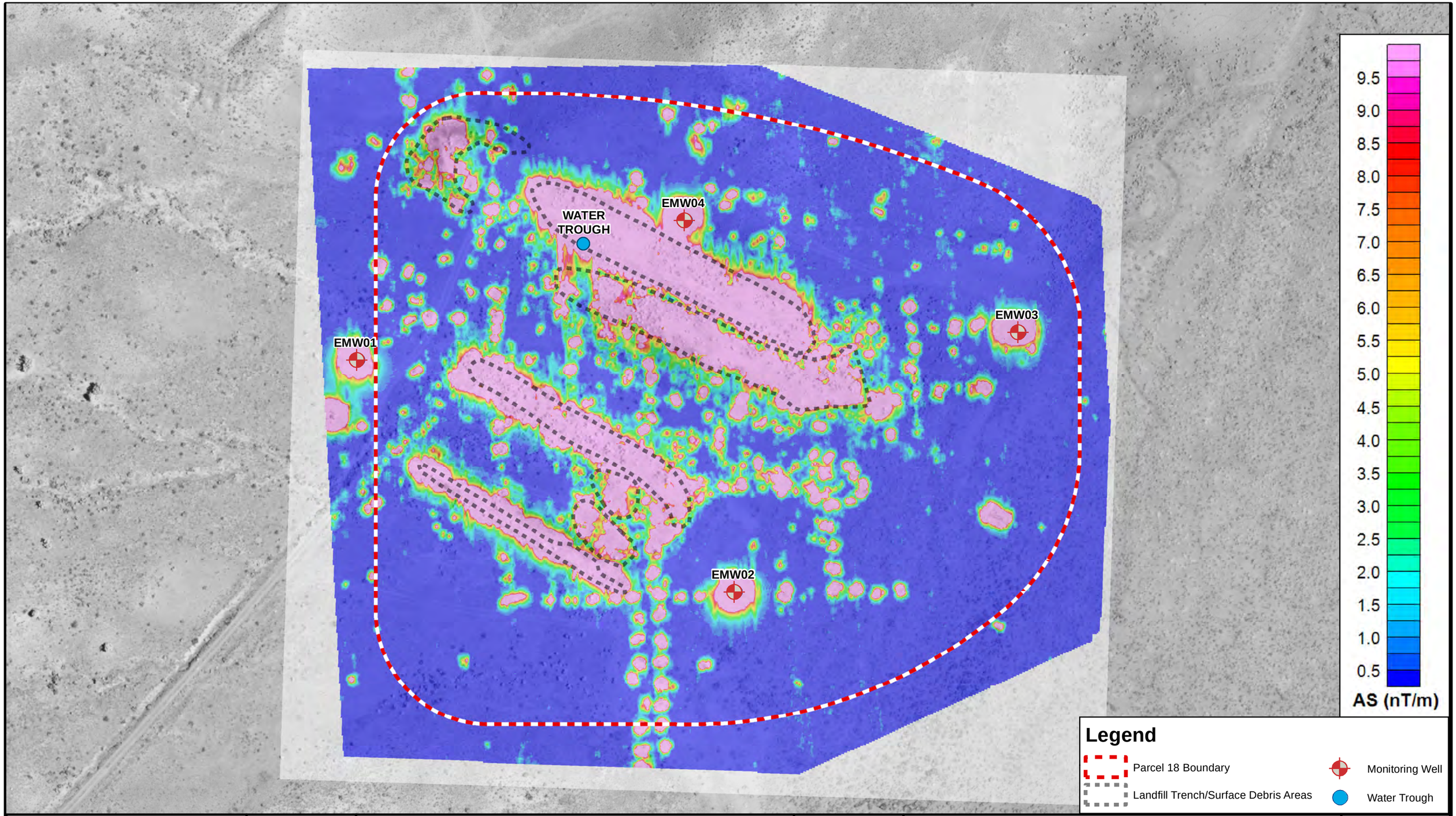
AMEC Environment & Infrastructure, Inc.

DWN BY: SFW
CHK'D BY: CW
DATUM: NAD 1983
PROJECTION: NM STATE PLANE
SCALE: 1:1,200

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 IR WORK PLAN

VERTICAL GRADIENT MAP OF THE EAST LANDFILL

DATE: FEBRUARY 2012
PROJECT NO.: 912640002.0002.01
FIGURE NO.: F-1




N

1 inch = 100 feet

U.S. ARMY CORPS OF ENGINEERS
FORT WORTH DISTRICT

AMEC Environment & Infrastructure, Inc.

DWN BY: SFW
CHK'D BY: CW
DATUM: NAD 1983
PROJECTION: NM STATE PLANE
SCALE: 1:1,200

FORT WINGATE DEPOT ACTIVITY
PARCEL 18 IR WORK PLAN

ANALYTIC SIGNAL MAP OF THE EAST LANDFILL

DATE: FEBRUARY 2012
PROJECT NO.: 912640002.0002.01
FIGURE NO.: F-2

# APPENDIX G

# DOCUMENTATION OF CULTURAL RESOURCES CONSULTATION

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**DEPARTMENT OF THE ARMY**
FORT WINGATE DEPOT ACTIVITY
P.O. BOX 268
FORT WINGATE, NM 87316

August 12, 2011

Ms. Jan V. Biella
Historic Preservation Division
407 Galisteo Street, Suite 236
Santa Fe, NM 87501

Dear Ms Biella:

The Army will soon prepare Work Plans for the removal of the Eastern Landfill at Fort Wingate Depot Activity (FWDA). The landfill is referenced in the Resource Conservation Recovery Act (RCRA) Permit as Solid Waste Management Unit 13 and it is identified as Parcel 18 on the FWDA installation map. Parcel 18 is a small parcel containing only the Eastern Landfill. The Army seeks SHPO comments to comply with the Programmatic Agreement regarding cultural resources sites in the vicinity of the Eastern Landfill. The Army is also seeking comments from the Navajo Nation and Pueblo of Zuni on this action.

In the past the New Mexico Environment Department (NMED) required the removal of several other landfills on FWDA and the Army believes NMED will require the same for this landfill.

A figure showing the location of the landfill and the locations of known cultural sites is enclosed. As evident by the figure, the landfill is in the vicinity of identified cultural sites. The Army will avoid these cultural sites during the removal of the highly disturbed site.

The Army is seeking SHPO comments pursuant to the Programmatic Agreement (PA). We seek input from the SHPO on the Army's decision to remove the landfill. The Army presumes the SHPO is comfortable with the decision to remove the landfill and that cultural sites are a sufficient distance away from the landfill as to not be encountered during the removal. If cultural resources are inadvertently encountered during the removal, the Army will immediately notify the Tribal cultural points of contact for consultation per section 1.8 of the PA. As stated in Section 1.4 of the PA, a*voidance of historic properties and potential NAGPRA cultural items will be the first choice for RCRA permit activities.*

Please provide SHPO concurrence on this proposed action or comments within 30 days of receipt of this letter or the Army shall assume your concurrence.

Should you have any questions, or require any further information concerning the above, please contact Ms. Nancy Parrish (Fort Wingate Project Archaeologist) of the U.S. Army Corps of Engineers, Fort Worth District, at (817) 886-1725, or by email at nancy.a.parrish@usace.army.mil.

Sincerely,

Mark Patterson

Mark Patterson
BRAC Environmental Coordinator
Fort Wingate Depot Activity

Enclosures
CF:
David Cobrain, NMED, HWB
Chuck Hendrickson, U.S. EPA Region 6
Steve Smith, USACE-SWF

**DEPARTMENT OF THE ARMY**
FORT WINGATE DEPOT ACTIVITY
P.O. BOX 268
FORT WINGATE, NM 87316

August 12, 2011

Mr. Ronald P. Maldonado
Navajo Nation Historic Preservation Department
Cultural Resource Compliance Section
P.O. Box 4950
Window Rock, Arizona 86515

Dear Mr. Maldonado:

The Army will soon prepare Work Plans for the removal of the Eastern Landfill at Fort Wingate Depot Activity (FWDA). The landfill is referenced in the Resource Conservation Recovery Act (RCRA) Permit as Solid Waste Management Unit 13 and it is identified as Parcel 18 on the FWDA installation map. Parcel 18 is a small parcel containing only the Eastern Landfill. The Army seeks Navajo Nation comments to comply with the Programmatic Agreement regarding cultural resources sites in the vicinity of the Eastern Landfill.

In the past the New Mexico Environment Department (NMED) required the removal of several other landfills on FWDA and the Army believes NMED will require the same for this landfill.

A figure showing the location of the landfill and the locations of known cultural sites is enclosed. As evident by the figure, the landfill is in the vicinity of identified cultural sites. The Army will avoid these cultural sites during the removal of the highly disturbed site.

The Army is seeking Navajo comments pursuant to the Programmatic Agreement (PA). We seek input from the Navajo Nation on the Army's decision to remove the landfill. The Army presumes the Navajo Nation is comfortable with the decision to remove the landfill and that cultural sites are a sufficient distance away from the landfill as to not be encountered during the removal. If cultural resources are inadvertently encountered during the removal, the Army will immediately notify the Tribal cultural points of contact for consultation per section 1.8 of the PA. As stated in Section 1.4 of the PA, a*voidance of historic properties and potential NAGPRA cultural items will be the first choice for RCRA permit activities.*

Please provide Navajo Nation comments on the landfill removal within 30 days of receipt of this letter or the Army shall assume your concurrence with the removal of the Eastern Landfill.

Should you have any questions, or require any further information concerning the above, please contact Ms. Nancy Parrish (Fort Wingate Project Archaeologist) of the U.S. Army Corps of Engineers, Fort Worth District, at (817) 886-1725, or by email at nancy.a.parrish@usace.army.mil.

Sincerely,

Mark Patterson

Mark Patterson
BRAC Environmental Coordinator
Fort Wingate Depot Activity

Enclosures
CF:
David Cobrain, NMED, HWB
Chuck Hendrickson, U.S. EPA Region 6
Steve Smith, USACE-SWF

**DEPARTMENT OF THE ARMY**
FORT WINGATE DEPOT ACTIVITY
P.O. BOX 268
FORT WINGATE, NM 87316

August 12, 2011

Mr. Darrell Tsabetsaye
Attn: Governor's Office
1203B State Highway 53
P.O. Box 339
Zuni, New Mexico 87327

Dear Mr. Tsabetsaye,

The Army will soon prepare Work Plans for the removal of the Eastern Landfill at Fort Wingate Depot Activity (FWDA). The landfill is referenced in the Resource Conservation Recovery Act (RCRA) Permit as Solid Waste Management Unit 13 and it is identified as Parcel 18 on the FWDA installation map. Parcel 18 is a small parcel containing only the Eastern Landfill. The Army seeks Pueblo of Zuni comments to comply with the Programmatic Agreement regarding cultural resources sites in the vicinity of the Eastern Landfill.

In the past the New Mexico Environment Department (NMED) required the removal of several other landfills on FWDA and the Army believes NMED will require the same for this landfill.

A figure showing the location of the landfill and the locations of known cultural sites is enclosed. As evident by the figure, the landfill is in the vicinity of identified cultural sites. The Army will avoid these cultural sites during the removal of the highly disturbed site.

The Army is seeking Zuni comments pursuant to the Programmatic Agreement (PA). We seek input from the Pueblo of Zuni on the Army's decision to remove the landfill. The Army presumes the Pueblo of Zuni is comfortable with the decision to remove the landfill and that cultural sites are a sufficient distance away from the landfill as to not be encountered during the removal. If cultural resources are inadvertently encountered during the removal, the Army will immediately notify the Tribal cultural points of contact for consultation per section 1.8 of the PA. As stated in Section 1.4 of the PA, a*voidance of historic properties and potential NAGPRA cultural items will be the first choice for RCRA permit activities.*

Please provide Pueblo of Zuni comments on the landfill removal within 30 days of receipt of this letter or the Army shall assume your concurrence with the removal of the Eastern Landfill.

Should you have any questions, or require any further information concerning the above, please contact Ms. Nancy Parrish (Fort Wingate Project Archaeologist) of the U.S. Army Corps of Engineers, Fort Worth District, at (817) 886-1725, or by email at nancy.a.parrish@usace.army.mil.

Sincerely,

Mark Patterson

Mark Patterson
BRAC Environmental Coordinator
Fort Wingate Depot Activity

Enclosures
CF:
David Cobrain, NMED, HWB
Chuck Hendrickson, U.S. EPA Region 6
Steve Smith, USACE-SWF

Arlen Quetawki, SR.
Governor

Willard Zunie
Lt. Governor

Steve K. Boone
Head Councilman

Vacant
Councilman

**PUEBLO OF ZUNI**
P. O. Box 339
Zuni, New Mexico 87327
1203-B NM State Hwy 53
Phone: (505) 782-7022
Fax: (505) 782-7202
www.ashiwi.org

505-782-7000 MAIN

Loren L. Leekela, SR
Councilman

Gerald Hooee, SR.
Councilman

Mark Martinez
Councilman

Birdena Sanchez
Councilwoman

19 August 2011

Mr. Mark Patterson, BRAC Environmental Coordinator
Fort Wingate Depot Activity
P.O. Box 268
Fort Wingate, NM 87316

RE: Removal of Eastern Landfill in Parcel 18 at Fort Wingate

Dear Mr. Patterson,

The Pueblo of Zuni has received and reviewed of your 12 August 2011 correspondence regarding the Army's intention to prepare a work plan for the removal of the Eastern Landfill, identified as Solid Waste Management Unit 13 in the RCRA Permit, located within Parcel 18 at Fort Wingate.

The Pueblo of Zuni concurs with the Army's decision to remove the landfill and also concurs with the Army's determination that all identified cultural sites are located a sufficient distance away from the landfill as to not be impacted by the proposed activities. The Pueblo of Zuni also appreciates the Army's intention to immediately notify the Pueblo of Zuni if cultural resources are inadvertently encountered during the removal activities.

Thank you for consulting with the Pueblo of Zuni. Should you require further information please contact me at 505.782.7000.

Sincerely,

Darrell Tsabetsaye
Pueblo of Zuni Fort Wingate Program

Xc: David Cobrain, NMED, HWB
Chuck Hendrickson, U.S. EPA Region 6
Steve Smith, USACE-SWF
Nancy Parrish, Ft. Wingate Project Archaeologist