AP - 111

SOIL BACKGROUND WORK PLAN

2019

Marathon Petroleum Company LP

September 26, 2019

Mr. John E. Kieling, Chief
New Mexico Environmental Department
2905 Rodeo Park Drive East, Bldg. 1
Santa Fe, NM 87505-6303

RE: Response to Disapproval
Investigation Work Plan Background Concentrations
Marathon Petroleum Company LP, Gallup Refinery
(dba Western Refining Southwest, Inc.)
EPA ID# NMD000333211
HWB-WRG-18-013

Dear Mr. Kieling:

Marathon Petroleum Company LP (dba Western Refining Southwest, Inc.) Gallup Refinery is submitting the enclosed responses to your comments dated May 30, 2019 on the referenced Investigation Work Plan. The Investigation Work Plan has been revised per your comments and enclosed for your review. If there are any questions, please call Brian Moore at 505-726-9745.

Certification

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision according to a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Sincerely,
Marathon Petroleum Company LP, Gallup Refinery

Robert S. Hanks

Robert S. Hanks
Refinery General Manager

Enclosure

cc K. Van Horn NMED
C. Chavez NMOCD
B. Moore Marathon Gallup Refinery

RESPONSE TO COMMENTS
May 30, 2019 Disapproval - Investigation Work Plan Background Concentrations
(November 2018)

NMED Comment 1:
In Section 2.3.1 (Anticipated Activities) the Permittee discusses sample collection from two areas to collect samples from three soil sample types: the Rehobeth soils, the Simitarq-Celavar soils, and the Chinle Group bedrock. A total of eight samples are proposed for each of these areas. While eight samples are sufficient for conducting statistical analyses, the NMED Risk Assessment Guidance for Investigations and Remediation (NMED, 2017 and 2019) (NMED Guidance) recommends a minimum sample size of 10 per background reference area. Additionally, the proposed sample locations appear to represent a very small proportion of each soil type. Additional samples will also help account for natural variations in metals/inorganic concentrations. To address spatial variability, additional sample locations must to be selected and the number of background samples must be increased to a minimum of 10 samples per soil type. Revise the Work Plan to propose to collect additional samples.

MPC Response 1:
The Work Plan is revised in Section 2.3.1 (Page 2-4) to include the collection of at least 10 samples per soil type over a larger area. Additional sampling locations are also included in Section 3.1 and Figures 4 and 5. We note that the sample location grid is already 200 feet by 200 feet, thus spacing background sample locations approximately 200 feet apart. It is further noted that the proposed sample areas are somewhat constrained due to the requirement to avoid any locations with possible past site operations and the following criteria as specified in NMED risk assessment guidance:

- Collected from areas where there is no potential for site contamination based on site history;
- Areas not impacted by neighboring areas of contamination (off-site migration);
- Collected from areas that are upwind of contaminated soil;
- Collected from areas that are upgradient of site contamination;
- Collected from soil types that are lithologically comparable to the samples that will be collected from contaminated areas.

NMED Comment 2:
The Permittee proposes to collect rock core samples and soil samples. In Section 3.1 (Soil Boring Drilling - Bedrock Sampling) the Permittee states, "[e]ight samples in total will be collected from four borings. The soil borings to be completed as background locations for the Chinle Group background samples will be drilled into the top of bedrock with samples collected from approximately 6" - 18" and 24" - 30" below the top of bedrock at each boring." Regarding soil sample collection, in Section 3.2 (Soil Sampling) the Permittee states, "[s]oil samples will be collected at the shallow background soil borings (Rehobeth and Simitarq-Celavar) from the near surface (6" to 18") interval to establish background concentrations for inorganic constituents. Eight sample locations will be selected for each of the two major soil types to support the development of distinct background concentrations for each major soil type, if required." One of the primary data objectives for the collection of background samples for delineation of naturally occurring inorganics is to provide background data as a comparison to soil laboratory analytical results and NMED's soil screening Guidance. The primary method for defining the magnitude of potential contamination is through conducting screening level risk assessments. As such, investigation data will be collected at soil exposure intervals sufficient to conduct not only a site

attribution analysis and determine nature and extent of contamination, but also to conduct risk assessments. The soil screening levels for risk assessments (human health and ecological) include surface soil (0-1 foot below ground surface, bgs) and 0-10 feet bgs. The proposed background intervals are between 6 to 18 inches for soils and 6 to 18 inches and twenty-four to thirty inches in rock and will not provide relevant data to support comparison of site investigations for risk assessments. Collection of background data must be designed to represent the exposure intervals needed for risk assessment: 1) soils representative of the 0-1 foot bgs exposure interval; 2) soils representative of the 0-10 foot bgs exposure interval. Revise the depth of background samples and provide lines of evidence that the data will be suitable for both determinations and nature and extent of contamination as well as for risk assessments.

MPC Response 2:
NMED directs that "background data must be designed to represent the exposure intervals needed for risk assessment: 1) soils representative of the 0-1 foot bgs exposure interval; 2) soils representative of the 0-10 foot bgs exposure interval." The *Investigation Work Plan Background Concentrations* was prepared to "conduct a soil background study" as referenced in NMED's Comment 2 in the August 17, 2015 comment letter on the Investigation Work Plan for SWMUs No. 4 and 5 (shown below). As explained in NMED's comment a risk assessment could be conducted as different option. We do not understand NMED's multiple references to risk assessments in direct regard to the soil background study. However, in an attempt to address this comment, the soil sample interval of 6" to 18" is now revised to 0-1 foot (consistent with the interval referenced by NMED for risk assessment) and a deeper sample interval of 5-6 feet has been added in Section 3.1. We believe the additional sample interval of 5-6 feet will help to address Comment 1 above for more background samples and also provide a sample more representative sample of the 0–10 foot "exposure interval." The number of soil samples is also revised in Section 3.1.

> August 17, 2015
> DISAPPROVAL
> INVESTIGATION WORK PLAN SWMU NO. 4 OLD BURN PIT
> AND SWMU NO. 5 LANDFILL AREAS
> WESTERN REFINING SOUTHWEST INC., GALLUP REFINERY
> EPA ID# NMD000333211
> HWB-WRG-14-004
>
> NMED Comment 2
> Some of the detected arsenic levels reported for the historic soil investigations (Work Plan Tables 1 and 2) exceed the current residential soil screening level (3.9 mg/kg). There are several options the Permittee may pursue to address elevated metals concentrations. The Permittee may conduct a soil background study which may address the higher levels of arsenic in order to reach corrective action complete status depending on whether or not corrective action complete without controls status is preferred. The Permittee may also conduct a risk assessment to determine whether or not the arsenic levels are a risk to human health or the environment. No revision to the Work Plan is necessary.

In reviewing NMED's Risk Assessment Guidance for Investigations and Remediation, and the refinery RCRA Permit, we cannot find any discussions that would drive the establishment of background concentrations for bedrock. The soil exposure pathways identified in the NMED guidance do not appear to be applicable to bedrock. The bedrock at the refinery has a very low permeability and should not be treated the same as the overlying soils. Therefore, the samples initially proposed for bedrock have been removed from the Work Plan in Sections 2.3.1., 3.1, 3.7, and 3.8. If in the future there is a clear need to establish background concentrations for inorganics in bedrock, then a new Work Plan will be prepared.

An additional correction is made in Section 2.2 (page 2-3) regarding the description and occurrence of the bedrock. The second to last paragraph described the Painted Desert Member as reddish-brown and grayish red mudstone with minor beds of resistant, laminated or crossbedded, litharenite and further noted this description is consistent with the bedrock encountered at the refinery. This is correct; however, the following paragraph noted that the sandstone (litharenite) facies in the Painted Desert Member had not been observed at shallow depths. More recent drilling at well OW-63 identified the sandstone facies of the Painted Desert Member at a depth of 28 feet. The last paragraph is deleted, as the paragraph above correctly and sufficiently describes the shallow bedrock.

NMED Comment 3:
Work Plan Section 2.3.1 states that the 95 percent upper tolerance limit (95UTL) will be derived for the background samples. However, the Work Plan does not discuss how the 95UTL will be determined. The most recent version of Pro UCL must be used to derive the 95UTLs. Revise the Work Plan to discuss how the 95UTL will be derived.

MPC Response 3:
The discussion in Section 2.3.1 (page 2-4) is revised to note that the most recent version of Pro UCL will be used to determine the 95 UTL.

INVESTIGATION WORK PLAN
Background Concentrations

Marathon Petroleum Company LP

Gallup Refinery
Marathon Petroleum Company.
Gallup, New Mexico

EPA ID# NMD000333211

NOVEMBER 2018

(Revised September 2019)

Scott T. Crouch

Scott T. Crouch, P.G.
Senior Geologist

DiSorbo
Environmental Consulting Firm

8501 North Mopac Expy | Suite 300 | Austin, TX 78759
512.693.4190 (P) | 512.279.3118 (F) | www.disorboconsult.com

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Executive Summary

The Gallup Refinery, which is located 17 miles east of Gallup, New Mexico, has been in operation since the 1950s. Pursuant to the terms and conditions of the facility Resource Conservation and Recovery Act (RCRA) Post-Closure Care Permit and 20.4.1.500 New Mexico Administrative Code, this Investigation Work Plan has been prepared to describe sample collection and analyses methods that will be used to support development of site-specific background concentrations for inorganic constituents.

The planned investigation activities include collection of soil samples, which will be analyzed for inorganic constituents. The specific sampling locations, sample collection procedures, and analytical methods are included.

Section 1
Introduction

The Gallup Refinery is located approximately 17 miles east of Gallup, New Mexico along the north side of Interstate Highway I-40 in McKinley County. The physical address is I-40, Exit #39 Jamestown, New Mexico 87347. The Gallup Refinery is located on 810 acres. Figure 1 presents the refinery location and the regional vicinity.

The Gallup Refinery generally processes crude oil from the Four Corners area transported to the facility by pipeline or tanker truck. Various process units are operated at the facility, including crude distillation, reforming, fluidized catalytic cracking, alkylation, sulfur recovery, merox treater, and hydrotreating. Current and past operations have produced gasoline, diesel fuels, jet fuels, kerosene, propane, butane, and residual fuel.

On October 31, 2013, the New Mexico Environment Department (NMED) issued a renewal of the Post-Closure Care Permit (“Permit”), which required among other activities the investigation of potential Areas of Concern and Solid Waste Management Units. This Work Plan has been prepared for the sole purpose of collecting soil samples to support development of site-specific background concentrations pursuant to Section IV.J.6 of the Permit.

Section 2
Soil Background Concentrations

This section presents background information, a discussion on site conditions, and a scope of services for establishment of site-specific background concentrations for inorganic constituents.

2.1 Background

This section presents background information, including a review of historical waste management activities to identity the following:

- Type and characteristics of all waste and all contaminants handled in the background investigation area;
- Known and possible sources of contamination;
- History of releases; and
- Known extent of contamination.

The area targeted for collection of soil samples to establish background concentrations is located on the far southwestern and northern portions of the refinery property so as to avoid any potential for current or historical impacts from refinery operations (Figure 2). There is no current commercial or industrial activity in these areas and no historical commercial or industrial activities are known to have occurred in these areas.

2.2 Site Conditions

The conditions at the site, including surface and subsurface conditions that could affect the fate and transport of any contaminants, are discussed below. This information is based on recent visual observations and subsurface investigations.

2.2.1 Surface Conditions

A topographic map of the refinery property is included as Figure 3. Site topographic features include high ground in the southeast gradually decreasing to a lowland fluvial plain to the northwest. Elevations on the refinery property range from 7,040 feet to 6,860 feet. The areas of the site selected for collection of background samples are at an approximate elevation of 6,893 feet above mean sea level (msl) at the southwestern location, 6,926 feet msl at the southern location, and 6,887 feet above msl at the northern area.

There are two primary soil types present on the refinery property in the area of operations (Appendix B). Surface soils to the north and west of the main area of operations excluding the evaporation ponds are predominantly the Rehobeth silty clay loam. To the east are the bordering Simitarq-Celavar sandy loams. Rehobeth soil properties include a pH ranging from 8 to 9 standard units and salinity measuring up to approximately 8 mmhos/cm (slightly saline). The Simitarq-Celavar soils are well drained with a conservative permeability of 0.20 inches/hour and minimal salinity. Simitarq soils have nearly neutral pH values ranging from 7.2 to 7.4 standard units with salinity values as low as approximately 0 mmhos/cm (nonsaline). The Celavar soils have a salinity maximum of 2 mmhos/cm (USDA, 2017).

Regional surface water features include the refinery evaporation ponds and a number of small ponds (one cattle water pond and two small unnamed spring fed ponds). The site is located in the Puerco River Valley, north of the Zuni Uplift with overland flows directed northward to the tributaries of the Puerco River. The Puerco River continues to the west to the confluence with the Little Colorado River. The Puerco River is intermittent and retains flow only during and immediately following precipitation events.

The native land surface is characterized by sparse shrubby vegetation, which is adapted to the arid conditions. Bare soil is exposed in many areas.

The prevailing wind direction for the area is from the west. At the Gallup airport, which is located approximately 20 miles west of the refinery, the prevailing wind direction is from the west-southwest and at the Grants airport, which is approximately 38 miles southeast of the refinery, the prevailing wind direction is out of the northwest (WRCC, 2017). The soil sample collection locations discussed in Sections 3.1 and 3.2 are located southwest, south, and northwest of the refinery process area and thus are not located downwind of potential on-site air emission sources based on the prevailing wind direction.

2.2.2 Subsurface Conditions

The shallow subsurface soils consist of fluvial and alluvial deposits comprised of clay and silt with minor inter-bedded sand layers. Very low permeability bedrock (e.g., claystones and siltstones) underlie the surface soils and effectively form an aquitard. The Chinle Group, which is Upper

Triassic, crops out over a large area on the southern margin of the San Juan Basin. The uppermost recognized local Formation is the Petrified Forest Formation and the Sonsela Sandstone Bed is the uppermost recognized regional aquifer. Aquifer test of the Sonsela Bed northeast of Prewitt indicated a transmissivity of greater than 100 ft^2/day (Stone and others, 1983). The Sonsela Sandstone's highest point occurs southeast of the site and slopes downward to the northwest as it passes under the refinery. The Sonsela Sandstone forms a water-bearing reservoir with artesian conditions throughout the central and western portions of the refinery property.

The diverse properties and complex, irregular stratigraphy of the surface soils across the site cause a wide range of hydraulic conductivity ranging from less than 10^{-2} cm/sec for gravel like sands immediately overlying the Petrified Forest Formation to 10^{-8} cm/sec in the clay soils located near the surface (Western, 2009). Generally, shallow groundwater at the refinery follows the upper contact of the Petrified Forest Formation with prevailing flow from the southeast to the northwest, although localized areas may have varying flow directions.

A review of the soil survey information (see Appendix B) also shows similar lithology within the upper five feet (USDA, 2017). The Rehobeth soil map unit is described as silty clay loam from 0 - 5" and clay from 5" – 80". The Celavar soil map unit is described as sandy loam to sandy clay loam from 0 – 31" inches underlain by bedrock. The Simitarq soils are described as sandy loam to sandy clay loam in the upper 6", with sandy clay extending to 14" where it overlies bedrock.

The Triassic bedrock that has been identified in the RFI areas as lying directly beneath the soils (Recent Alluvium) at the site is the Painted Desert Member of the Petrified Forest Formation, Chinle Group. The stratigraphy of the Chinle Group was described in detail for the nearby Fort Wingate quadrangle by Lucas *et al*, 1997. The Painted Desert Member of the Petrified Forest Formation is the uppermost member of the Chinle Group present in the area of the refinery. The Painted Desert Member is described as reddish-brown and grayish red mudstone with minor beds of resistant, laminated or crossbedded, litharenite. This is consistent with the bedrock encountered at the refinery.

2.3 Scope of Services

This subsection presents a brief description of the anticipated sample collection activities to be performed during the background soil sample collection activities, background information research conducted to develop the Scope of Services, a description of the collection and management of investigation derived waste, and surveying to be conducted to record sample location data.

2.3.1 Anticipated Activities

The objective is to obtain a sufficient number of samples to support calculation of the 95% upper tolerance limit (UTL) pursuant to Section IV.J.6 of the Permit and NMED's *Risk Assessment Guidance for Investigations and Remediation*. The required summary statistics per Permit Section IV.J.6 will be reported. The 95% upper tolerance limit with 95% coverage will be determined using the most current version of ProUCL software and guidance. The minimum number of samples for each respective data set is 10. The areas chosen for background samples were selected based on the fact that no site-related or other industrial activities are known to have taken place in these areas and based on a review of soil survey information. As shown on the soil survey map included in Appendix B, there are two primary soil types (Rehobeth and Simitarq-Celavar) mapped on the refinery property.

Based on the site geology and soil types, the sampling effort will collect sufficient samples (i.e., a minimum of 10) to support calculation of separate UTLs for the materials represented by the Rehobeth soils and Simitarq-Celavar soils, as necessary. The areas in which the samples will be collected for the Rehobeth soil type are located south of evaporation pond 9 and on the far northern portion of the refinery property to the northeast of the Land Treatment Unit. Five sample locations will be selected south of EP-9 and six in the northern area. The 10 sample locations for the area representing the Simitarq-Celavar soils are located southwest of the refinery operations area and west of the access road. All locations will be selected away from any surface drainage features. The individual sample locations will be surveyed following the procedures in Section 2.3.4.

2.3.2 Background Information Research

Scoping documents that provided information on historical operations and documents containing the results of previous investigations were reviewed to facilitate development of this work plan and are listed below. The previously collected data provides very good information on the overall surface and subsurface conditions, including verification of areas with past industrial operations.

- Geoscience Consultants, Ltd., 1985, Inventory of Solid Waste Management Units;
- Black and Veatch, 1987, RCRA Facility Assessment Report;
- Applied Earth Sciences, Inc., 1989, SWMU Site-Specific Facility Investigation Work Plan RCRA Facility Investigation;
- Giant Refining Company, 1991, RCRA Facility Investigation Phase I Report;
- Giant Refining Company, 1991, RCRA Facility Investigation Phase II Report;

- Giant Refining Company, 1992, RCRA Facility Investigation Phase III Report; and
- Giant Refining Company, 1994, Report on Additional RFI Sampling.

2.3.3 Collection and Management of Investigation Derived Waste

Minimal, if any, excess sample material is anticipated to be associated with the collection of the shallow (e.g. up to 18 inches) soil samples. As there will be minimal excess material and it is being collected in areas that are fully anticipated to be devoid of any contamination, the excess sample material will be placed back into the hole from which the sample was retrieved, unless field screening results (e.g., organic vapor monitoring, olfactory or visual) indicates potential impacts. If potential impacts are observed, then the soil will be placed into steel drums pending waste characterization sampling. Cuttings from the deeper soil borings will be handled in a similar manner. The IDW will be characterized using methods based on the boring location, boring depth, drilling method, and type of constituents suspected or encountered in the borings. All decontamination water will be characterized prior to disposal unless it is disposed in the refinery wastewater treatment system upstream of the API Separator. An IDW management plan is included as Appendix A.

2.3.4 Surveys

The horizontal coordinates and elevation of each soil sample location and the locations of all other pertinent structures will be determined by a registered New Mexico professional land surveyor in accordance with the State Plane Coordinate System (NMSA 1978 47-1-49-56 (Repl. Pamp. 1993)). The surveys will be conducted in accordance with Sections 500.1 through 500.12 of the Regulations and Rules of the Board of Registration for Professional Engineers and Surveyors Minimum Standards for Surveying in New Mexico. Horizontal positions will be measured to the nearest 0.1-ft and vertical elevations will be measured to the nearest 0.01-ft pursuant to Section IV.J.2.e of the Permit.

Section 3
Investigation Methods

The purpose of the background investigation is to determine concentrations of inorganic constituents in soil that are unaffected by any site-related operations, due to either historical or current operations. Guidance on selecting and developing sampling plans as provided in Guidance for Choosing a Sampling Design for Environmental Data Collection (EPA, 2000) was utilized to select the appropriate sampling strategy for background soil samples.

3.1 Soil Sampling

Soil samples will be collected at the shallow background soil borings (Rehobeth and Simitarq-Celavar) from the near surface (0” to 12”) interval and from 5 to 6 feet to establish background concentrations for inorganic constituents. Ten sample locations will be selected for the Simtarq-Celavar soil type, which has a smaller background sampling area available, and 11 sample locations will be selected for the Reheboth soils to support the development of distinct background concentrations for each major soil type, if required. The areas in which the samples will be collected are located southwest and northwest of the main process and storage areas. The approximate areas from within which background samples will be collected for the Rehobeth soils are shown in Figures 4 and 5. The approximate area from within which background samples will be collected for the Simitarq-Celavar soils is shown on Figure 6. Each area will be gridded into individual cells of approximately the same size with dimensions of 200 feet by 200 feet, with sample collection locations staked in the center of each grid cell. As necessary, sample locations may be moved from the center of individual grid cells to avoid collection within surface drainage features.

As the area representing the Rehobeth soil type covers a large area to the southwest and northwest of the process area, the sample collection will be split with 10 samples collected to the southwest and 12 samples to the northwest. Due to a smaller area represented by the Simitarq-Celavar soil type that is upwind and away from the process and storage areas, all 10 sample collection locations (20 samples) will be to the southwest of the process area.

Background soil borings will be completed to a depth of 6 feet using direct push, or a hollow-stem auger, as necessary.

A portion of the sample will be directly placed into pre-cleaned, laboratory-prepared sample containers for laboratory chemical analysis. The remaining portions of the samples will be used for logging as discussed in Section 3.2.1. Sample handling and chain-of-custody procedures will be in accordance with the procedures presented below in Section 3.3.

Quality Assurance/Quality Control (QA/QC) samples will be collected to monitor the validity of the soil sample collection procedures as follows:

- Field duplicates will be collected at a rate of 10 percent with a minimum of one per each soil type (i.e., Rehobeth and Simitarq-Celavar); and
- Equipment blanks will be collected from all sampling apparatus at a frequency of one per day.

3.1.1 Soil Sample Logging

The soil borings will be continuously logged. The physical characteristics of the samples (such as mineralogy, ASTM soil classification, moisture content, texture, color, and/or presence of stains or odors), depth where each sample was obtained, method of sample collection, and other observations will be recorded in the field log by a qualified geologist. Detailed logs of each boring will be completed in the field by a qualified geologist. Additional information, such as the presence of water-bearing zones and any unusual or noticeable conditions encountered during drilling, will be recorded on the logs.

3.2 Sample Handling

At a minimum, the following procedures will be used at all times when collecting samples during investigation, corrective action, and monitoring activities:

1. Neoprene, nitrile, or other protective gloves will be worn when collecting samples. New disposable gloves will be used to collect each sample;
2. All samples collected of each medium for chemical analysis will be transferred into clean sample containers supplied by the project analytical laboratory. Sample container volumes and preservation methods will be in accordance with the most recent standard EPA and industry accepted practices for use by accredited analytical laboratories. Sufficient sample volume will be obtained for the laboratory to complete the method-specific QC analyses on a laboratory-batch basis; and

3. Sample labels and documentation will be completed for each sample following procedures discussed below. Immediately after the samples are collected, they will be stored in a cooler with ice or other appropriate storage method until they are delivered to the analytical laboratory. Standard chain-of-custody procedures, as described below, will be followed for all samples collected. All samples will be submitted to the laboratory soon enough to allow the laboratory to conduct the analyses within the method holding times. At a minimum, all samples will be submitted to the laboratory within 48 hours after their collection.

Chain-of-custody and shipment procedures will include the following:

1. Chain-of-custody forms will be completed at the end of each sampling day, prior to the transfer of samples off site.
2. Individual sample containers will be packed to prevent breakage and transported in a sealed cooler with ice or other suitable coolant or other EPA or industry-wide accepted method. The drainage hole at the bottom of the cooler will be sealed and secured in case of sample container leakage.
3. Each cooler or other container will be delivered directly to the analytical laboratory.
4. Glass bottles will be separated in the shipping container by cushioning material to prevent breakage.
5. Plastic containers will be protected from possible puncture during shipping using cushioning material.
6. The chain-of-custody form and sample request form will be shipped inside the sealed storage container to be delivered to the laboratory.
7. Chain-of-custody seals will be used to seal the sample-shipping container in conformance with EPA protocol.
8. Signed and dated chain-of-custody seals will be applied to each cooler prior to transport of samples from the site.
9. Upon receipt of the samples at the laboratory, the custody seals will be broken, the chain-of-custody form will be signed as received by the laboratory, and the conditions of the samples will be recorded on the form. The original chain-of-custody form will remain with the laboratory and copies will be returned to the relinquishing party.
10. Copies of all chain-of-custody forms generated as part of sampling activities will be maintained on-site.

3.3 Decontamination Procedures

The objective of the decontamination procedures is to minimize the potential for cross-contamination. A designated decontamination area will be established for decontamination of drilling equipment and any reusable sampling equipment. The drilling rig will be decontaminated prior to entering the site. Drilling equipment or other exploration equipment that may come in contact with the borehole will be decontaminated by high pressure washing prior to drilling each new boring.

Sampling or measurement equipment, including but not limited to, stainless steel sampling tools, split-barrel or core samplers, etc. will be decontaminated in accordance with the following procedures or other methods approved by the Department before each sampling attempt or measurement:

1. Brush equipment with a wire or other suitable brush, if necessary or practicable, to remove large particulate matter;
2. Rinse with potable tap water;
3. Wash with nonphosphate detergent or other detergent approved by the Department (examples include Fantastik™, Liqui-Nox®); and
4. Double rinse with deionized water.

All decontamination solutions will be collected and stored temporarily as described in Appendix A. Decontamination procedures and the cleaning agents used will be documented in the daily field log.

3.4 Field Equipment Calibration Procedures

Field equipment requiring calibration will be calibrated to known standards, in accordance with the manufacturers' recommended schedules and procedures. At a minimum, calibration checks will be conducted daily and the instruments will be recalibrated, if necessary. Calibration measurements will be recorded in the daily field logs. If field equipment becomes inoperable, its use will be discontinued until the necessary repairs are made. In the interim, a properly calibrated replacement instrument will be used.

3.5 Documentation of Field Activities

Daily field activities, including observations and field procedures, will be recorded in a field log book. The original field forms will be maintained at the Facility. Copies of the completed forms will be maintained in a bound and sequentially numbered field file for reference during field activities. Indelible ink will be used to record all field activities. Photographic documentation of field activities will be performed, as appropriate. The daily record of field activities will include the following:

1. Site or unit designation;
2. Date;
3. Time of arrival and departure;
4. Field investigation team members including subcontractors and visitors;
5. Weather conditions;
6. Daily activities and times conducted;
7. Observations;
8. Record of samples collected with sample designations and locations specified;
9. Photographic log, as appropriate;
10. Field monitoring data, including health and safety monitoring;
11. Equipment used and calibration records, if appropriate;
12. List of additional data sheets and maps completed;
13. An inventory of the waste generated and the method of storage or disposal; and
14. Signature of personnel completing the field record.

3.6 Chemical Analyses

All samples collected for laboratory analysis will be submitted to an accredited laboratory. The laboratory will use the most recent standard EPA and industry-accepted analytical methods for target analytes as the testing methods for each medium sampled. Chemical analyses will be performed in accordance with the most recent EPA standard analytical methodologies and extraction methods.

Soil samples will be analyzed for the following constituents using the indicated analytical methods.

Analyte	Analytical Method
Antimony	SW-846 method 6010/6020
Arsenic	SW-846 method 6010/6020
Barium	SW-846 method 6010/6020
Beryllium	SW-846 method 6010/6020
Cadmium	SW-846 method 6010/6020

Analyte	Analytical Method
Chloride	EPA method 300
Chromium	SW-846 method 6010/6020
Cobalt	SW-846 method 6010/6020
Cyanide	SW-846 method 335.4/335.2 mod
Fluoride	EPA method 300
Iron	SW-846 method 6010/6020
Lead	SW-846 method 6010/6020
Manganese	SW-846 method 6010/6020
Mercury	SW-846 method 7470/7471
Nickel	SW-846 method 6010/6020
Selenium	SW-846 method 6010/6020
Silver	SW-846 method 6010/6020
Uranium	SW-846 method 6010/6020
Vanadium	SW-846 method 6010/6020
Zinc	SW-846 method 6010/6020

3.7 Data Quality Objectives

The Data Quality Objectives (DQOs) were developed to ensure that newly collected data are of sufficient quality and quantity to address the projects goals, including Quality Assurance/Quality Control (QA/QC) issues (EPA, 2006). The project goals are established in the Permit and are to determine and evaluate the presence, nature, and extent of releases of contaminants at specified SWMUs/AOCs and pursuant to Section IV.J.6 to determine an appropriate background data set. The type of data required to meet the project goals includes chemical analyses of soil to determine background concentrations of inorganic constituents in soil.

The quantity of data is dependent upon the soil type and geology at the site. As discussed above, the work plan addresses the presence of two primary soil types. The quality of data that is required is consistent across locations and is specified in Section IV.J.3 of the Permit. In general, method detection limits should be 20% or less of the applicable cleanup standards and screening levels.

Additional DQOs include precision, accuracy, representativeness, completeness, and comparability. Precision is a measurement of the reproducibility of measurements under a given set of circumstances and is commonly stated in terms of standard deviation or coefficient of variation (EPA, 1987). Precision is also specific to sampling activities and analytical performance. Sampling precision will be evaluated through the analyses of duplicate field samples and laboratory replicates will be utilized to assess laboratory precision.

Accuracy is a measurement in the bias of a measurement system and may include many sources of potential error, including the sampling process, field contamination, preservation, handling, sample matrix, sample preparation, and analysis techniques (EPA, 1987). An evaluation of the accuracy will be performed by reviewing the results of field/trip blanks, matrix spikes, and laboratory QC samples.

Representativeness is an expression of the degree to which the data accurately and precisely represent the true environmental conditions. Sample locations and the number of samples have been selected to ensure the data is representative of actual environmental conditions. Sample collection techniques (e.g., purging of monitoring wells to collect formation water) will be utilized to help ensure representative results.

Completeness is defined as the percentage of measurements taken that are actually valid measurements, considering field QA and laboratory QC problems. EPA Contract Laboratory Program (CLP) data has been found to be 80-85% complete on a nationwide basis and this has been extrapolated to indicate that Level III, IV, and V analytical techniques will generate data that are approximately 80% complete (EPA, 1987). As an overall project goal, the completeness goal is 85%; however, some samples may be critical based on location or field screening results and thus a sample-by-sample evaluation will be performed to determine if the completeness goals have been obtained.

Comparability is a qualitative parameter, which expresses the confidence with which one data set can be compared to another. Industry standard sample collection techniques and routine EPA analytical methods will be utilized to help ensure data are comparable to historical and future data. Analytical results will be reported in appropriate units for comparison to historical data and cleanup levels.

Section 4
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FIGURES

Appendix A
Investigation Derived Waste (IDW) Management Plan

IDW Management Plan

All IDW will be properly characterized and disposed of in accordance with all federal, state, and local rules and regulations for storage, labeling, handling, transport, and disposal of waste. The IDW may be characterized for disposal based on the known or suspected contaminants potentially present in the waste. It is assumed that there are no wastes or contaminants present in environmental media at any of the planned background investigation areas.

A dedicated decontamination area will be setup prior to any sample collection activities. The decontamination facility will be constructed so as to capture and contain all decontamination fluids (e.g., wash water and rinse water) and foreign materials washed off the sampling equipment. The fluids will be pumped directly into suitable storage containers (e.g., labeled 55-gallon drums), which will be located at satellite accumulation areas until the fluids are disposed in the refinery wastewater treatment system upstream of the API separator. The solids captured in the decontamination pad will be shoveled into 55-gallon drums and stored at the designated satellite accumulation area pending proper waste characterization for off-site disposal.

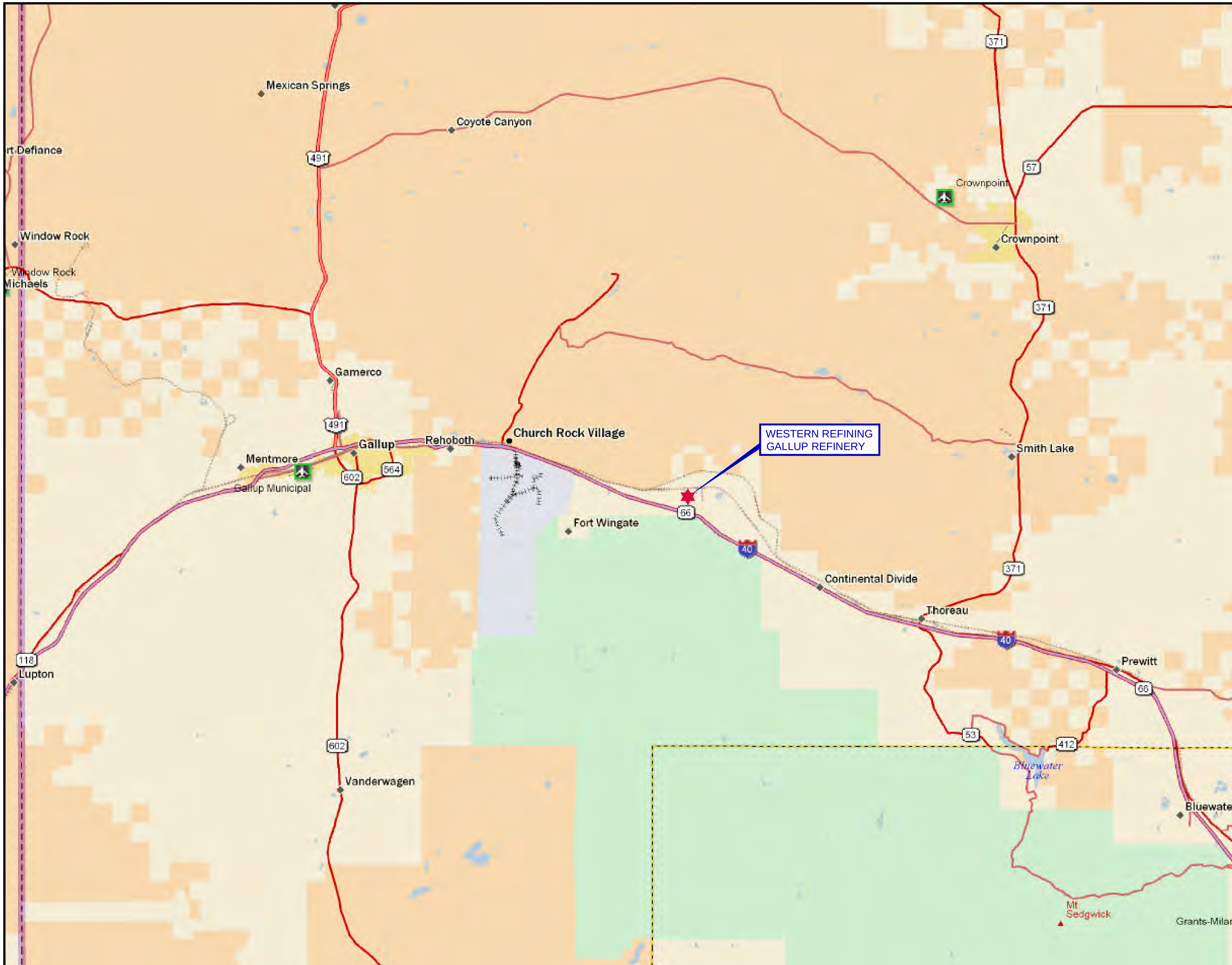
Drill cuttings generated during installation of soil borings are not anticipated to be contaminated and will be placed back in the boring and/or spread on the land surface following customary water well drilling practices. If there is any indication of contamination (e.g., odors, elevated organic vapor monitoring readings, stained soil, presence of potential waste materials, etc.), then the cuttings will be placed directly into 55-gallon drums and staged in the satellite accumulation area pending results of the waste characterization sampling. The drill cuttings will be characterized by testing to determine if there are any hazardous characteristics in accordance with 40 Code of Federal Regulations (CFR) Part 261. This includes tests for ignitability, corrosivity, reactivity, and toxicity. If the materials are not characteristically hazardous, then further testing will be performed pursuant to the requirements of the facility to which the materials will be transported. Depending upon the results of analyses for individual investigation soil samples, additional analyses may include TPH and polynuclear aromatic hydrocarbons.

All miscellaneous waste materials (e.g., discarded gloves, packing materials, etc.) will be placed into the refinery's solid waste storage containers for off-site disposal.

Appendix B

Soils Data

FIGURES



Map Source: DeLorme Street Atlas USA 2007 Plus.

0 5
SCALE IN MILES

Western Refining
GALLUP REFINERY

PROJ. NO.: Western Refining	DATE: 07/13/14	FILE: WestRef–B198

FIGURE 1
SITE LOCATION MAP
GALLUP REFINERY

DiSorbo
Environmental Consulting Firm

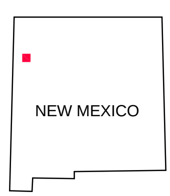
8501 N. MoPac Expy.
Suite 300
Austin, Texas 78759

Map Source: Google Earth Aerial, 03/18/2016.

0 1000
SCALE IN FEET

LEGEND

BACKGROUND SAMPLE
COLLECTION AREAS



SITE LOCATION

MARATHON

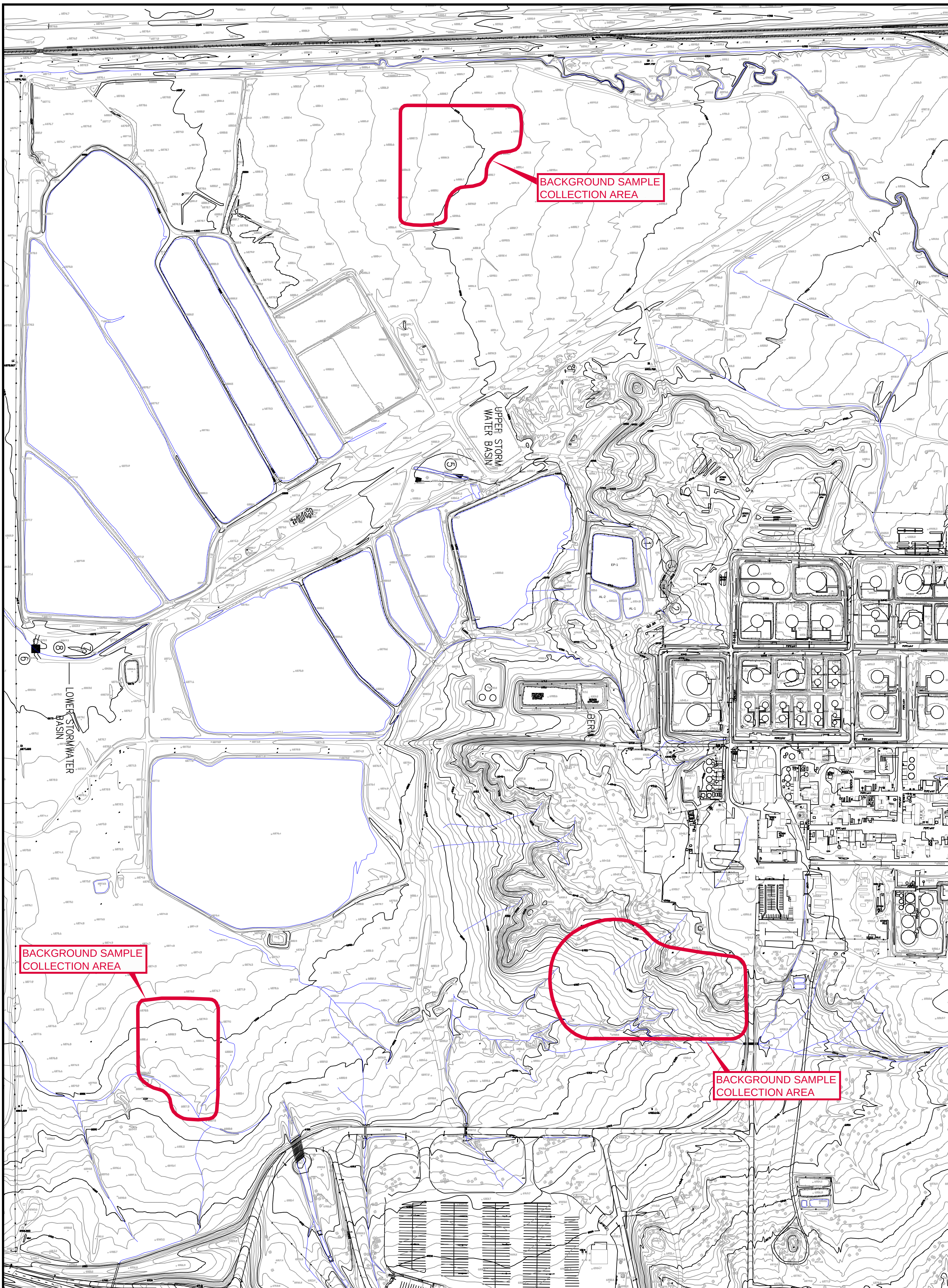
MARATHON PETROLEUM COMPANY
GALLUP REFINERY

PROJ. NO.: Marathon	DATE: 09/13/19	FILE: Mathon–dA120

FIGURE 2
BACKGROUND SAMPLE
COLLECTION AREAS
GALLUP REFINERY

DiSorbo
Environmental Consulting Firm

8501 N. MoPac Expy.
Suite 300
Austin, Texas 78759

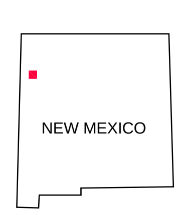


Map Source: Compiled by Photogrammetric Methods from Photography Acquired on March 1, 1998.

0 500
SCALE IN FEET

LEGEND

BACKGROUND SAMPLE COLLECTION AREAS



SITE LOCATION

MARATHON PETROLEUM COMPANY
GALLUP REFINERY

PROJ. NO.: Marathon	DATE: 09/13/19	FILE: Mathon–dB144

FIGURE 3
TOPOGRAPHIC MAP
GALLUP REFINERY

DiSorbo Environmental Consulting Firm
8501 N. MoPac Expy.
Suite 300
Austin, Texas 78759

Map Source: USDA, Natural Resources Conservation Service and Web Soil Survey, National Cooperative Soil Survey.

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

N

0 300
SCALE IN FEET

LEGEND

- BACKGROUND SAMPLE LOCATION
- 200' x 200' SAMPLE GRID COLLECTION AREA

MARATHON

MARATHON PETROLEUM COMPANY
GALLUP REFINERY

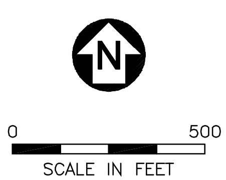
PROJ. NO.: Marathon	DATE: 09/13/19	FILE: Mathon–dA122

FIGURE 4
REHOBETH SAMPLE
AREA SOUTH
GALLUP REFINERY

DiSorbo
Environmental Consulting Firm

8501 N. MoPac Expy.
Suite 300
Austin, Texas 78759

Map Source: USDA, Natural Resources Conservation Service and Web Soil Survey, National Cooperative Soil Survey.



LEGEND

- BACKGROUND SAMPLE LOCATION
- 200' x 200' SAMPLE GRID COLLECTION AREA

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
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- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MARATHON PETROLEUM COMPANY
GALLUP REFINERY

PROJ. NO.:Marathon	DATE: 09/13/19	FILE: Mathon–dA123

FIGURE 5
REHOBETH SAMPLE AREA NORTH
GALLUP REFINERY

DiSorbo Environmental Consulting Firm
8501 N. MoPac Expy.
Suite 300
Austin, Texas 78759

Map Source: USDA, Natural Resources Conservation Service and Web Soil Survey, National Cooperative Soil Survey.

N

0 300
SCALE IN FEET

LEGEND

- BACKGROUND SAMPLE LOCATION
- 200' x 200' SAMPLE GRID COLLECTION AREA

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
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- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MARATHON

MARATHON PETROLEUM COMPANY
GALLUP REFINERY

PROJ. NO.:Marathon	DATE: 09/13/19	FILE: Mathon–dA124

FIGURE 6
SIMITARQ-CELAVAR SAMPLE AREA
GALLUP REFINERY

DiSorbo
Environmental Consulting Firm

8501 N. MoPac Expy.
Suite 300
Austin, Texas 78759

Appendix A
Investigation Derived Waste (IDW) Management Plan

IDW Management Plan

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All miscellaneous waste materials (e.g., discarded gloves, packing materials, etc.) will be placed into the refinery's solid waste storage containers for off-site disposal.

Appendix B

Soils Data

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties

Gallup Refinery

April 19, 2017

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

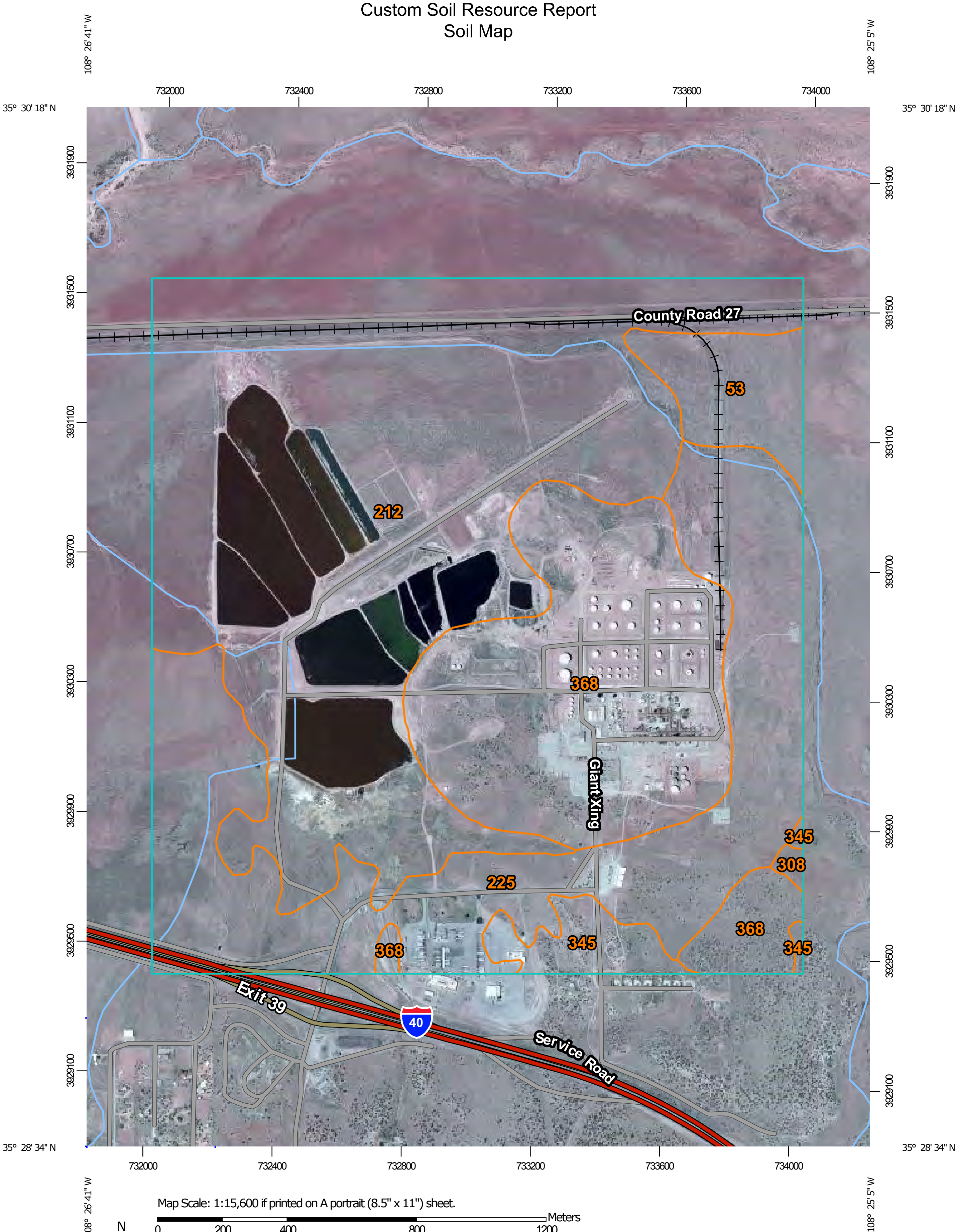
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:15,600 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 200, 400, 800, 1200

Feet: 0, 500, 1000, 2000, 3000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 12N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties
Survey Area Data: Version 11, Sep 26, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 25, 2010—Apr 2, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties (NM692)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
53	Hawaikuh clay loam, 0 to 2 percent slopes	40.3	3.8%
212	Rehobeth silty clay loam, 0 to 1 percent slopes	520.1	48.5%
225	Aquima-Hawaikuh complex, 1 to 5 percent slopes	260.6	24.3%
308	Fikel-Venzuni complex, 1 to 6 percent slopes	2.2	0.2%
345	Rock outcrop-Tuces complex, 20 to 70 percent slopes	25.0	2.3%
368	Simitarq-Celavar sandy loams, 2 to 8 percent slopes	224.3	20.9%
Totals for Area of Interest		**1,072.5**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

McKinley County Area, New Mexico, McKinley County and Parts of Cibola and San Juan Counties

53—Hawaikuh clay loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 1xmp
Elevation: 6,000 to 6,900 feet
Mean annual precipitation: 10 to 13 inches
Mean annual air temperature: 49 to 54 degrees F
Frost-free period: 120 to 140 days
Farmland classification: Farmland of local importance

Map Unit Composition

Hawaikuh and similar soils: 80 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hawaikuh

Setting

Landform: Stream terraces on valley floors
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Stream alluvium derived from sandstone and shale

Typical profile

Ap - 0 to 10 inches: clay loam
Bt - 10 to 24 inches: sandy clay
Btk - 24 to 32 inches: clay loam
Bk1 - 32 to 42 inches: clay loam
Bk2 - 42 to 65 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: High (about 10.5 inches)

Interpretive groups

Land capability classification (irrigated): 2s
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Ecological site: Clayey (R035XA128NM)
Hydric soil rating: No

212—Rehobeth silty clay loam, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2tjgf
Elevation: 6,600 to 6,800 feet
Mean annual precipitation: 10 to 13 inches
Mean annual air temperature: 46 to 49 degrees F
Frost-free period: 100 to 135 days
Farmland classification: Not prime farmland

Map Unit Composition

Rehobeth and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rehobeth

Setting

Landform: Flood plains, stream terraces
Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear, concave
Across-slope shape: Linear
Parent material: Stream alluvium derived from gypsum

Typical profile

A - 0 to 2 inches: silty clay loam
Bw - 2 to 5 inches: silty clay loam
Bss - 5 to 12 inches: clay
Bnssy1 - 12 to 18 inches: clay
Bnssy2 - 18 to 32 inches: clay
Bnssy3 - 32 to 80 inches: clay

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Occasional
Frequency of ponding: Frequent
Calcium carbonate, maximum in profile: 5 percent
Gypsum, maximum in profile: 10 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 14.0
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c

Hydrologic Soil Group: C
Ecological site: Salty Bottomland (R036XB010NM)
Hydric soil rating: No

225—Aquima-Hawaikuh complex, 1 to 5 percent slopes

Map Unit Setting

National map unit symbol: 2rrlg
Elevation: 6,000 to 6,800 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 47 to 51 degrees F
Frost-free period: 100 to 150 days
Farmland classification: Not prime farmland

Map Unit Composition

Aquima and similar soils: 40 percent
Hawaikuh and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Aquima

Setting

Landform: Stream terraces, alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope, tread, rise
Down-slope shape: Concave, linear
Across-slope shape: Linear
Parent material: Fan alluvium over stream alluvium derived from sandstone and shale

Typical profile

A - 0 to 2 inches: silt loam
Bk1 - 2 to 11 inches: silt loam
Bk2 - 11 to 17 inches: sandy clay loam
Bk3 - 17 to 49 inches: silt loam
Bk4 - 49 to 65 inches: gravelly clay loam

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: B
Ecological site: Loamy Wash 10-14" p.z. (R035XC312AZ)
Hydric soil rating: No

Description of Hawaikuh

Setting

Landform: Stream terraces, fan remnants
Landform position (three-dimensional): Tread
Down-slope shape: Concave, convex
Across-slope shape: Linear, convex
Parent material: Fan alluvium over stream alluvium derived from sandstone and shale

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

Properties and qualities

Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.57 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 2.0
Available water storage in profile: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Ecological site: Clay Loam Upland 10-14" p.z. (R035XC307AZ)
Hydric soil rating: No

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

Map Unit Setting

National map unit symbol: 1xkp
Elevation: 7,000 to 7,600 feet
Mean annual precipitation: 13 to 16 inches
Mean annual air temperature: 49 to 53 degrees F
Frost-free period: 115 to 135 days
Farmland classification: Not prime farmland

Map Unit Composition

Fikel and similar soils: 50 percent
Venzuni and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Fikel

Setting

Landform: Fan remnants on valley sides
Landform position (three-dimensional): Side slope, tread
Down-slope shape: Convex, concave
Across-slope shape: Convex, concave
Parent material: Fan alluvium derived from sandstone and shale

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

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: High (about 9.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified

Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Ecological site: Clayey (R035XA128NM)
Hydric soil rating: No

Description of Venzuni

Setting

Landform: Stream terraces on valley floors
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Stream alluvium derived from sandstone and shale

Typical profile

A - 0 to 7 inches: clay
Bss1 - 7 to 22 inches: clay
Bss2 - 22 to 42 inches: clay
Bk1 - 42 to 56 inches: sandy clay
2Bk2 - 56 to 75 inches: sandy clay loam

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Low to moderately low (0.01 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Moderate (about 8.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: D
Ecological site: Clayey (R035XA128NM)
Hydric soil rating: No

345—Rock outcrop-Tuces complex, 20 to 70 percent slopes

Map Unit Setting

National map unit symbol: 1xl2
Elevation: 7,400 to 8,000 feet
Mean annual precipitation: 13 to 16 inches
Mean annual air temperature: 46 to 49 degrees F

Frost-free period: 100 to 135 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 40 percent
Tuces and similar soils: 40 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Typical profile

R - 0 to 60 inches: bedrock

Properties and qualities

Slope: 20 to 70 percent
Depth to restrictive feature: 0 inches to lithic bedrock
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Other vegetative classification: WOODLAND (null_40)
Hydric soil rating: No

Description of Tuces

Setting

Landform: Escarpments on cuestas
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Slope alluvium and colluvium derived from sandstone over residuum weathered from shale

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 to 40 inches: bedrock

Properties and qualities

Slope: 20 to 70 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Low (about 3.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Ecological site: Gravelly - Woodland (F035XG134NM)
Other vegetative classification: pinyon-juniper forest (null_3)
Hydric soil rating: No

368—Simitarq-Celavar sandy loams, 2 to 8 percent slopes

Map Unit Setting

National map unit symbol: 1xlg
Elevation: 7,200 to 8,100 feet
Mean annual precipitation: 13 to 16 inches
Mean annual air temperature: 49 to 53 degrees F
Frost-free period: 115 to 135 days
Farmland classification: Not prime farmland

Map Unit Composition

Simitarq and similar soils: 60 percent
Celavar and similar soils: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Simitarq

Setting

Landform: Dip slopes on cuestas, mesas
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Convex
Across-slope shape: Concave, linear, convex
Parent material: Eolian deposits and slope alluvium over residuum weathered from sandstone

Typical profile

A - 0 to 1 inches: sandy loam
Bt1 - 1 to 6 inches: sandy clay loam
Bt2 - 6 to 14 inches: sandy clay
R - 14 to 60 inches: bedrock

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: About 14 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: Gravelly - Woodland (F035XG134NM)
Other vegetative classification: pinyon-juniper forest (null_3)
Hydric soil rating: No

Description of Celavar

Setting

Landform: Mesas, dip slopes on cuestas
Landform position (three-dimensional): Side slope, talf
Down-slope shape: Convex
Across-slope shape: Convex, linear, concave
Parent material: Eolian deposits over slope alluvium derived from sandstone and shale

Typical profile

Oi - 0 to 1 inches: slightly decomposed plant material
A - 1 to 2 inches: sandy loam
Bt - 2 to 11 inches: sandy clay loam
Btk1 - 11 to 27 inches: sandy clay loam
Btk2 - 27 to 31 inches: sandy clay loam
R - 31 to 40 inches: bedrock

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6c
Hydrologic Soil Group: C
Ecological site: Steep Gravelly - Woodland (F035XG135NM)
Other vegetative classification: pinyon-juniper forest (null_3)
Hydric soil rating: No

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