Western Refining Southwest LLC
A subsidiary of Marathon Petroleum Corporation
I-40 Exit 39
Jamestown, NM 87347

March 3, 2022

Mr. Kevin Pierard, Chief
New Mexico Environment Department
2905 Rodeo Park Drive East, Bldg. 1
Santa Fe, NM 87SOS-6303

RE: Conceptual Site Model
Western Refining Southwest LLC, D/B/A Marathon Gallup Refinery
EPA ID# NMD000333211

Dear Mr. Pierard:

Western Refining Southwest LLC (D/B/A Marathon Gallup Refinery [Refinery]) in Gallup, New Mexico is submitting this *Conceptual Site Model* (CSM) report as part of a wholistic evaluation of soil and groundwater impacts at the Refinery. The CSM was prepared to consolidate environmental data sets for the Refinery and summarize interpretations to support future decision-making regarding remediation and monitoring at the Refinery. This report is meant to augment the information presented in the following reports:

- “Marketing Tank Farm Laser-Induced Fluorescence/Hydraulic Profiling Investigation Report,” submitted on March 31, 2021 and disapproved in the New Mexico Environment Department (NMED) letter dated June 2, 201.
- “Tank 570 Release and Additional Areas Laser-Induced Fluorescence/Hydraulic Profiling Investigation Report,” submitted on November 1, 2021
- “Marketing Tank Farm Laser-Induced Fluorescence/Hydraulic Profiling Investigation Report Addendum,” submitted on November 15, 2021

The CSM was proposed and discussed at several conference calls with the New Mexico Environment Department (NMED) during 2021, including:

- May 25, 2021. The Refinery presented Laser-Induced Fluorescence (LIF) investigation preliminary results and initial elements of conceptual site model.
- July 15, 2021. The Refinery presented the site wide LIF results and a three-dimensional model to NMED. The CSM report was identified as a next step in site evaluation.

The Refinery is requesting that NMED review and approve the CSM to aid in the implementation of groundwater remediation and monitoring. In addition, the CSM provides beneficial information regarding the site geology, which will be used to direct soil remediation.

If you have any questions or comments regarding the information contained herein, please do not hesitate to contact Mr. John Moore at (505) 879-7643.

Western Refining Southwest LLC
A subsidiary of Marathon Petroleum Corporation
I-40 Exit 39
Jamestown, NM 87347

Certification

I certify under penalty of law that this document and all attachments were prepared under my direction of 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,
Western Refining Southwest LLC, Marathon Gallup Refinery

Ruth a Cade

Ruth Cade
Vice-President

Enclosure

cc: D. Cobrain, NMED HWB
L. Barr, NMOCD
K. Luka, Marathon Petroleum Corporation
M. Bracey, Marathon Petroleum Corporation
M. Suzuki, NMED HWB
J. Moore, Marathon Gallup Refinery
H. Jones, Trihydro Corporation

Conceptual Site Model Report

Western Refining Southwest LLC

(dba Marathon Gallup Refinery)

Gallup, New Mexico

EPA ID# NMD000333211

MARCH 3, 2022

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List of Acronyms and Abbreviations

%	percent
AOC	areas of concern
BTEX	benzene, toluene, ethylbenzene, and xylene
BTEXN	benzene, toluene, ethylbenzene, xylene, and naphthalene
COC	constituents of concern
CSM	conceptual site model
DRO	diesel range organics
EP	evaporation pond
ft	feet
ft/d	feet per day
GAC	granular activated carbon
GPM	gallons per minute
GRO	gasoline range organics
HP	hydraulic profiling
I-40	Interstate Highway 40
IM	interim measures
KOD	knock out drum
LDU	leak detection units
LIF	laser-induced fluorescence
LNAPL	light nonaqueous-phase liquids
LTU	land treatment unit
MKTF	Marketing Tank Farm
mg/L	milligrams per liter

List of Acronyms and Abbreviations (cont.)

MTBE	methyl tert butyl ether
NAPIS	new American Petroleum Institute separator
NM	New Mexico
NMED	New Mexico Environment Department
NSZD	natural source-zone depletion
OAPIS	old API Separator
PAH	polycyclic aromatic hydrocarbon
RCRA	Resource Conservation and Recovery Act
RCRA Permit	Resource Conservation and Recovery Act Post-Closure Care Permit
Refinery	Western Refining Southwest LLC (dba Marathon Gallup Refinery)
RW	recovery well
SPH	separate phase hydrocarbons
STP	sanitary treatment pond
SVOC	semi-volatile organic compound
SWMU	solid waste management unit
SZD	source-zone depletion
TPH	total petroleum hydrocarbon
VOC	volatile organic compound
WWTP	wastewater treatment plant

Executive Summary

This document describes the conceptual site model (CSM) for hydrocarbon impacts, including separate phase hydrocarbons (SPH) and dissolved phase hydrocarbons, at Western Refining Southwest LLC (dba Marathon Gallup Refinery [Refinery]) in Gallup, New Mexico. A CSM is an iterative tool that utilizes available data to characterize the current and historical conditions affecting the distribution, mobility, and fate of chemicals in the environment. The CSM is used to assess and communicate the potential for human health and environmental risks as well as to aid in the evaluation and design of remediation approaches.

Environmental investigations at the Refinery have documented the presence of SPH in portions of the Refinery, and SPH recovery efforts have been ongoing. This Report was prepared to provide the framework for future remediation of soil and groundwater hydrocarbon impacts above environmental screening and cleanup levels at the Refinery. Key considerations from the Refinery CSM are summarized below.

Hydrogeologic Setting

The geology at the Refinery includes fluvial and alluvial deposits, primarily clay and silt, and low permeability claystones and siltstones of the Chinle Group. Groundwater occurs sporadically in discontinuous lithologic units. At depth, inter-bedded within the Chinle Group, is the Sonsela Sandstone bed (Sonsela), which is a notable but relatively thin aquifer. Very low permeability bedrock (e.g., claystones and siltstones) underlie the surface soils and effectively form an aquitard between the discontinuous shallow aquifers and the Sonsela. Within the shallow aquifers, lithology is highly heterogeneous alluvial clay mixed with sand stringers. SPH migration in this geologic setting may be complex and highly dependent on fine-scale lithologic variations across the Refinery.

Refinery Impacts

When the Refinery is operating, the types of materials potentially generated would include volatile organic compounds, and semi-volatile organic compounds (SVOCs) (primarily hydrocarbon constituents), solvents, acids, caustic solutions, and heavy metals. These materials could be in the form of wastewater, sludge, dry solids, or chemicals. . Releases of petroleum hydrocarbons from the Refinery are the source of SPH impacts. Both historical and recent releases (within the last 5 years) are present. Types of SPH present range from light-end gasoline to heavy weathered crude oils. SPH has been found in multiple locations within the refinery. The SPH generally occurs within the shallow soils and sediments overlying the Chinle. The most commonly detected analyte in excess of screening levels is benzene. Also commonly detected above standards in groundwater are toluene, ethylbenzene, xylenes, naphthalene, and methyl tert butyl ether (MTBE). Amongst metals, arsenic and lead have a relatively high detection frequency and are commonly detected above screening levels. Phenanthrene has the highest detection frequency amongst SVOCs and polycyclic aromatic hydrocarbons.

Fate and Transport Considerations

SPH tends to be present in coarser materials (sandy clays, sandy silts, sandy gravels) and migration may have occurred primarily in coarser lithologic zones. In fine-grained materials migration pathways are complex, controlled by geometry of heterogeneous features within the subsurface. In addition to direct migration of SPH, constituents of the SPH may partition to other media (e.g., groundwater), and be transported by physical mechanisms governing the flow of the entraining media. Exposure pathways include direct contact of the SPH itself, and exposure to SPH constituents released to other media (e.g., groundwater). SPH attenuation mechanisms include volatilization, dissolution, and biodegradation.

Conclusions

Discrete SPH impacts are present at the Refinery due to releases and other refinery related processes. The physical characteristics of the SPH and the properties of aquifer materials determine the saturation and mobility of SPH, and these properties will vary across the Refinery. SPH and associated impacts are found to some degree in subsurface soil at the site, the alluvial/fluvial aquifer, the Chinle/Alluvium aquifer, and at depth in the Sonsela aquifer. The primary constituents of concern are benzene, toluene, ethylbenzene, xylenes, and naphthalene, MTBE, arsenic, lead, and phenanthrene. Most impacts are present in the Chinle/Alluvium aquifer.

In general, objectives at the Refinery include addressing SPH , and dissolved phase groundwater impacts from the subsurface SPH sources. Based on these concerns, key metrics for tracking progress and focusing remediation efforts during the remediation process will be developed. Application of these metrics will allow for an objective-based, repeatable decision-making process to govern SPH monitoring, recovery, and remediation.

Schedule for Proposed Future Work

The next phases of work at the Refinery involve designing and implementing a comprehensive remediation approach to mitigate residual SPH impacts at the Refinery. For groundwater, design of a groundwater recovery and treatment system is underway. Installation will be initiated in 2022. For soil, remediation activities are scheduled to commence in 2022 and will continue as needed if additional areas of concern are identified.

1.0 Introduction

This document (Report) summarizes information collected by Western Refining Southwest LLC (dba Marathon Gallup Refinery [Refinery]) on the occurrence and characteristics of separate phase hydrocarbons (SPH) and associated hydrocarbon impacts at the Refinery located in Gallup, New Mexico (NM) (Figure 1.0-1). The document presents a broad review of available data and provides a conceptual site model (CSM) for SPH that is present in the subsurface underlying the Refinery. This evaluation forms the technical basis for development of a remedy and monitoring program for the SPH and affected groundwater.

1.1 Purpose and Objectives

The CSM is the collection of information that incorporates key attributes of the SPH impacts with site setting and hydrogeology to support site assessment and corrective action decision-making. The CSM integrates information and considerations specific to the SPH impacts and contaminant sources with information on exposure pathways and receptors. The conceptual understanding of the subsurface has evolved over time as different phases of the corrective action process contribute information. It is expected that the CSM will continue to evolve and be updated in the future.

These efforts are being performed under regulations and guidance of the New Mexico Environment Department (NMED). The goal of this process is to identify remedies for site related SPH and dissolved phase impacts that are both reasonable and practicable, will achieve statutory requirements, will be protective of human health and the environment during their implementation life cycles, and will act in support of opportunity for future beneficial use of the property. The remedy selection process is outside the scope of this CSM. This CSM provides a comprehensive and detailed summary of SPH occurrence at the Refinery, including information about SPH release history, historical refinery infrastructure and locations where SPH is found , SPH migration pathways, dissolved phase hydrocarbon impacts to groundwater, SPH types, other indications of SPH occurrence, and observed hydrocarbon recovery rates based on technologies that have been or are currently employed at the Refinery.

1.2 Regulatory Guidance

An overview of the guidance and regulatory oversight for CSM development from industry standard sources is presented in this subsection. The CSM was prepared in general accordance with current guidance, including but not limited to the following:

- Standard Guide for Development of Conceptual Site Models and Remediation Strategies for Light Nonaqueous-Phase Liquids (LNAPL) Released to the Subsurface, ASTM E2531-06(2014) (ASTM 2014b)
- Standard Guide for Developing Conceptual Site Models for Contaminated Sites, ASTM41 E1689-95 (reapproved 2014) (ASTM 2014a)

- Environmental Cleanup Best Management Practices: Effective Use of the Project Life Cycle Conceptual Site Model (EPA 2011)
- LNAPL Site Management: LCSM Evolution, Decision Process, and Remedial Technologies (LNAPL-3), Interstate Technology Regulatory Council (ITRC 2018)

1.3 Document Organization

The remaining portions of this document are organized as follows:

- Chapter 2 discusses Refinery operational history, the history of documented releases, and ongoing environmental assessments.
- Chapter 3 documents the CSM.
  - Section 3.1 discusses the physical setting of the Refinery.
  - Section 3.2 discusses surface water.
  - Section 3.3 discusses geology and hydrogeology of the subsurface.
  - Section 3.4 discusses sources of petroleum and other refinery-related impacts.
  - Section 3.5 discusses relevant constituents of concern.
  - Section 3.6 discusses the observed distribution of impacts.
  - Section 3.7 discusses fate and transport mechanisms.
  - Section 3.8 discusses attenuation mechanisms.
  - Section 3.9 discusses site management and remediation.
- Chapter 4 presents a summary of the CSM and salient conclusions.

2.0 Background

This section provides an overview of background information relevant for the Refinery.

2.1 Refinery Operations

Built in the 1950s, the Refinery is located within a rural and sparsely populated area east of Gallup, NM. The Refinery is indefinitely idled as of October 9, 2020 and is being maintained near operating conditions. During operation, the Refinery was a crude oil refining and petroleum products manufacturing facility. There were no organic chemicals, plastics, or synthetic fibers manufactured that contributed to the process flow of wastewater. The Refinery did not manufacturer lubricating oils. As a result of the processing steps, the Refinery produced a wide range of petroleum products including propane, butane, unleaded gasoline, diesel, residual fuel, and commercial products of fertilizer and solid elemental sulfur.

Historically, the Refinery primarily received crude oil via two 6-inch diameter pipelines, which entered the Refinery property from the north (Four Corners Area). In addition, the Refinery also received natural gasoline feedstock via a 4-inch diameter pipeline that came in from the west along the I-40 corridor from the Western Refining Southwest LLC – Wingate Plant, which is also indefinitely idled. Crude oil and other products also arrived at the Refinery via railroad cars. These feed stocks were then stored in tanks until refined into products.

Above ground storage tanks were used throughout the Refinery to hold and store crude oil, gasoline, intermediate feed stocks, finished products, chemicals, and water. Capacity of these tanks ranged in size from less than 1,000 barrels to 80,000 barrels. Pumps, valves, and piping systems were used throughout the Refinery to transfer various liquids among storage tanks and processing units. A railroad spur track and a railcar loading rack were used to transfer feed stocks and products from Refinery storage tanks into and out of railcars. Several tank truck loading racks were used at the Refinery to load out finished products, received crude oil, other feed stocks, additives, and chemicals when operating.

Even though the Refinery has an indefinite idle status, the process wastewater system remains in operation. The system is a network of curbing, paving, catch basins, and underground piping used to collect wastewater from various processing areas within the Refinery. The wastewater effluent then flows into the equalization tanks and the New American Petroleum Institute Separator Unit (NAPIS). Currently, only remediation fluids are processed through the system.

While the Refinery is in indefinite idle, water is held in EP-2 to evaporate and is not distributed to the other ponds. No wastewater is currently discharged from the Refinery to surface waters of the state.

Currently, all above-ground large tanks have leak detection or equivalent systems, such as radar gauges. Pumps that could leak hydrocarbons are within containment areas and all tanks are located inside earthen bermed areas to contain spills. The NAPIS has double walls and a leak detection system installed.

2.2 Environmental Investigations and Assessments

There are 14 Solid Waste Management Units (SWMUs) identified at the Refinery and one closed Land Treatment Unit (LTU). On December 31, 2013, the Resource Conservation and Recovery Act (RCRA) Post-Closure Care Permit (RCRA Permit, NMED 2013) became effective under the New Mexico Administrative Code §20.4.1.901A(10). The RCRA Permit identified an additional 21 Areas of Concern (AOCs) requiring corrective action. These units are listed below. The locations of the SWMUs and AOCs are identified on Figure 2.1-1.

RCRA Regulated Units

- LTU

SWMUs

- SWMU 1 – Aeration Basin
- SWMU 2 – Evaporation Ponds
- SWMU 3 – Empty Container Storage Area
- SWMU 4 – Old Burn Pit
- SWMU 5 – Landfill Areas
- SWMU 6 – Tank Farm
- SWMU 7 – Fire Training Area
- SWMU 8 – Railroad Rack Lagoon
- SWMU 9 – Drainage Ditch and the Inactive Land farm
- SWMU 10 – Sludge Pits
- SWMU 11 – Secondary Oil Skimmer
- SWMU 12 – Contact Wastewater Collection System
- SWMU 13 – Drainage Ditch between North and South Evaporation Ponds
- SWMU 14 –API Separator

AOCs

- AOC 15 – New API Separator
- AOC 16 – New API Separator Overflow Tanks
- AOC 17 – Railroad Loading/Unloading Facility
- AOC 18 – Asphalt Tank Farm (tanks 701-709, 713, 714)

- AOC 19 – East Fuel Oil Loading Rack
- AOC 20 – Crude Slop and Ethanol Unloading Facility
- AOC 21 – Main Loading Racks
- AOC 22 – Loading Rack Additive Tank Farm
- AOC 23 – Retail Fuel Tank Farm (tanks 1-7, 912, 913, 1001, 1002)
- AOC 24 – Crude Oil Tank Farm (tanks 101 and 102)
- AOC 25 – Tank 573 (Kerosene Tank)
- AOC 26 – Process Units
- AOC 27 – Boiler and Cooling Unit Area
- AOC 28 – Warehouse and Maintenance Shop Area
- AOC 29 – Equipment Yard and Drum Storage Area
- AOC 30 – Laboratory
- AOC 31 – Tanks 27 and 28
- AOC 32 – Flare and Ancillary Tanks (tanks Z85V2, Z85V3, Z84-T105)
- AOC 33 – Storm Water Collection System
- AOC 34 – Scrap Yard
- AOC 35 – Marketing Tank Farm

Existing groundwater monitoring wells effectively surround the LTU, SWMUs, and AOCs. Groundwater monitoring wells are subdivided into geographical groupings and are sometimes referred to as such (e.g., the Marketing Tank Farm [MKTF] wells). The monitoring well groups are depicted on Figure 2.2-1. The RCRA Permit was modified in September 2017 (NMED 2017a), with SWMU 8 and AOCs 19 and 25 granted Corrective Action Complete status. AOC 32 was combined with SWMU 14; AOC 33 was combined with SWMU 12. AOCs 20, 21, 22, and 23 were combined to make AOC 35. The schedule in the RCRA Permit Appendix E, Table E-1 was amended to reflect prior submittals, revised due dates and deferral of other units. A new Consent Order was executed in January 2017 (NMED 2017b), which resulted in 11 AOCs (AOC 16, 17, 18, 24, 26, 27, 28, 29, 30, 31, and 34) being removed from the RCRA Permit and transferred to the Consent Order for further evaluation. The Refinery received correspondence from the New Mexico Environmental Department (NMED) on August 19, 2021, to restore the 11 AOCs back to the RCRA Permit. The Permit modification was submitted by the Refinery to NMED on December 2, 2021 (Western 2021a).

Figure 2.1-1 also identifies known release areas and other Refinery features. Release areas and investigation areas are described in the following subsections. Where appropriate, reference to figures depicting detailed views of specific areas where investigation borings have been conducted or planned are included in the text of the following subsections. The figures referenced have been copied from the relevant work plans and compiled into Appendix A of this report. No other modifications were made to the figures and their inclusion here is intended to provide an overview of the assessments. For additional detail, refer to the relevant work plan or report.

2.2.1 Groundwater Monitoring and Sampling

The Refinery conducts quarterly groundwater sampling in accordance the Annual Groundwater Workplan (Western 2021b). The groundwater workplan is updated and submitted to NMED annually. There are a total of 120 groundwater monitoring wells and 12 evaporation ponds that are sampled each year (Figure 2.2-1). The evaporation ponds are sampled semi-annually. There are 103 wells that are sampled quarterly and 13 wells that are sampled semiannually. An Annual Groundwater Report is submitted to NMED by September 1, as required in the permit.

2.2.2 New American Petroleum Institute Separator Unit

The NAPIS unit (AOC 15 on Figure 2.1-1) was put into service in October 2004 (Attachment A-1). The NAPIS has one up-gradient well, NAPIS-1, located on the east side and three down-gradient shallow monitoring wells, NAPIS-2, NAPIS-3, and KA-3, which are located along the west side (Figures 2.2-1 and A-1). The NAPIS unit is equipped with three leak detection units (LDUs) on the east and west bays, including the oil sump section in the east bay, and are designated as East LDU, West LDU, and oil sump LDU. The Refinery is currently investigating the source of the fluid found in the East and West LDU's. Preliminary assessment of the NAPIS does not indicate leaking from the concrete secondary containment (Western 2021b).

2.2.3 Aeration Basin

The aeration basin (SWMU-1 on Figures 2.1-1 and A-1) in the Facility's RCRA Permit (NMED 2017a), includes three cells known as aeration lagoon (AL)-1, AL-2 and holding pond 1 (currently referred to as EP-1) (Appendix A-1). These three cells have been out of service since the startup of the WWTP in 2012. SWUM-1 closure is scheduled to begin during the first quarter of 2022 with the excavation of AL-1 and AL-2, followed by the excavation of EP-1 during the first quarter of 2023.

2.2.4 Heat Exchanger Bundle Pad

A workplan to investigate benzene exceedances near the Bundle Cleaning Pad (near SWMU 3 in the center of the Refinery on Figures 2.1-1 and A-2) was submitted to NMED in September 2021 (Western 2021c). Benzene exceedances have been found near the Bundle Cleaning Pad, in MKTF-16, since 2013

(Appendix A-2). The workplan proposed to install soil borings around the Bundle Pad to evaluate the source of the benzene found in MKTF-16.

2.2.5 North Drainage Ditch

On April 22, 2015, the Refinery notified NMED-Hazardous Waste Bureau (HWB) of the discovery of SPH in a drainage ditch in the northern portion of the property, north of SWMU 4 on Figures 2.1-1 and A-3 (Appendix A-3). Surface water samples were collected from the standing water in the drainage ditch. Benzene, toluene, ethylbenzene, and xylenes (BTEX) were detected as well as methyl tert butyl ether (MTBE), total petroleum hydrocarbons (TPH)-gasoline range organics (GRO) and TPH-diesel range organics (DRO). An investigation was conducted in May 2016 with installation of well OW-56. An additional investigation in the North Drainage Ditch was conducted in August 2021, which included the installation of five temporary wells, three new monitoring wells, and soils samples collected from six soil borings. Findings were presented in a report to NMED on December 17, 2021 (Western 2021d).

2.2.6 Sour Naphtha Release

On March 26, 2017, a sour naphtha release occurred from a pipeline approximately 4 ft beneath the service road near the intersection northwest of the bundle cleaning pad (Figures 2.1-1 and A-4 and Appendix A-4). The estimated volume released was less than 210 gallons which surfaced and flowed down the road to the west. Following the release, approximately 16 tons of impacted soil were excavated. The Sour Naphtha Release Workplan was submitted to NMED on September 28, 2021 (Western 2021e). The Sour Naphtha Release Workplan proposed to install soil borings and collect surface samples to delineate impacts from the sour naphtha release.

2.2.7 Railcar Release

On May 7, 2017, a hydrocarbon spill was discovered pooling underneath the pipe rack located along the west side of the rail car loading area (Figures 2.1-1 and A-5 and Appendix A-5). An estimated 8,820 gallons of recovered gasoline were placed in the slop tank. The on-site laboratory analyzed a release sample, which verified that the released hydrocarbon was gasoline. In an effort to remove impacts, approximately 153 tons of impacted soils were excavated from beneath the pipe rack in November 2018. On March 13, 2019, diesel was discovered leaking in the same area as the 2017 gasoline release. Diesel leaked across the railroad tracks into a culvert, carrying the diesel into the stormwater system. An estimated 1,764 gallons were released; 1,680 gallons were recovered via vacuum truck and 84 gallons were released onto the ground surface. An investigation of the release area was conducted in August 2021. The investigation included collecting surface samples and installing soil borings to delineate the extent of hydrocarbon impacts in the area. The investigation report was submitted to NMED on December 12, 2021 (Western 2021f).

2.2.8 Flare Knock Out Drum Investigation

The Flare Knock Out Drum (KOD) is located adjacent to OAPIS-1 on Figures 2.1-1 and A-6 (Appendix A-6). On April 20, 2017, a hose attached to a Sandpiper (double diaphragm) pump at the flare KOD tank ruptured which resulted in a release of approximately 80 barrels of caustic (approximately 20 to 30 percent [%] sodium hydroxide, with a pH of 12.0) to the surrounding area. Approximately 20 to 30 gallons of caustic were pumped from the area into a vacuum truck, which had been diluted with approximately 100 gallons of water and pumped into the refinery sewer system at a pH of 8.0. An investigation into the affected soils was conducted in July and September of 2021. The investigation consisted of collecting soil samples and pH data to determine if excavation and/or further investigation is warranted. The Flare KOD Investigation report was submitted to NMED on October 27, 2021 (Western 2021g).

2.2.9 French Drain Investigation

The French Drain is located on the east side of STP-1 (Figures 2.1- and A-7 and Appendix A-7). Hydrocarbon impacts were discovered in the drain line of the STP-1 French Drain on February 6, 2018. Subsequent investigation efforts were completed on February 8 and 10, 2018. The *French Drain Soil Sampling Investigation Work Plan* was approved with modifications on January 8, 2021 (MPC 2021). The work plan proposed installation of soil borings and sample collection further north, east and west of the STP-1 French Drain and north of the wastewater treatment plant. This investigation is intended to reduce data gaps and will be utilized to determine if additional remediation or investigation is warranted. The investigation is planned for 2022 pending approval from NMED (NMED 2021).

2.2.10 Sanitary Lagoon

The sanitary lagoon is adjacent to well MKTF-25 (Figures 2.2-1 and A-9 and Appendix A-8). It was installed when the facility opened in 1957. The lagoon held wastewater and/or raw sewage prior to October 11, 2018 and has since dried out. There is a pipeline that carried sewage from the laboratory, warehouse, truck rack, and machine shop to the sanitary lagoon. The pipeline that discharged to the lagoon was cut and the up-stream portion plugged with concrete on October 11, 2018. A 2019 investigation was conducted in the sanitary lagoon to determine if past use of the lagoon has caused groundwater impacts. The Sanitary Lagoon investigation report, submitted February 2020, concluded that impacts found beneath the Sanitary Lagoon are generally consistent with those observed in the surrounding MKTF wells and that the area should be addressed as part of the larger MKTF plume (MPC 2020). The initial investigation was to include collecting soil samples beneath the pipeline to determine if there were impacts from any potential leaks in the pipe. This part of the investigation was postponed due to the Truck Loading Rack release in October 2019. The investigation below the pipeline, which was altered to include analysis for hydrocarbon as well as sewage impacts, was conducted in September 2021. The results of the investigation are pending.

2.2.11 Tank 570 Release

On October 23, 2019, a tank inspection indicated multiple leaks in the floor of Tank 570 (Figure 2.1-1). Tank 570 was used for 83 octane gasoline storage and was taken out of service for repair. The gasoline release from Tank 570 was investigated in the November 2019 and May 2021 LIF investigations. The LIF investigations indicated that the gasoline had migrated to the northeast, north, and northwest. Section 2.3 discusses the investigation results.

2.2.12 Truck Loading Rack Release/Marketing Tank Farm Area

On October 27, 2019, a leak was discovered in an underground gasoline transfer line west of the truck loading rack (Figure 2.1-1). Hydrocarbon was observed seeping out of the ground into a stormwater ditch. The line was immediately taken out of service when the release was discovered and has since been replaced. The initial volume estimate was greater than 100 barrels of hydrocarbon. The initial LIF Investigation, conducted November 2019, was conducted to investigate the extent of the release in the Marketing Tank Farm and Truck Loading Rack areas. Subsequent LIF investigations conducted in February and May 2021 were conducted, in part, to further delineate the gasoline release originating from Truck Loading Rack release. Section 2.3 discusses the investigation results.

2.2.13 AOC 35 – Marketing Tank Farm

AOC 35 (Figure 2.1-1) includes the main truck loading rack, crude slop and ethanol unloading facility, additive tank farm loading rack, and the retail tank farm (Appendix A-9). Historical groundwater sample results within and around AOC 35 have shown impacts from petroleum hydrocarbons. The work originally scheduled for AOC 35, described in the investigation work plan originally dated August 2018, was postponed due to the Truck Loading Rack Release. The Revised AOC 35 Investigation Work Plan No. 2 (Western 2021h) was submitted to NMED on September 1, 2021 and included revisions to the original work plan to incorporate the Truck Loading Rack release as well as data from LIF investigations in the area. The investigation will be conducted once the revised work plan is approved by NMED.

2.3 Laser-Induced Fluorescence/Hydraulic Profiling Investigations

In response to more recent releases (approximately 2019 to present) a series of Laser-Induced Fluorescence/Hydraulic Profiling (LIF/HP) investigations were conducted. LIF is a direct push site characterization method in which laser light excites fluorescent molecules that exist in most petroleum fuels and oils. Fluorescence is measured as a proxy for SPH presence. The HP tool is run concurrently and is used to assess the geologic unit permeability and hydrostratigraphy. The combination of LIF and HP tools on a single direct push probe facilitates investigation of SPH while simultaneously characterizing lithologic variability that influences SPH mass storage and transport.

The November 2019 LIF investigation was conducted to investigate the extent of the releases in the Marketing Tank Farm and Tank 570 areas. A subsequent LIF investigation in February 2021 was conducted to further delineate the gasoline release originating from the Marketing Tank Farm and Truck

Loading Rack areas. The May 2021 investigation focused on Tank 570 and additional areas of the Refinery, including the northern and eastern boundary, Tank Farm, Marketing Tank Farm, and in and around the wastewater. Data gaps from the initial Marketing Tank Farm investigation were also addressed. The Marketing Tank Farm LIF report (Western 2021i), the Tank 570 and additional areas report (Western 2021j), and the Marketing Tank Farm Addendum (Western 2021k) have been submitted to NMED. Additional details on the methods and the investigations can be found in these reports.

2.4 Interim Actions

This section describes ongoing interim remediation actions conducted at the Refinery.

2.4.1 Hydrocarbon Seep Area

In June 2013, a hydrocarbon seep was discovered east of Tanks 101 and 102 (Figure 2.1-1, Appendix A-10). Excavations in the area indicated sufficient hydrocarbons were present for six 6-inch sumps to be installed for fluid recovery via vacuum truck. The area was identified as the “Hydrocarbon Seep Area” and quarterly interim measures (IM) reports are submitted to NMED. Additionally, in 2016, a series of retention ditches were installed north of the sumps. Fluid is extracted from the sumps, at a minimum, of once a month. Any standing water and/or hydrocarbon found in the first retention ditch is also recovered, though the retention ditch has been dry since January 2020. Between 2013 and 2018, 19,009 gallons of SPH and 1,549,620 gallons of water were extracted from the sumps. Since 2019, no measurable SPH has been extracted from the sumps and 49,300 gallons of water have been extracted. A total of 50 MKTF monitoring wells have been installed to monitor impacts to groundwater in relation to the Hydrocarbon Seep area.

2.4.2 Borrow Pit Seep Area

A gasoline seep, expected to be related to the Truck Loading Rack release, was discovered December 2020 west of the truck loading rack, in the borrow pit (Figure 2.1-1, Appendix A-11). In April 2021, six sumps and two piezometers were installed in the borrow pit. Fluid recovery from the sumps is conducted via vacuum truck 3 to 4 times per week as an IM to prevent further hydrocarbon migration. Recovery efforts began in May 2021 with a consistent average of 31.5 gallons of SPH extracted per day through October 2021.

3.0 Conceptual Site Model

ITRC (2018) describes the general evolution of CSMs over time and which elements are of importance at different phases in the process. This chapter presents the current CSM for the Refinery, which is an "Initial LCSM" in the terminology of ITRC (2018). The Initial LCSM (with "L" denoting light non-aqueous phase liquid or SPH) identifies concerns by defining the nature and extent of SPH and how it relates to receptors and pathways.

The nature and extent of refinery-related impacts have been identified to varying degrees in the different media evaluated at the Facility. SPH and other refinery related impacts are present in surface soil, subsurface soil, and groundwater in portions of the Refinery. Impacts to surface water from refinery processes occur in portions of the Refinery. Impacts to sediment in ponds at the Refinery have not been investigated yet Additionally, the Refinery is an operable facility, and this should be considered in future phases of environmental investigation and remediation. Prevention of additional releases is a component of the overall remediation strategy.

3.1 Physical Setting

The Refinery is situated in the high desert plain on the western flank of the Continental Divide. The surrounding land is comprised primarily of public and private lands used for cattle and sheep grazing. 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 ft to 6,860 ft. Surface soils within most of the area of investigation are primarily Rehobeth silty clay loam. A topographic map showing the general layout of the Refinery in comparison to the local topography is presented on Figure 3.1-1.

Surface vegetation consists of native xerophytic vegetation, including grasses, shrubs, small junipers, and prickly pear cacti. Average rainfall at the Refinery is less than 7 inches per year, although it can vary to slightly higher levels elsewhere in the county depending on elevation. Erosion features such as arroyos are present in portions of the property.

3.2 Surface Water

Surface water in the region consists of the man-made evaporation ponds and aeration basins located within the Refinery, two small unnamed spring fed ponds located south of the Refinery, and the South Fork of the Rio Puerco (Figure 3.1-1) and its tributary arroyos. The various ponds and basins typically contain water throughout the year when the Refinery is in operation. As of this writing (Fall 2021), with the Refinery idled, about half of the evaporation ponds are mostly dry. The water level in the ponds fluctuates in response to natural weather patterns including seasonal changes in evapotranspiration, and monsoonal variations in precipitation. The South Fork of the Rio Puerco and its tributaries are intermittent and generally contain water only during and immediately after precipitation.

The storm water system is a network of valves, gates, berms, embankments, culverts, trenches, ditches, natural arroyos, and retention ponds that collect, convey, control, and release storm water that falls within or passes through Refinery property. Storm water that falls within the processing areas is considered equivalent to process wastewater. Storm water accumulated in the process units is sent to tanks T-35, T-27, and T-28 when needed before it reaches the NAPIS, WWTP, STP-1, and into EP 2, where flow is gravitated to the rest of the ponds (Figure 2.1-1, Appendix A-12). Storm water discharge from the Refinery is very infrequent due to the arid, desert-like nature of the surrounding geographical areas.

There are several storm water conveyance ditches located throughout the Refinery. These ditches divert storm water around regulated industrial activity and discharge into contained basins. Storm water may be collected and recycled for use as process water, allowed to evaporate, or discharged into two designated outfalls located on the east and west section of the property, identified as Outfall 1 and Outfall 2 (Figure 3.2-1). Outfall 1 is located directly south of EP 8 on the western edge of the Refinery's property boundary and equipped with four separate small diameter overflow pipelines, each with a manual flow valve for independent control. Outfall 2 is located north of the railroad loading rack on the eastern section of the Facility. This outfall consists of a concrete barrier with a valve to control discharges from a deep ditch that collects/ponds the runoff from the rail rack loading area.

Directly west of the crude tank area, there is a concrete barrier (Figure 3.2-1) with a control valve that discharges from a culvert that carries storm water flow from the Truck Loading Rack area. This concrete barrier is located downstream of the "hydrocarbon seep area." The flow from this concrete barrier continues in a north-northwest direction alongside the southern bermed areas of evaporation ponds 3, 4, 5, and 6 and outward towards the Outfall 1 area. At the new WWTP, there are three storm drains located on the south, southwest, and west side of the WWTP. These drains are connected to an underground storm culvert that exits on the northwest section of STP-1 into a conveyance ditch along the northern edge of pond 2 and into a holding pond equipped with manual flow valves, located north of EP 3. The discharge from this holding pond then flows west towards the Outfall 1 area.

3.3 Geology and Hydrogeology

The Refinery is in an east-west trending valley. Perpendicular to this valley is a monoclinal structure with a sedimentary sequence of geologic units. Figure 3.3-1 identifies the location of the Refinery on a regional geologic map (Darton 1928) to provide an orientation to the regional structure and stratigraphy. In the immediate area of the Refinery, the local stratigraphy is well described by Hackman and Olson (1977), wherein the Petrified Forest Member of the Chinle Formation is subdivided in three parts: the upper part, the Sonsela Sandstone bed, and the lower part. Stratigraphically, older units are present to the south of I-40 with the Upper Triassic Chinle Formation forming bedrock outcrops on bluffs south of I-40. Quaternary Alluvium forms the surficial deposits within the valley, and bluffs and the north side of I-40 expose units of Jurassic age including the Entrada Sandstone and the Morrison Formation. Due the monoclinal structure, bedding within these units is nearly horizontal in the vicinity of the Refinery (Robertson 2006). A cross sectional view of the regional geologic structure is depicted on Figure 3.3-2.

The Zuni Uplift is a major structural feature located south of the Refinery. The Refinery is located on the northern flank of the uplift, about 20 miles from the core of the uplift. The Zuni uplift is an elongate dome, oriented northwest-southeast, with exposures of Precambrian granitic and metamorphic rocks in the central part of the uplift. Sedimentary rocks dip away from the uplift. Dips on the northeastern flank range from 3 to 10 degrees (Baldwin and Anderholm 1992).

Groundwater occurs in the alluvial sediments and the upper weathered portion of the of the Chinle Formation. Groundwater also occurs at depth in the Sonsela Sandstone bed. This is described in additional detail in Section 3.3.2.

3.3.1 Geological Characteristics

The Refinery property is located on layered geologic units. Site boring logs indicate that subsurface fluvial and alluvial soils are comprised of primarily clays and silts with minor inter-bedded sand layers. Very low permeability bedrock (e.g., claystones and siltstones) underlie the surface soils. The Chinle Group, from the Upper Triassic period, crops out over a large area south of the Refinery. The uppermost subunit within the Chinle Group is the Petrified Forest Formation, which is also sometimes referred to as the Petrified Forest Member. Inter-bedded within the Chinle Group is the Sonsela Sandstone bed, which lies within and parallels the dip of the Chinle Group. Its high point is located southeast of the Refinery and slopes downward to the northwest as it passes under the Refinery.

Most of the Refinery is located on soils and sediments derived from weathering of sedimentary rock units. Boring log data from conventional drilling and direct push methods were used to develop five cross sections that show the geologic materials present in the shallow subsurface at the refinery. In a regional sense, the materials depicted on these cross sections are alluvium or the upper portion of the Chinle Group (Petrified Forest Member). The location and orientation of each cross section was based upon historical hydrocarbon impacts and release areas are shown on Figure 3.3-3.

Cross section A – A' (Figures 3.3-4A and 3.3-4B) trends west to east from Pond 8 at the western edge of the refinery, across the west borrow area, through the MKTF loading rack, process areas, to the south end of the rail loading rack. Along the western edge, the surficial soils are dominantly clayey silts and silty clays. Immediately below this, adjacent to and below the west borrow pit, sandy clay, and clayey sand lithologies occur. The LIF/HP borings confirm this lithology. Near the truck loading rack, the sandy clays and clayey sands pinch out and boring logs indicate a silty clay from ground surface down to the contact with the Chinle Formation. This lithologic sequence is consistent until boring PA-LIF-4 where a sandy gravel interval is observed beneath the process area and the thin unit extends eastward to the railroad loading rack. The lithology below the gravel interval consists of silty clay and clayey silt that lies above the Chinle Formation interface. Near and around EB-LIF-09, the surface lithology changes to a clayey sand, underlain by the sandy gravel interval that grades into the silty clay.

Cross section B – B' (Figure 3.3-5) runs north south from near the STP, through the north seep area, down to and through the MKTF parking lot. The area around the STP consists of silty clay that lies directly over shale of the Chinle Formation that grades into a clay near EP-1. Adjacent to the north seep area, the lithology consists of a clayey sand that lies above some clayey silt and shale of the Chinle Formation. Further south in the MKTF area, the geology is very discontinuous and complex, consisting of surficial layers of fill, silty clay, sandy clay, sandy silt, all underlain by a relatively consistent layer of clayey sand from MKTF-26 to MKTF-17. South of MKTF-17 is a relatively complex sequence of fine-grained soils comprised of fill, silty clay, sandy clay, and clay that lies on top of the Chinle Formation.

Cross section C – C' (Figure 3.3-6) runs north to south from SWMU 8 to the middle of the process area. This area of the refinery is underlain primarily by clay soils on the northern portion, which grades into silty sands to sandy silts at EB-LIF-15 immediately west of the railroad loading rack. The soils sit above siltstone of the Chinle Formation.

Cross section D – D' (Figure 3.3-7) runs west to east from Pond EP-1 and the aeration lagoons AL-1 and AL-2 to well EB-LIF-13 near Tank 576. Soils along this cross section are predominantly clays and sandy clays intermixed with fill material along the northern portions of the tank farm. Near RW-2 a very thin interval of sandy gravel occurs that may be connected to portions of the sandy gravels encountered within the process area.

Cross section E – E' (Figure 3.3-8) runs west to east just south of Pond 2 through the tank farm north of the process area, to the east fuel loading rack. The lithology is predominantly silty clay and silty sand overlying siltstone bedrock of the Chinle Formation. Near EB-LIF-28 some thin sandy and clayey gravel lenses occur but pinch out to finer grain soils composed of silty clay to east.

3.3.2 Hydrogeological Characteristics

The shallow aquifer is complex and variable, and in the past some authors have divided this shallow water bearing zone into an alluvial/fluvial upper sand aquifer located on the far western edge of the Refinery (not depicted in cross sections reviewed in the previous section) and a deeper more continuous Chinle/alluvium aquifer. As described in Section 3.3, surface soils generally consist of fluvial and alluvial deposits, primarily clay and silt with minor inter-bedded sand layers. Below the surface layer is the Chinle Formation, which consists of very low permeability claystones and siltstones that comprise the shale of this geologic unit. The majority of the Chinle Formation effectively serves as a low permeability sequence. Interbedded within the Chinle Formation is the Sonsela Sandstone bed, which is a significant but relatively thin aquifer. The Sonsela Sandstone bed lies within and parallels the dip of the Chinle Formation. The Sonsela outcrops southeast of the Refinery and it slopes downward to the northwest as it passes under the Refinery. Due to the confinement of the overlying portions of the Chinle Formation, the Sonsela Sandstone bed can function as a confined water-bearing unit. Artesian conditions exist through much of the central and western portions of the Refinery property. Aquifer tests of the Sonsela Sandstone bed northeast of Prewitt, NM (about 25 miles southeast of the Refinery) indicated a transmissivity of greater than 100 square ft per day (Stone et al. 1983). Wells screened in the alluvial/fluvial upper sand aquifer, the Chinle/alluvium aquifer, and the Sonsela Sandstone aquifer are shown on Figure 2.2-1. Available data on soil moisture and specific gravity of soil samples were compiled into Appendix B.

Groundwater flow within the shallow alluvium and the upper Chinle Formation is highly variable due to the presence of complex and irregular stratigraphy including sand stringers, cobble beds, and dense clay layers. Hydraulic conductivity ranges from 30 feet per day (ft/d) for gravel-like sands immediately overlying the Petrified Forest Formation to 3 x 10^{-5} ft/d in the clay soils located near the surface. Generally, shallow groundwater flow at the Refinery follows the upper contact of the Petrified Forest Formation (Chinle Group) with prevailing flow from the southeast to the northwest, although localized areas may have varying flow directions based on the subsurface geology. Groundwater flow within the Lower Chinle Formation is extremely slow and typically averages less than 2.83 x 10^{-7} ft/d (i.e., less than 0.01 feet per year).

Water level data are collected on a quarterly basis at the Refinery. Wells at the Refinery have been categorized based on the hydrogeologic unit in which they are screened, including the alluvial/fluvial upper sand aquifer, the Chinle/alluvium aquifer, and the Sonsela Sandstone aquifer (Figure 2.2-1). The alluvial/fluvial upper sand aquifer has a limited aerial extent, existing only on the western margin on the Refinery. Groundwater occurrence in this aquifer is sporadic and limited. Wells screened in the alluvial/fluvial upper sand aquifer except for BW-2A were dry as of third quarter 2020 (Figure 3.3-9).

The majority of the wells monitored lie within the shallow weathered sediments that comprise the Chinle/alluvium aquifer. Figure 3.3-10 shows the potentiometric surfaces in the Chinle/alluvium aquifer from third quarter 2020. Within the Chinle/alluvium aquifer, shallow groundwater located under the Refinery property generally flows along the upper contact of the Chinle Formation. The shallow groundwater high corresponds with a topographic high near the western portion of the process area. Groundwater flow radially away from the potentiometric high with the prevailing flow direction from the process area toward the northwest, and to the northeast toward the Refinery tank farm (Figure 3.3-10).

Figure 3.3-11 shows the potentiometric surfaces in the Sonsela Sandstone aquifer from third quarter 2020. Groundwater within the Sonsela flows southeast to northwest (Figure 3.3-11). Hydraulic heads measured within the Sonsela are generally lower than those observed within the shallow aquifer near the topographic high on which the Refinery process area and tank farm are situated, and higher than those observed within the shallow aquifer in topographically low areas to the west and northwest, near the ponds (Figure 3.3-12). The higher head in the Sonsela in low areas is due to confining pressure from lower permeability Chinle Formation bedrock between the shallow Chinle/alluvium aquifer and the Sonsela Sandstone bed at depth, which makes the Sonsela aquifer artesian. Head differences range from near zero in portions of the refinery process area and tank farm to over 30 feet near PW-2 near the western boundary of the Refinery. Figure 3.3-12 shows a cross sectional view illustrating the difference in potentiometric head between the Sonsela and the shallow Chinle/alluvium aquifers. The shallow aquifer potentiometric surface follows the surface of the Chinle while the Sonsela aquifer potentiometric surface has less variation.

3.4 Contaminant Types, Characteristics, and Possible Sources

A primary concern at the Refinery is the presence of released petroleum hydrocarbons in the subsurface as SPH. In some portions of the Refinery, SPH is in contact with groundwater. The SPH generally occurs within the shallow soils and sediments overlying the Chinle. SPH has not been observed in the Sonsela aquifer. Figure 3.4-1 shows the SPH occurrences in monitoring wells for the third quarter 2020. A summary of the documented release history at the Refinery was provided above in Sections 2.2 and 2.3.

SPH has been detected in the Main Tank Farm, Hydrocarbon Seep Area, Aeration Basin, French Drain, Truck Loading Rack, and NAPIS Unit areas (Figure 2.1-1). In the Main Tank Farm area, SPH was found within the shallow groundwater in the mid-1990s. A series of recovery wells (RWs) were installed and SPH has been recovered since the initial discovery. Recovery wells in the Main Tank Farm and the down-gradient area are RW-1, RW-2, RW-5, RW-6, OW-14, OW-30, OW-55, and OW-58 (Figure 2.2-1). In the Hydrocarbon Seep area, data regarding the liquid recovered from the sumps and retention ditch is available in the quarterly Hydrocarbon Seep Reports. In the Aeration Basin, SPH has been detected in GWM-1 since the third quarter sampling event in 2015 through December 2020. In the French Drain area, a mixture of hydrocarbon and water spilled in 2018. Five monitoring wells (OW-61 thru OW-65) were installed in an effort to delineate the hydrocarbon plume that had been discharging from the PVC pipe. During 2020 quarterly gauging, SPH was detected in OW-61, OW-62, and OW-65 during each event. In the Truck Loading Rack area, a gasoline release was observed in 2019. The source of the release was determined to be an underground transfer line on the north side of the Truck Loading Rack. In the NAPIS unit area, SPH was detected in NAPIS-1 from 2017 to the third quarter of 2020. SPH was not detected in NAPIS-1 during the fourth quarter of 2020. Figure 3.4-1 shows the SPH occurrences for the third quarter 2020.

Several different types of SPH are present at the Refinery, ranging from light end gasoline to heavy weathered crude oils. Historically, other types of materials present at the Refinery included other industrial chemicals such as solvents, acids, caustic solutions, and metals.

Historically, wastewater from the railroad loading rack flowed to a settling and separation lagoon north of the rack. Wastewater flow exited at the north end of the lagoon, where the water was distributed across a flat open site known as the fan-out area. The free flow of liquids led to subsurface soil impacts. This area is identified as SWMU 8 (Figure 2.1-1) and has been remediated and granted Corrective Action Complete with Controls status.

3.5 Constituents of Concern

This section presents an analysis of analytical data from soil and groundwater samples at the Refinery to identify constituents that are commonly detected in exceedance of applicable standards at the Refinery, i.e., the constituents of concern (COC). Environmental sampling at the Refinery has targeted analytes from a Modified Skinner List as approved by NMED (NMED 2013). Generally, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), total and dissolved metals, and general chemistry analyses were performed.

This section provides information on Refinery related constituents present in sampled media. As the Refinery begins remediation, the remediation process should be based on defined concerns, verifying concerns through the application of threshold metrics, establishing remedial goals, and determining remediation objectives (ITRC 2018). The constituents highlighted below be may considered in this process.

3.5.1 Soil

Table 3.5-1 displays results of a query of the Refinery database for all soil samples. Analytes are sorted by detection frequency. Benzene, toluene, ethylbenzene, xylenes, and naphthalene (BTEXN) were amongst the most commonly detected compounds. These compounds are common gasoline related constituents and are often summed as BTEXN. In Section 3.6, the sum of these COC is used to describe the spatial distribution rather than discussing the individual compounds, except for benzene. Benzene and BTEXN were selected for mapping, and these maps are described below in Section 3.6.1. MTBE was not detected frequently in soil, indicating that this relatively soluble compounds is most prevalent in groundwater. Amongst metals, arsenic and lead were selected for mapping, because they have a high detection frequency and are commonly detected above screening levels. Phenanthrene has the highest detection frequency amongst SVOCs and polycyclic aromatic hydrocarbons (PAHs), so it was selected for mapping as well. TPH-DRO and TPH-GRO were also mapped because they provide a broadly encompassing view of petroleum related impacts.

3.5.2 Groundwater

Table 3.5-2 displays results of a query of the Refinery database for all groundwater samples. Analytes are sorted by detection frequency. The most commonly detected analyte in excess of screening levels is benzene. Also commonly detected in excess of screening levels are toluene, ethylbenzene, xylenes, and naphthalene. Maps of benzene and BTEXN have been created for this report, and these are described below in Section 3.6.2. MTBE is commonly in excess of standards in groundwater and is also mapped. MTBE has not been used at the Refinery since April 2006. However, MTBE is present in groundwater in some areas, and several monitoring wells monitored specifically for SPH, and MTBE are located on the northeast section of the plant (Western 2021l). Amongst metals, arsenic and lead were selected for mapping because they have a high detection frequency and are commonly detected above screening levels. Phenanthrene has the highest detection frequency amongst SVOCs and PAHs, so it was selected for mapping as well. TPH-DRO and TPH-GRO were also mapped because they provide a broadly encompassing view of petroleum related impacts.

3.6 Distribution of Impacts

This chapter provides a synopsis of environmental sampling data which may indicate the presence of Refinery-related impacts.

3.6.1 Soil

The spatial distribution of seven constituents of concern (arsenic, benzene, BTEXN, lead, phenanthrene, TPH-DRO, and TPH-GRO) throughout the surface and subsurface soils are presented in Figures 3.6-1 through 3.6-14. These maps depict the sampling locations and mean concentrations of each constituent measured in all samples at that location over the last 5 years (2016-2021). For the purposes of this mapping, samples from intervals with bottom depth of 3 ft below ground or less were considered surface soil, while all other samples were considered subsurface soil. The bullets below present some of the observations noted on the soil analyte maps;

- Arsenic concentrations in surface and subsurface soil (Figures 3.6-1 and 3.6-2) are relatively low overall; no results were in excess of 25 milligrams per kilogram. Comparatively elevated (relative to screening levels) concentrations typically occur near the aeration lagoons.
- Elevated concentrations of TPH-DRO and TPH-GRO are present in surface soil in portions of the aeration basin (particularly AL-2 and EP-1) (Figures 3.6-11 and 3.6-13). Subsurface soil generally has lower concentrations of TPH-DRO and TPH-GRO, comparatively (Figures 3.6-12 and 3.6-14).
- Lead concentrations in surface and subsurface soil are generally below screening levels (Figures 3.6-7 and 3.6-8, Table 3.5-1).
- In contrast, Benzene and BTEXN are typically present in higher concentrations in subsurface soil (Figures 3.6-4 and 3.6-6) compared to surface soil (Figures 3.6-3 and 3.6-5).
- Phenanthrene is present in surface and subsurface soils throughout the area of the aeration lagoons (Figures 3.6-9 and 3.6-10).

3.6.2 Groundwater

The distribution of eight constituents of concern (arsenic, benzene, BTEXN, MTBE, lead, phenanthrene, TPH-DRO, and TPH-GRO) throughout the shallow Chinle/alluvium aquifers and the deep Sonsela aquifer are presented in Figures 3.6-15 through 3.6-30. These maps depict the sampling locations and mean concentrations of each constituent measured in all samples at that location over the last 5 years (2016-2021). Figures 3.6-17, 3.6-19, and 3.6-29 depict elevated levels of benzene, BTEXN, and TPH-GRO are present in the vicinity of wells MKTF-15, MKTF-49, and RW-2, respectively, with the highest concentrations at RW-2 (41.18 milligrams per liter (mg/L) for benzene, 50.81 mg/L for BTEXN, and 127.45 mg/L for TPH-GRO). Zones of relatively high concentrations of MTBE, phenanthrene and TPH-DRO on Figures 3.6-21, 3.6-25 and 3.6-27, respectively, are elevated generally in the area around wells MKTF-13, MKTF-19, MKTF-22, and MKTF-31. MTBE has elevated values on the east side of the site also. Lead concentrations on Figure 3.6-23 show elevated levels near BW-4B on the southwest side of the site. Dissolved arsenic is present in several areas in excess of screening levels in the Chinle/alluvium aquifer (Figure 3.6-15), specifically in portions of the Marketing Tank Farm and the northern part of the Main Tank Farm, and areas to the west around the evaporation ponds. The arsenic concentrations are all within an order of magnitude of the screening level (the NMED cleanup level is 0.010 mg/L and the mean arsenic concentrations are generally less than 0.027 mg/L).

In the Sonsela aquifer, Well OW-12 is impacted by benzene, BTEXN, and TPH-GRO (Figures 3.6-18, 3.6-20 and 3.6-30). Well OW-13 is impacted by MTBE (Figure 3.6-22). Dissolved lead is detected at an average concentration of 0.01 mg/L at Well BW-26 northwest of the evaporation ponds (Figure 3.6-24). Arsenic and phenanthrene are generally not present above screening levels in the Sonsela (Figures 3.6-16 and 3.6-26). TPH-DRO concentrations in the Sonsela are relatively low, less than 1 mg/L (Figure 3.6-28).

3.6.3 Laser-Induced Fluorescence / Hydraulic Profiling

A series of LIF/HP investigations were conducted from Fall of 2019 to Spring of 2021 to better understand the nature and extent of the hydrocarbons within the shallow soil and weathered bedrock within the refinery. Details of the investigation can be found in the MKTF, and Tank 570 and Additional Areas LIF Reports (Western 2021j and Western 2021k, respectively). SPH type and extent based on the LIF data are presented on Figure 3.6-31. LIF intensity is likely to increase with increasing SPH saturation (i.e., proportion of the soil pore spaces filled with SPH). HP data were collected from 107 of the borings and were used to evaluate subsurface geology with respect to potential SPH migration. Cross sections were developed using these LIF/HP investigations for the entire Refinery. The cross-section locations are depicted on Figure 3.3-3, which are the same as the geologic cross section locations discussed in Section 3.3.1. Figures 3.6-32 through 3.6-36 present the cross sections depicting the interpolated LIF reflectance signal (%RE) and estimated hydraulic conductivity from the HP data below the water table in the alluvium. The HP data are highly variable, so the HP value presented on the cross sections is divided into two categories based on the mean of the overall dataset (8 ft/d). The two categories distinguish relatively low hydraulic conductivity areas (represented in yellow) from areas of comparatively high conductivity (represented in gray).

The LIF data defined the areas of hydrocarbons related to more recent known releases and helped to better delineate historical hydrocarbon release areas. Investigation data also showed where hydrocarbons from different releases have mixed within the shallow subsurface. These data are discussed with references to specific areas in the following section.

The LIF surveys have established sufficient resolution of the SPH presence to define the boundaries of the affected area with a moderate to high degree of confidence. Figure 3.6-37 presents an aerial view of the modeled extent of SPH based on the LIF data. Figure 3.6-38 presents an oblique view of the 3D interpolation, which reveals some of the complexity with depth.

A series of cross sections have been developed to show the extent of non-aqueous phase hydrocarbons (LNAPL/ SPH) across the Refinery. Five cross sections were developed using boring and monitoring well data, along with the geophysical data sets collected during multiple phases using LIF and HP logging techniques. SPH measurement data and LIF profiles were used to develop the extent of LNAPL shown on Figures 3.6-32 through 3.6-38.

Cross section A – A' (Figures 3.3-4A, 3.3-4B, 3.6-32) runs from the east edge of Pond 9 east through the loading rack area, through the northern portion of the process area to just south of the railroad loading area. LIF borings MKTF-37, -42, -46, -54, -73, and -74 showed hydrocarbon presence within sandy clay and clayey sand intervals that extend west from the truck loading rack area. Fluid level data from monitoring well MTKF-33, which is adjacent MKTF-LIF-54, consistently shows up to 6 ft of SPH. LIF wavelength data suggest that the detected hydrocarbons are of a gasoline range and may be a result of a release from the truck loading rack. The vertical interval of elevated LIF signal at MKTF-LIF-54 was relatively small, from about 24 to 26 ft below ground surface. This interval corresponds to the approximate depth to water at MKTF-33. The hydrocarbons found in this area have discharged within the borrow pit area where new recovery sumps/wells have been installed to mitigate the SPH. In this area, six sumps were installed, and these are vacuumed out to remove SPH each working day. A thin sandy gravel interval located east of the truck loading area and extending beneath the process area (Figure 3.3-4B) contains LNAPL/SPH. LIF logs from EB-LIF-108 and EB-LIF-03 show hydrocarbons near the bottom of each boring, within this sandy gravel interval at approximately 6930 ft above mean sea level.

Cross section B – B' (Figure 3.3-5 and Figure 3.6-33) runs north to south from just north of STP-1, runs along the western edges of EP 1, south to the loading rack area. Monitoring wells just south of EP 1, from GWM-2 to the truck loading rack consistently show the presence of SPH; up to 1.7 ft based on historical monitoring data. LIF borings from WB-LIF-128 to MKTF-LIF-38 show the presence of hydrocarbons. The inferred hydrocarbon types, based on LIF wavelength profiles, is from diesel and gasoline sources. Boring and well lithologic data show that the LNAPL/SPH occurs within relatively fine grain materials; silty clay, sandy clay, and clayey sand. The hydrocarbons found in LIF borings MKTF-LIF-38 to MKTF-LIF- 36 appear to be from a gasoline source associated with the truck loading rack. Hydrocarbons found in borings MKTF-LIF-39 and MKTF-LIF-40 appear to be a mixture of gasoline and diesel-range hydrocarbons from the truck loading rack and diesel. Diesel-range hydrocarbons in this area are believed to have originated from the Marketing Tank Farm (AOC 35) (Western 2021h). Some of the tanks in AOC 35 (Figure 2.1-1) have been used to store and process diesel fuel in the past. The LIF waveforms from several borings in the area are consistent with a diesel product type (Figures 3.3-5 and 3.6-33). Several monitoring wells west of the tanks in AOC 35 generally contain SPH (Figure 3.4-1), including MKTF-13, MKTF-07, and MKTF-08. Hydrocarbons found farther north in borings MKTF-LIF-87 to WB-LIF-128 also show a diesel-type SPH, also believed to have originated from AOC 35 (Western 2021i) or to the east in the process area (Western 2021j).

Cross section C – C' (Figure 3.3-6 and Figure 3.6-34) runs north to south from near the inactive land farm to PA-LIF-06 in the process area. PA-LIF-06 shows an interval of diesel range hydrocarbons within the sandy clay, sandy silt, and silty sand intervals found at that location. Similar hydrocarbon distributions occur at EB-LIF-04 but these two occurrences may not be continuous in the shallow soils. Diesel range hydrocarbons occur at borings EB-LIF-121 and EB-LIF-104 and SPH is present at well RW-2. RW-2 is a recovery well located southwest of Tank 570 and adjacent to EB-LIF-121. There is a discontinuous coarse gravelly sand layer near the base of RW-2 and EB-LIF-121 that aligns approximately with the zone of LNAPL.

Cross section D – D' (Figure 3.3-7 and Figure 3.6-35) runs west to east from the western edge of EP 1 to EB-LIF-13 near the northern end of the railcar release area. SPH occurs within wells GWM-1 and NAPIS-1 within the clay and sandy clay intervals associated with those wells. WB-LIF-114 also shows the presence of hydrocarbons in that area. LIF data from EB-LIF-98 to EB-LIF-13 consistently show the presence of hydrocarbons of a diesel range mixture. As discussed above, RW-2 (adjacent EB-LIF-121) consistently shows the presence of SPH.

Cross section E – E' (Figure 3.3-8 and Figure 3.6-36) runs west to east from just south of EP 2 to EB-LIF-12 in the railroad loading facility. Borings WB-LIF-112, 136, and 128 show intervals of diesel range hydrocarbon within the shallow silty clay, sandy silt, and clayey sand soils. Well MKTF-50 consistently shows a thick sheen of SPH near tank 101. EB-LIF-94 near this well shows a thin interval of hydrocarbon within silty clay soils, but EB-LIF-28 and -20 show thicker intervals of a gasoline-diesel range hydrocarbon mixture. Further east at EB-LIF-12, a relatively thick interval of diesel-gasoline range hydrocarbons occurs at the railcar loading facility.

3.7 Contaminant Fate and Transport

The fate and transport of constituents in the environment are dependent on the nature of the materials in present, the pathways available for transport, and the properties of the media exposed to contaminants. Chemical mobility varies between media, (e.g., soil vs. groundwater), and will often vary within a specific medium, based on variations in natural features and physical characteristics at a facility. Fate and transport processes will vary for different chemicals and will diverge for different types of contaminant (e.g., metals compared to VOCs). It is, therefore, important to note that the extent of impacts may vary depending upon the constituent and the media evaluated. The following sections discuss the environmental fate and transport of refinery-related impacts.

3.7.1 Transport Mechanisms

In heterogeneous low permeability media, such as the Petrified Forest Formation at the Refinery and within the soils derived from this geologic unit, the LNAPL/SPH migration path is governed by the geometry of higher permeability zones. Occurrence of measurable LNAPL/SPH in monitoring wells is governed by the frequency and magnitude of groundwater surface fluctuations and the sediment/soil type of the screened interval (ITRC 2018). As discussed above, the LNAPL/SPH hydrocarbons generally occur in a wide range of lithologies. It is generally understood that LNAPL migrates most easily within the coarser grain soils: silty sand, clayey sand, and sandy gravel intervals. The LNAPL/SPH can also move within weathered bedrock intervals at the boundary between the surface soils and Petrified Forest Formation. In general, the LNAPL/SPH moves along a direction similar to the general shallow groundwater gradient but appears to migrate within the coarser soils. LNAPL/SPH migration typically stabilize after the source of the hydrocarbons is addressed. The hydrocarbon mass then can be depleted by dissolution, volatilization, and subsequent natural attenuation mechanisms. Given the control of subsurface heterogeneity and structural trends on SPH migration at the Refinery, including a large dataset of observations from Refinery borings, fluid recovery data, and LIF data, identification of specific migration pathways can be challenging in some cases.

The following discussion is based upon combined interpretations of the lithologic and LIF-HP cross sections. Hydrocarbon distribution and potential for migration is based upon LIF intensity and the lithologic characteristics, mapped out based upon available boring and well data.

Cross section A – A' shown in Figure 3.3-4A, 3.3-4B, and 3.6-32 shows a complex sequence of interbedded soils between the truck loading rack and the borrow pit area on the west side of the refinery. A known release of hydrocarbons occurred at the track loading rack and LNAPL/SPH has migrated from the release area to the area surrounding the borrow pit where LNAPL/SPH has been observed in the shallow subsurface. The LNAPL/SPH appears to migrate within discontinuous sandy clay and clayey sand intervals that slope downward with the ground surface until encountering the excavated areas within the borrow pit area. LNAPL/SPH recovery sumps have been installed to address the hydrocarbon occurrence and intercept any further migration. East of the truck loading rack and within and east of the process area, a relatively continuous interval of sandy gravel occurs and may function as a migration pathway for any hydrocarbon releases.

Cross sections B – B' and E – E' in Figures 3.3-5, 3.3-8, 3.6-33, and 3.6-36 show hydrocarbon occurrences near the aeration ponds, at MKTF-50, and several monitoring wells associated with the truck loading facility. LNAPL/SPH in this area and along the French drain area could be from separate releases, co-mingling as the hydrocarbons migrate. A release at the truck loading rack appears to be the LNAPL/SPH source for the monitoring wells shown on B – B', and the hydrocarbons appear to follow a zone of clayey sand trending north.

Cross sections C – C' as shown in Figures 3.3-6 and 3.6-34 show hydrocarbon occurrences near PA-LIF-06 in the process area and impacts within the Tank 575 berm area near RW-2. The LNAPL/SPH occurs within the sand clay soils at PA-LIF-06. Finer soils outside of this localized area appear to isolate the hydrocarbon impacts. Around RW-2, hydrocarbons occur within sandy clay, silt sand and gravelly sand soils. This occurrence appears to be isolated within the northern most tank berm area within a lens of coarser soils with little to no migration observed to the north.

Cross sections D – D' as shown in Figures 3.3-7 and 3.6-35 show hydrocarbons with the clay and sandy clay soils near the aeration basin and the NAPIS unit. These hydrocarbons may contribute to migration and occurrence along the French drain area. The other occurrences along this section appear to be isolated within finer grain soils (clay, silty clay) and fill within portions of the northern tank berms.

Cross sections E – E' as shown in Figures 3.3-8 and 3.6-36 show hydrocarbons occurring in boring WB-LIF-112, 136, and 128. These LNAPL/SPH impacts may have migrated from releases to the east within sandy silt and clayey sand intervals. LNAPL/SPH is also present in borings EB-LIF-28, 20, and 12. However these hydrocarbon impacts appear to be separated from the western impacts by a fine-grain silty clay interval east of MKTF-50. The eastern impacts beginning at EB-LIF-28 occur with coarser soils in an isolated clayey gravel lens and a more continuous clayey sand layer that extends eastward through EB-LIF-12.

In addition to direct migration of SPH, constituents of the SPH may partition to other media: soil, groundwater, surface water, and air, and be transported by physical mechanisms governing the flow of the entraining media.

3.7.2 Exposure Pathways

Exposure pathways (human health and ecological) include direct contact with the SPH. In addition, exposure could result from contact with SPH constituents released to other media: soil, groundwater, surface water, and air. Section 3.6.1 of this Report addressed the horizontal and vertical distribution of SPH in the subsurface soils. SPH in the vadose zone most likely is a source of dissolved-phase constituents to groundwater. Dissolved-phase hydrocarbons within groundwater are discussed in Section 3.6.2. SPH may also partition to the vapor phase and migrate through soil as gas by advection and diffusion.

3.8 Attenuation Mechanisms

Several naturally occurring contaminant transformation processes act to attenuate or decrease the SPH mass and SPH constituents in the subsurface over time. Attenuation is defined as the reduction in mass or concentration of a compound in soil or groundwater over time or distance from the source due to biological, chemical, and physical processes, such as biodegradation, dispersion, dilution, immobilization, sorption, and volatilization. Biodegradation and volatilization predominantly result in reductions of total contaminant mass in soil and groundwater.

Biodegradation, which relies upon microorganisms to convert contaminants to less harmful compounds, is the dominant natural attenuation mechanism for reducing mass and contaminant concentrations. For inorganic contaminants or those not subject to biodegradation, other attenuation processes such as dilution, chemical transformation, or sorption may serve to reduce, or limit dissolved or mobile concentrations.

3.8.1 Volatilization

SPH mass within the vadose zone may be redistributed to soil gas by volatilization of hydrocarbon constituents. Constituents will volatilize into soil vapor based on their pure chemical vapor pressure and their mole fraction. Lighter molecular weight releases such as gasoline or lighter crude oil fractions tend to volatilize readily. Volatilization is most intense immediately after release and becomes less significant over time as the SPH ages and the volatile fraction in the SPH decreases. Volatilized constituents may be transported away from the source and dispersed by diffusion and advection. With diffusion, volatile constituents or gaseous biodegradation byproducts move from areas of higher concentration to areas of lower concentration. Advection is the movement of bulk soil gas from areas of higher pressure to areas of lower pressure due to the presence of a pressure gradient.

3.8.2 Dissolution

Portions of source zones that are submerged or in contact with pore water in general are subject to dissolution of SPH constituents into groundwater according to the constituents' aqueous solubility. "Effective solubility" represents the maximum equilibrium concentration of a constituent from a multicomponent NAPL mixture in groundwater at a specific temperature and pressure (EPA 1995). Effective solubility (S_{ei}) of an individual NAPL constituent is a product of its mole fraction in the NAPL (X_i) and solubility of the constituents in its pure phase (S_i).

$$S_{ei} = X_i S_i$$

Over time, mole fractions of relatively soluble constituents in a SPH mixture tend to decrease as those constituents are preferentially removed from the mixture by dissolution.

3.8.3 Biodegradation

Biodegradation occurs when microbes break down the molecular structure of a hydrocarbon compound, altering it to a different, usually less harmful compound. Biodegradation occurs in both vapor and dissolved phases. The biodegradation of petroleum is an oxidation process (releases electrons). As groundwater flows through the submerged source zone, petroleum hydrocarbon constituents dissolve into the groundwater, where they become available for biodegradation. Source zone mass is lost as the dissolved-phase constituents and biodegradation by-products leave the source zone via groundwater transport. This biodegradation in the saturated zone is reflected in spatial changes in concentrations of dissolved electron acceptors and dissolved biodegradation by-products.

3.8.4 Source Zone Depletion

Source-zone depletion (SZD) encompasses the variety of processes described above that act to biologically degrade and physically redistribute SPH constituents to the aqueous or gaseous phases where they are also subsequently broken down biologically (ITRC 2018). Source-zone depletion can be natural (NSZD) or enhanced/engineered by altering the subsurface environment. NSZD processes are observable at all SPH release sites, including the Refinery. The rate that NSZD reduces the SPH mass (i.e., the bulk NSZD rate) can be estimated by measuring CO_2 efflux rates at the ground surface, CO_2 or O_2 gradients in vertically nested soil gas monitoring systems, and from temperature gradients measured with vertical thermocouple arrays placed in the ground (API 2017). The NSZD rates of individual compounds of interest (e.g., BTEX) are difficult to estimate with these approaches at this time but can be assessed by observing the chemical changes in SPH composition over time.

NSZD rates at a given site are affected by several interrelated factors, including temperature, soil moisture, soil gas permeability, groundwater geochemistry, and microbiology. NSZD rates at other LNAPL sites can be hundreds to thousands of gallons per acre per year (Garg et al. 2017). The NSZD rate at the Gallup Refinery has not been investigated.

3.9 Separate Phase Hydrocarbon Management and Remediation

This section presents SPH concerns and SPH remediation goals for the Refinery. These concerns and goals were developed based on ITRC guidance (ITRC 2018), while also considering site-specific characteristics of the Refinery and the available data on SPH occurrence at the Refinery. Table 3.9-1 identifies the primary concerns associated with SPH at the Refinery. Saturation-based concerns include the occurrence of SPH in monitoring wells and the potential for SPH migration. Composition-based concerns include the generation of hydrocarbon impacts to groundwater from SPH sources. A receptor-based concern associated with SPH is the proximity of SPH to potential human and ecological receptors. Goals associated with each concern are identified on Table 3.9-1 and include reducing the mobile SPH saturation, terminating the SPH body migration and reducing the potential for SPH migration, reducing constituent concentrations in the dissolved phase from the SPH sources, and preventing direct contact between SPH and potential receptors.

4.0 Summary and Conclusions

This section provides a succinct summary of the Refinery CSM.

4.1 Conceptual Site Model Summary

Environmental investigations at the Refinery have documented the presence of SPH in limited portions of the Refinery, and SPH recovery efforts have been implemented and are ongoing. This Report was prepared to provide the framework for future focused remediation of SPH impacts at the Refinery. Key considerations from the Refinery CSM are summarized below.

4.1.1 Hydrogeologic Setting

The subsurface geology at the Refinery includes fluvial and alluvial deposits, primarily clay and silt, and low permeability claystones and siltstones of the Chinle Group. Groundwater occurs sporadically in discontinuous lithologic units. At depth, and inter-bedded within the Chinle Group, is the Sonsela Sandstone bed, which is a notable but relatively thin aquifer. Very low permeability bedrock (e.g., claystones and siltstones) underlie the surface soils and effectively form an aquitard between the discontinuous shallow aquifers and the Sonsela. Within the shallow aquifers, lithology is highly heterogeneous alluvial clay mixed with sand stringers. SPH migration in this geologic setting may be complex and highly dependent on fine-scale lithologic variations across the Refinery.

4.1.2 Refinery Impacts

When the Refinery is operating, the types of materials potentially generated would include VOCs and SVOCs (primarily hydrocarbon constituents), solvents, acids, caustic solutions, and heavy metals. SPH has been found in multiple locations within the refinery. The SPH generally occurs within the shallow soils and sediments overlying the Chinle. The most commonly detected analyte in excess of screening levels is benzene (Tables 3.5-11 and 3.5-2). Also commonly detected above standards in groundwater are toluene, ethylbenzene, xylenes, naphthalene, and MTBE. Amongst metals, arsenic and lead have a relatively high detection frequency and are commonly detected above screening levels. Phenanthrene has the highest detection frequency amongst SVOCs and PAHs.

4.1.3 Fate and Transport Considerations

SPH tends to be present in coarser materials (sandy clays, sandy silts, sandy gravels) and migration may have occurred primarily in coarser lithologic zones. . In fine grain materials migration pathways may be complex, controlled by geometry of heterogeneous features within the subsurface. SPH attenuation mechanisms include volatilization, dissolution, and biodegradation.

4.2 Conclusions

The physical characteristics of the SPH and the properties of aquifer materials determine the saturation and mobility of SPH, and these properties will vary across the Refinery. SPH and associated impacts are found to some degree in subsurface soil at the site, the alluvial/fluvial aquifer, the Chinle/Alluvium aquifer, and at depth in the Sonsela aquifer. The primary constituents of concern are BTEXN, MTBE, arsenic, lead, and phenanthrene. Most impacts are present in the Chinle/Alluvium aquifer.

In general, concerns at the Refinery include addressing SPH , and dissolved phase groundwater impacts from the subsurface SPH sources. Based on these concerns, key metrics for tracking progress and focusing remediation efforts during the remediation process will be developed. Application of these metrics will allow for an objective-based, repeatable decision-making process to govern SPH monitoring, recovery, and remediation.

4.3 Schedule for Proposed Future Work

The next phases of work at the Refinery involve designing and implementing a comprehensive remediation approach to mitigate residual SPH at the Refinery. For groundwater, design of a groundwater recovery and treatment system is underway. Installation will be initiated in 2022. For soil, remediation activities are scheduled to commence in 2022 and will continue as needed if additional areas of concern are identified.

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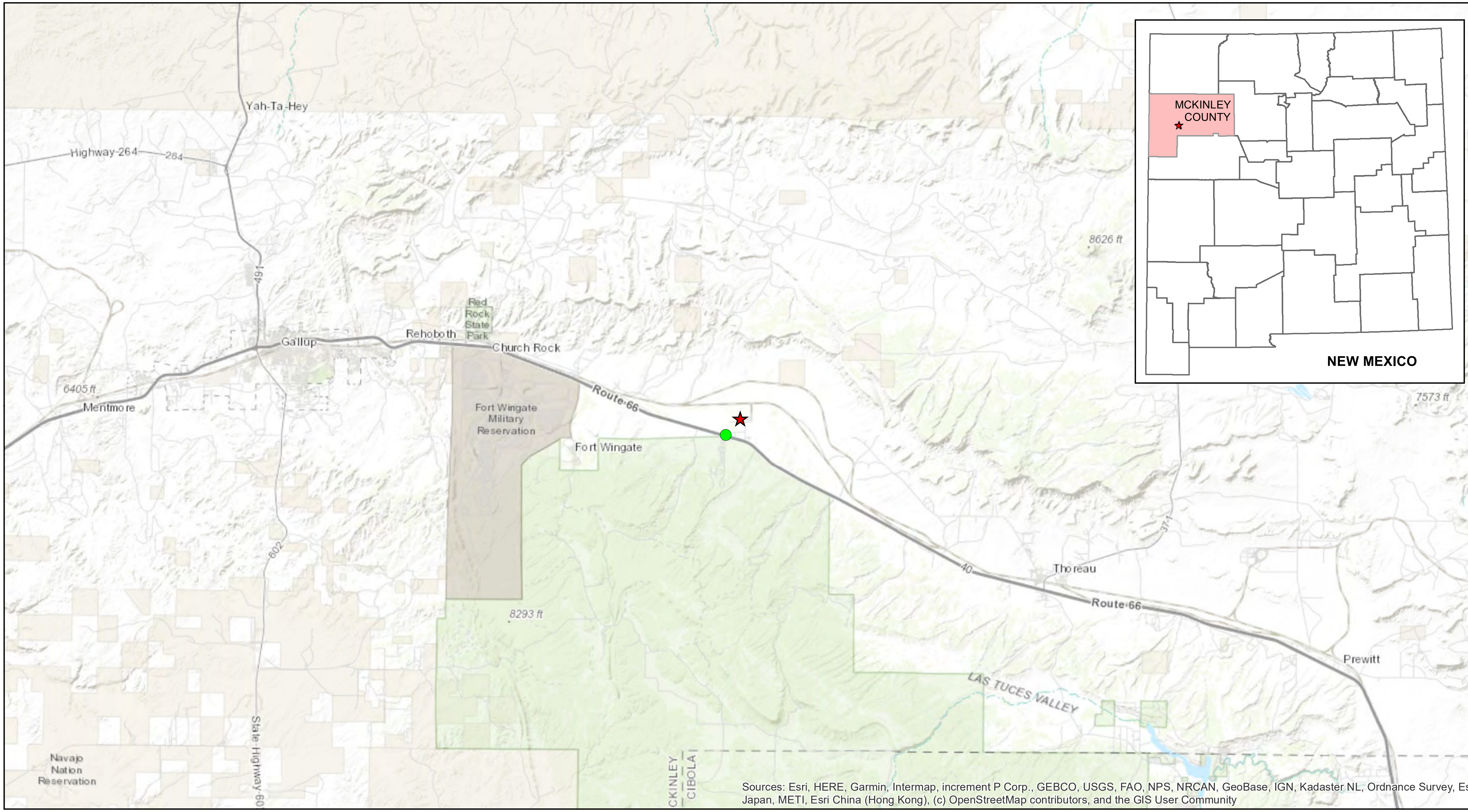
Figures



EXPLANATION

★ MARATHON GALLUP REFINERY

● TRAVEL CENTER

N

0 20,000 '

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FIGURE 1.0-1

MARATHON GALLUP REFINERY - SITE LOCATION

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: KH	Checked By: LA	Scale: 1 " = 20,000 '	Date: 10/29/21	File: 1_SiteLocation_Fig1.mxd

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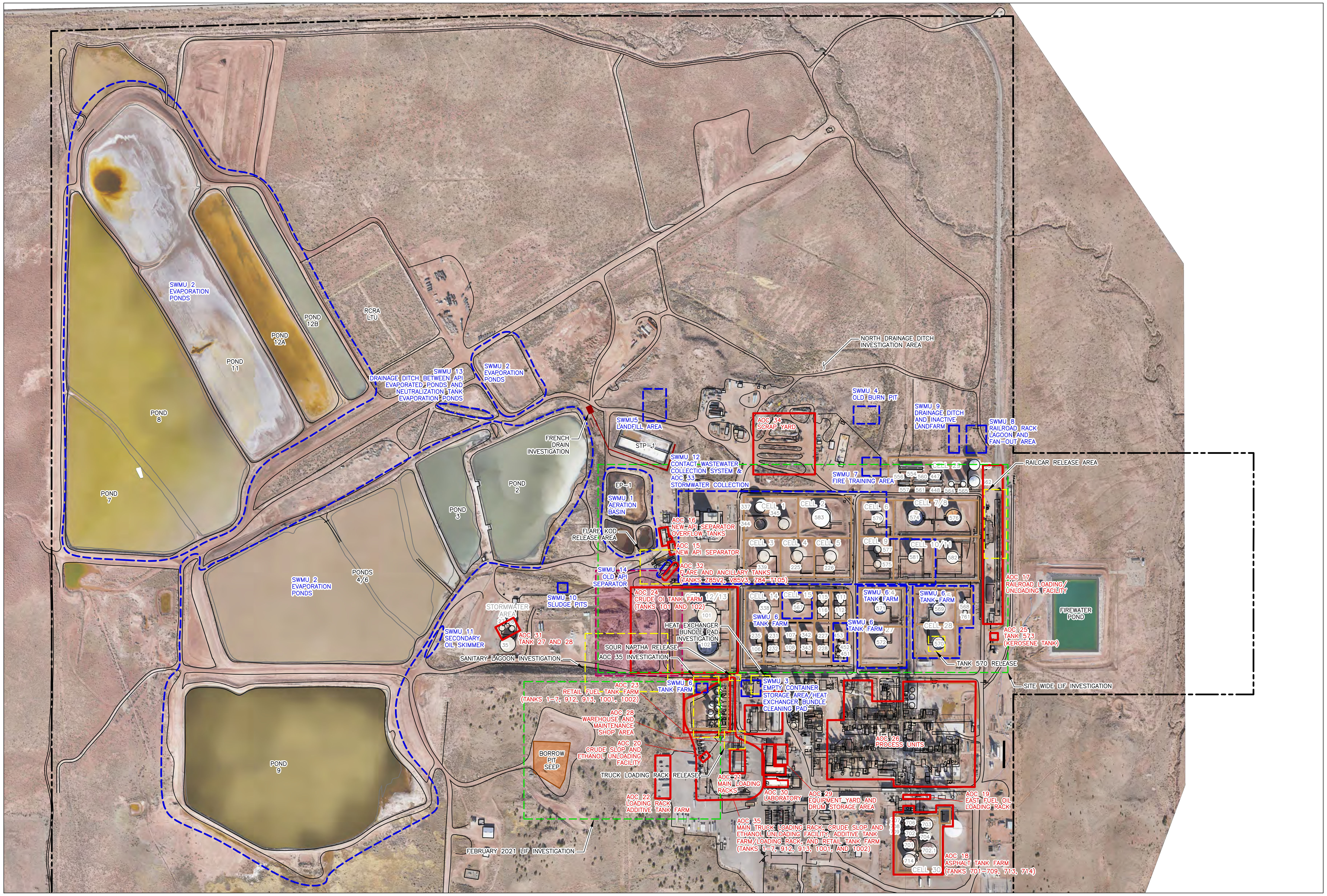

Image Cite: USDA/FSA – Aerial Photography Field Office, NAIP MrSID – Publication: 2014

EXPLANATION

PROPERTY BOUNDARY (APPROXIMATE)	
AOC LOCATION	
SWMU LOCATION	
FRENCH DRAIN	
RELEASE AND/OR INVESTIGATION AREA	
LIF (LASER INDUCED FLUORESCENSE)	
BORROW PIT SEEP (APPROXIMATE)	
HYDROCARBON SEEP AREA	

AOC	AREA OF CONCERN
STP	SANITARY TREATMENT POND
SWMU	SOLID WASTE MANAGEMENT UNIT

NOTE:

THE FOLLOWING WORK INVESTIGATIONS ARE COMPLETED SITE WIDE: GROUNDWATER MONITORING, FENCELINE MONITORING, WEEKLY ON-SITE SUPPORT.

N

0 400' 800'

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FIGURE 2.1-1

SITE MAP

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: REP	Checked By: BM	Scale: 1" = 400'	Date: 10/14/2021	File: 697-CSM-SITEMAP-2021

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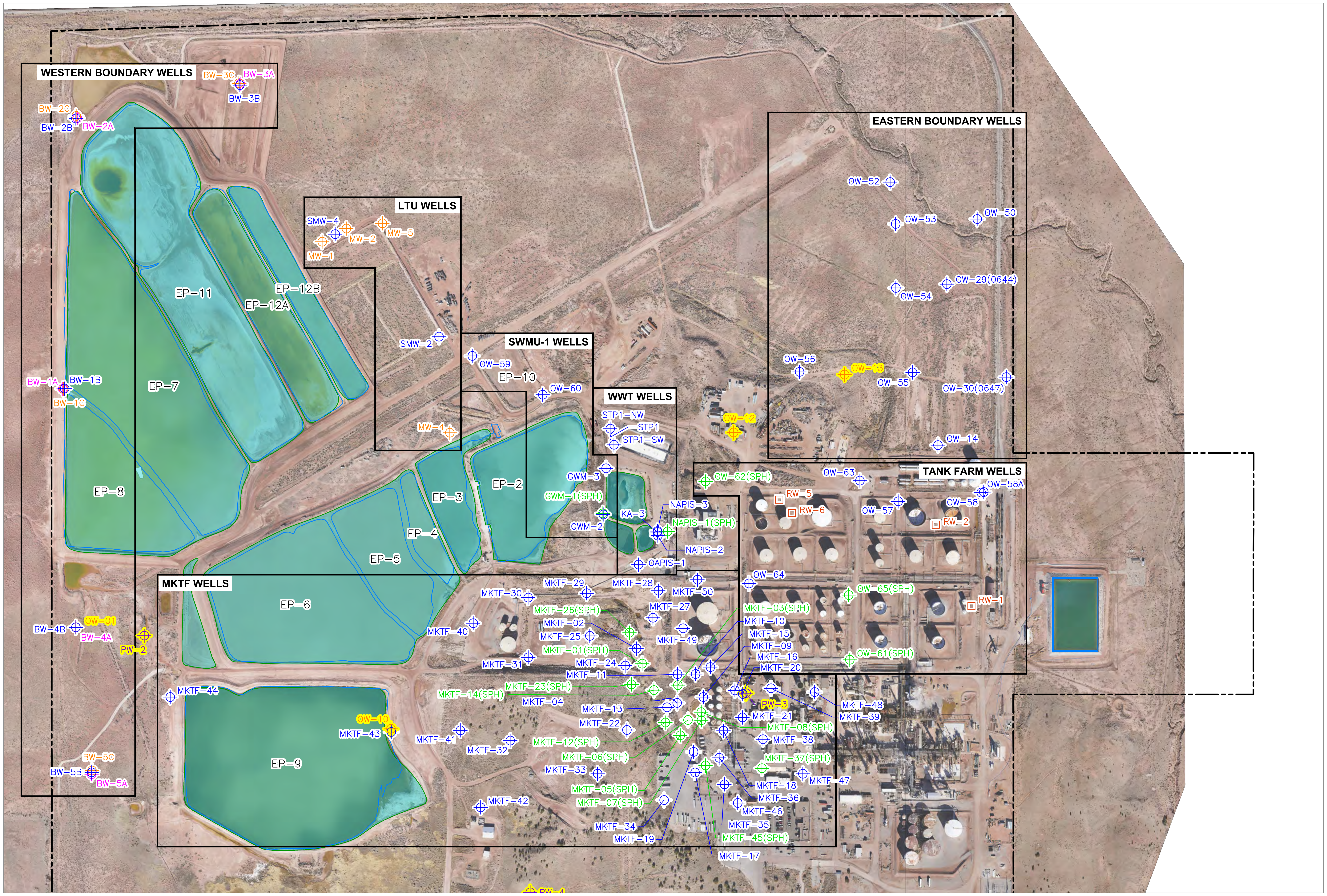

Image Cite: USDA/FSA – Aerial Photography Field Office, NAIP MrSID – Publication: 2014

EXPLANATION

OW-10	SONSELA WELL AND DESIGNATION		SURFACE WATER
OW-11	CHINLE/ALLUVIUM INTERFACE WELL AND DESIGNATION	EP	EVAPORATION POND
SMW-2	ALLUVIAL/FLUVIAL UPPER SAND WELL AND DESIGNATION	LTU	LAND TREATMENT UNIT
MKTF-45	SPH MONITORING WELL AND DESIGNATION	SPH	SEPARATE-PHASE HYDROCARBON (DETECTED IN 2020)
PW-4	RAW WATER PRODUCTION WELL AND DESIGNATION	STP	SANITARY TREATMENT POND
RW-6	RECOVERY WELL AND DESIGNATION	SWMU	SOLID WASTE MANAGEMENT UNIT
	WELL GROUP	WWT	WASTE WATER TREATMENT

NOTE:

DEEP WELL GROUP: PW-2, PW-3, PW-4, OW-1, OW-10, OW-11, OW-12 AND OW-13 ARE SHOWN IN YELLOW HALO.

N

0 400' 800'

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FIGURE 2.2-1

FACILITY AND WELL GROUPS 2021

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: REP	Checked By: LA	Scale: 1" = 400'	Date: 7/27/21	File: 697-GW-FACWELLGROUPS-2021

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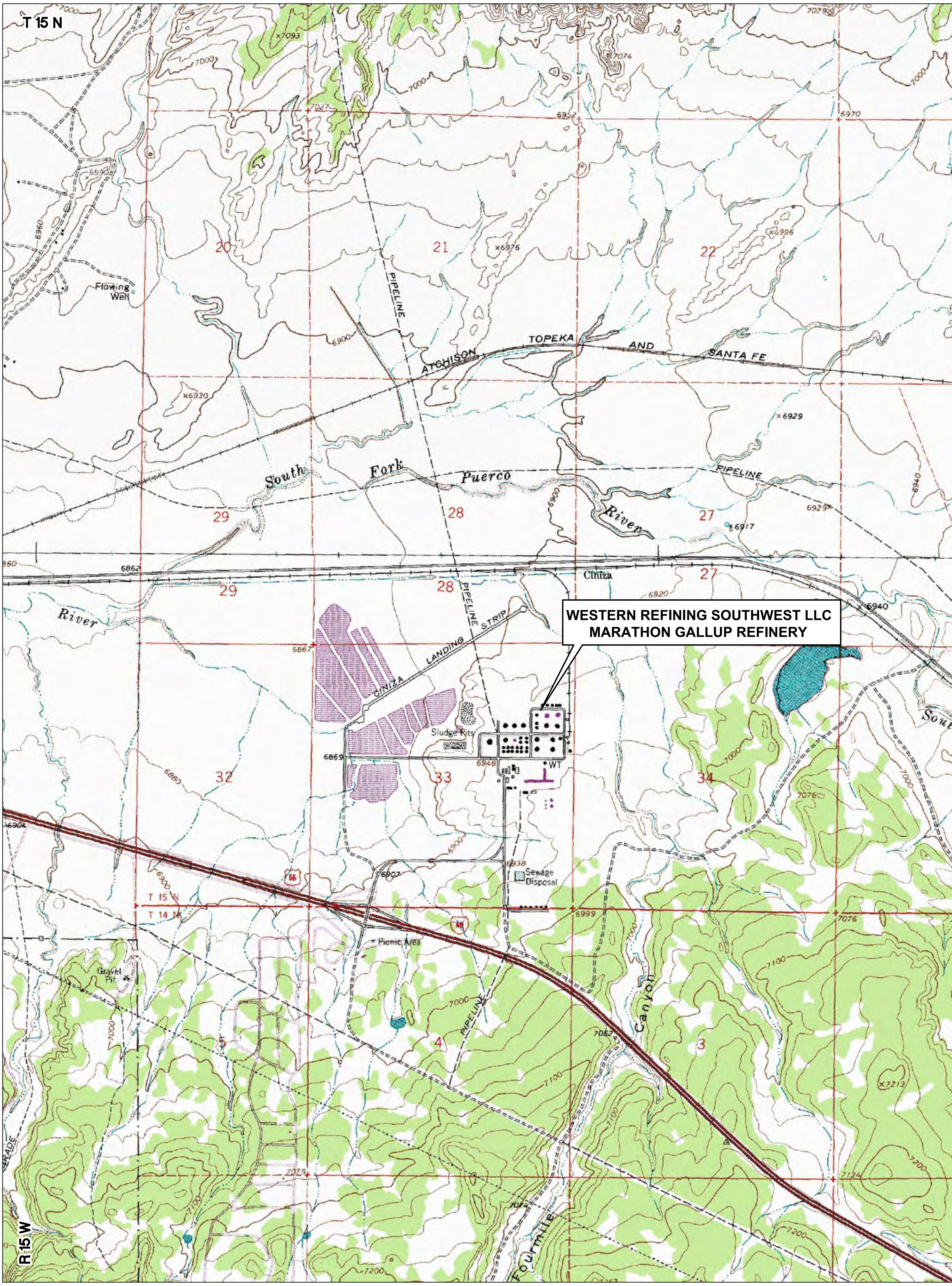
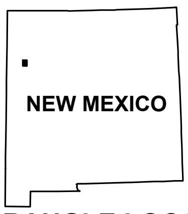


Image Cite: U.S. Geological Survey, 1:24,000–Scale 7.5 Minute Digital Raster Graphic Quadrangle, McKinley County, Publication: 2004

NOTE:
SITE LEGAL DESCRIPTION - TOWNSHIP 15 NORTH, RANGE 15 WEST, SECTION 33, LOWER QUARTER SECTION 28, AND NORTHEAST QUARTER SECTION 4.



QUADRANGLE LOCATION

N

0 2,000'

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FIGURE 3.1-1

SITE LOCATION AND TOPOGRAPHIC MAP

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: REP	Checked By: LA	Scale: 1" = 2,000'	Date: 9/15/21	File: 697-GW-TOPOMAP-2020

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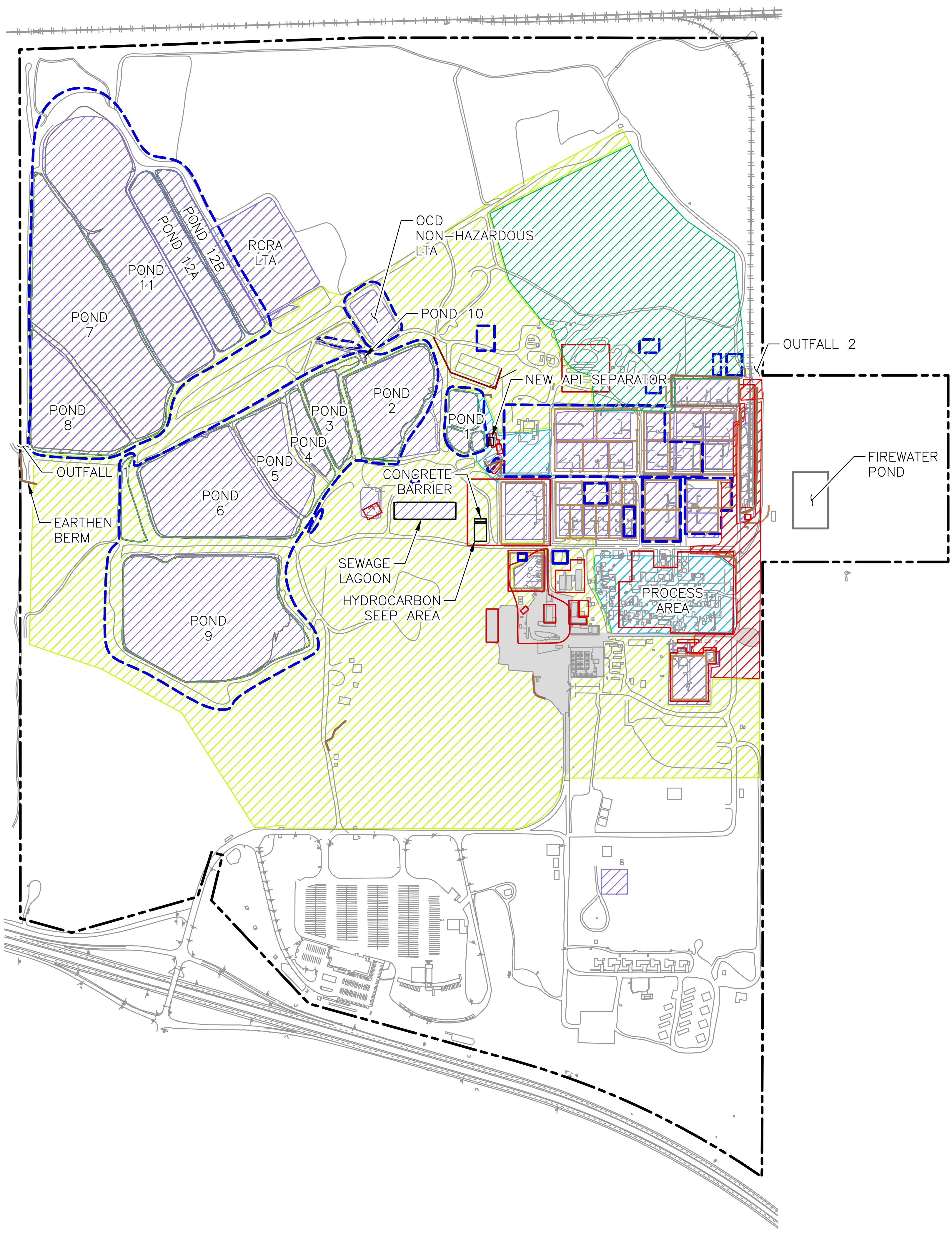

EXPLANATION

- PROPERTY BOUNDARY (APPROXIMATE)
- SOLID WASTE MANAGEMENT UNIT (SWMU)
- AREA OF CONCERN (AOC)
- EARTHEN BERM
- CONTAINED/BERMED AREA, NO STORMWATER RUN OFF DISCHARGED TO ANOTHER POINT
- AREA CONTRIBUTING FLOW TO OUTFALL 2
- DRAINS TO GRASSY AREA, DOES NOT LEAVE SITE
- NEW STORMWATER COLLECTION BASIN
- AREA CONTRIBUTING FLOW TO OUTFALL 1
- PROCESS AREA, STORMWATER DRAINS TO POND 1
- IMPERVIOUS SURFACE

NOTE:

IMPERVIOUS AREAS ARE IDENTIFIED FOR DISCHARGING AREAS ONLY. IMPERVIOUS SURFACES WITHIN AREAS WHERE STORMWATER DOES NOT DISCHARGE HAVE NOT BEEN IDENTIFIED, CONSIDERING THESE AREAS DO NOT PRODUCE REGULATED STORMWATER DISCHARGES.

N

0 800'

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FIGURE 3.2-1

STORMWATER CATCH BASINS 2020

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: REP	Checked By: MS	Scale: 1" = 800'	Date: 11/2/21	File: 697-GW-STRMCTCHBASIN-2021

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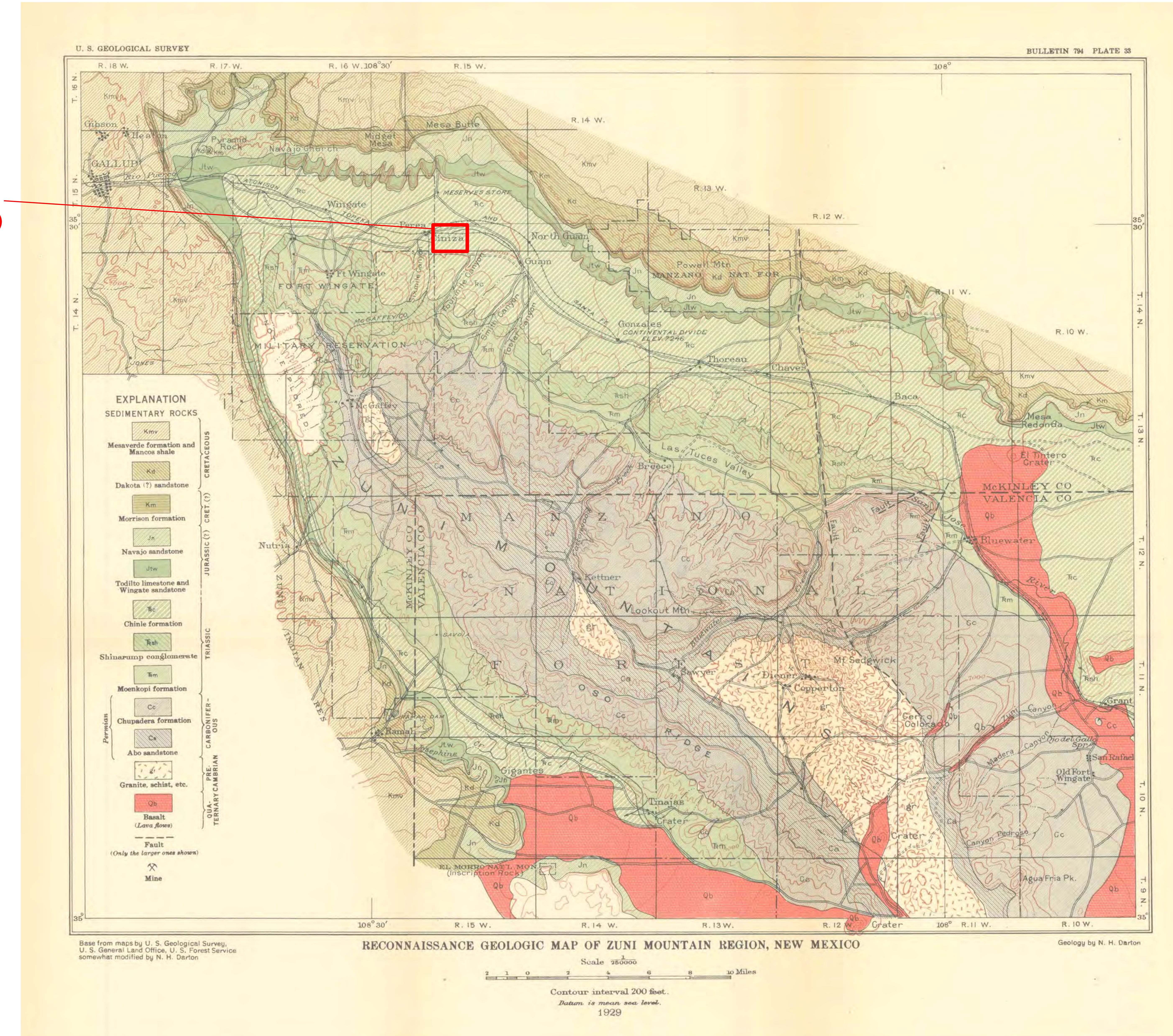
REFINERY SITE
(APPROXIMATE)



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GEOLOGIC MAP FROM: DARTON, N.H. 1928. RED BEDS AND ASSOCIATED FORMATIONS IN NEW MEXICO, WITH AN OUTLINE OF THE GEOLOGY OF THE STATE [ZUNI MOUNTAIN REGION, PL.33], UNITED STATES GEOLOGICAL SURVEY, BULLETIN 794, 1:250,000. HTTPS://NGMDB.USGS.GOV/PRODESC/PRODDESC_20439.HTM

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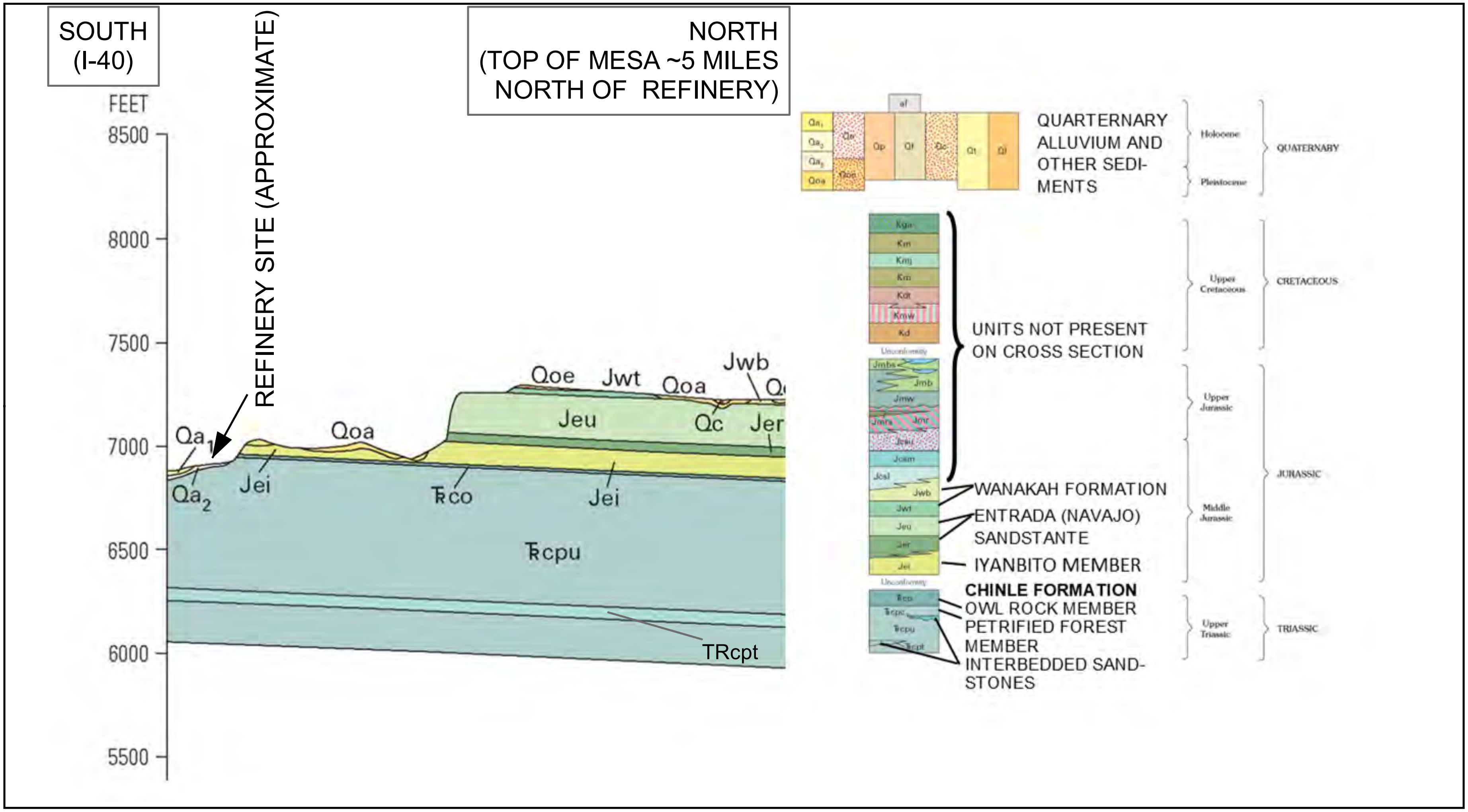
FIGURE 3.3-1

REGIONAL GEOLOGY MAP

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: TM	Checked By: BS	Scale: AS SHOWN	Date: 11/2/21	File: 3.3-1_RegionalGeo.mxd



NOTE:

ADAPTED FROM: ROBERTSON, J.F. 2006, GEOLOGIC MAP OF THE PINEDALE QUADRANGLE, MCKINLEY COUNTY, NEW MEXICO, UNITED STATES GEOLOGICAL SURVEY, MISCELLANEOUS FIELD STUDIES MAP MF-2417, 1:24,000.

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FIGURE 3.3-2

REGIONAL GEOLOGIC CROSS SECTION

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: TM	Checked By: BS	Scale: AS SHOWN	Date: 11/2/21	File: 3.3-2_RegionalGeoXS.mxd

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EXPLANATION

- 05/2021 LIF BORING LOCATION
- 02/2021 LIF BORING LOCATION
- 11/2019 LIF BORING LOCATION
- HISTORICAL BORING
- MONITORING WELL

SPH OCCURRENCE

- DIESEL
- GASOLINE
- NAPHTHA
- RESIDUAL/NO RESPONSE

CROSS-SECTION LINE

- A
- B
- C
- D
- E

NOTES:

-LIF - LASER-INDUCED FLORESCENCE
-SPH - SEPARATE PHASE HYDROCARBON

N

0 160 320'

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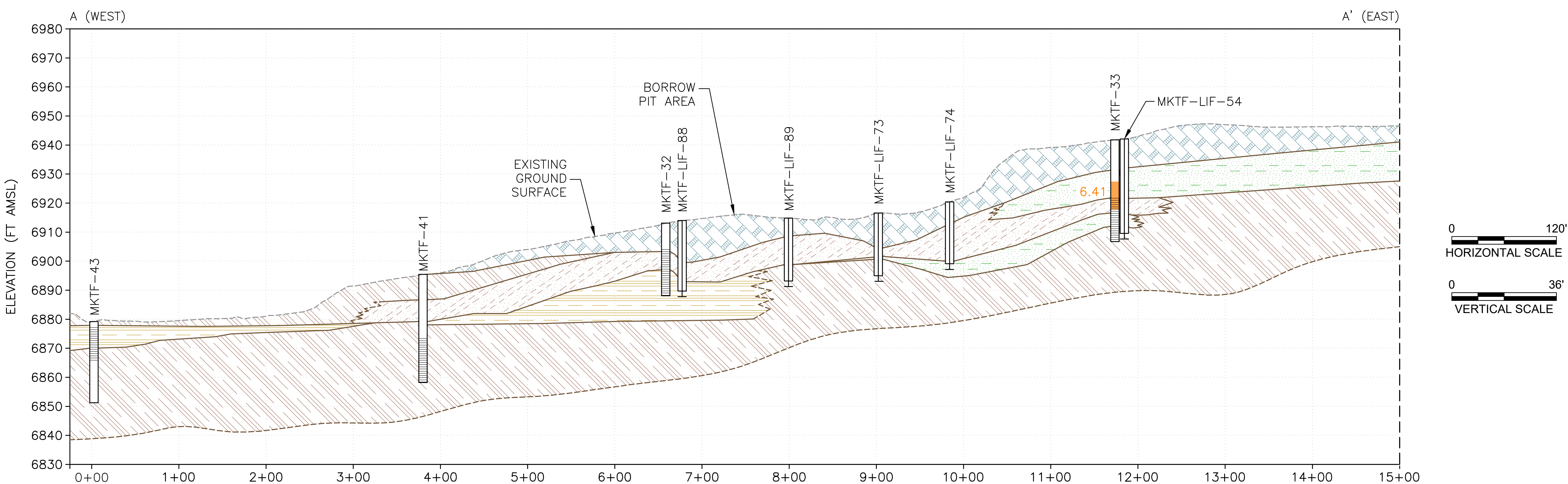
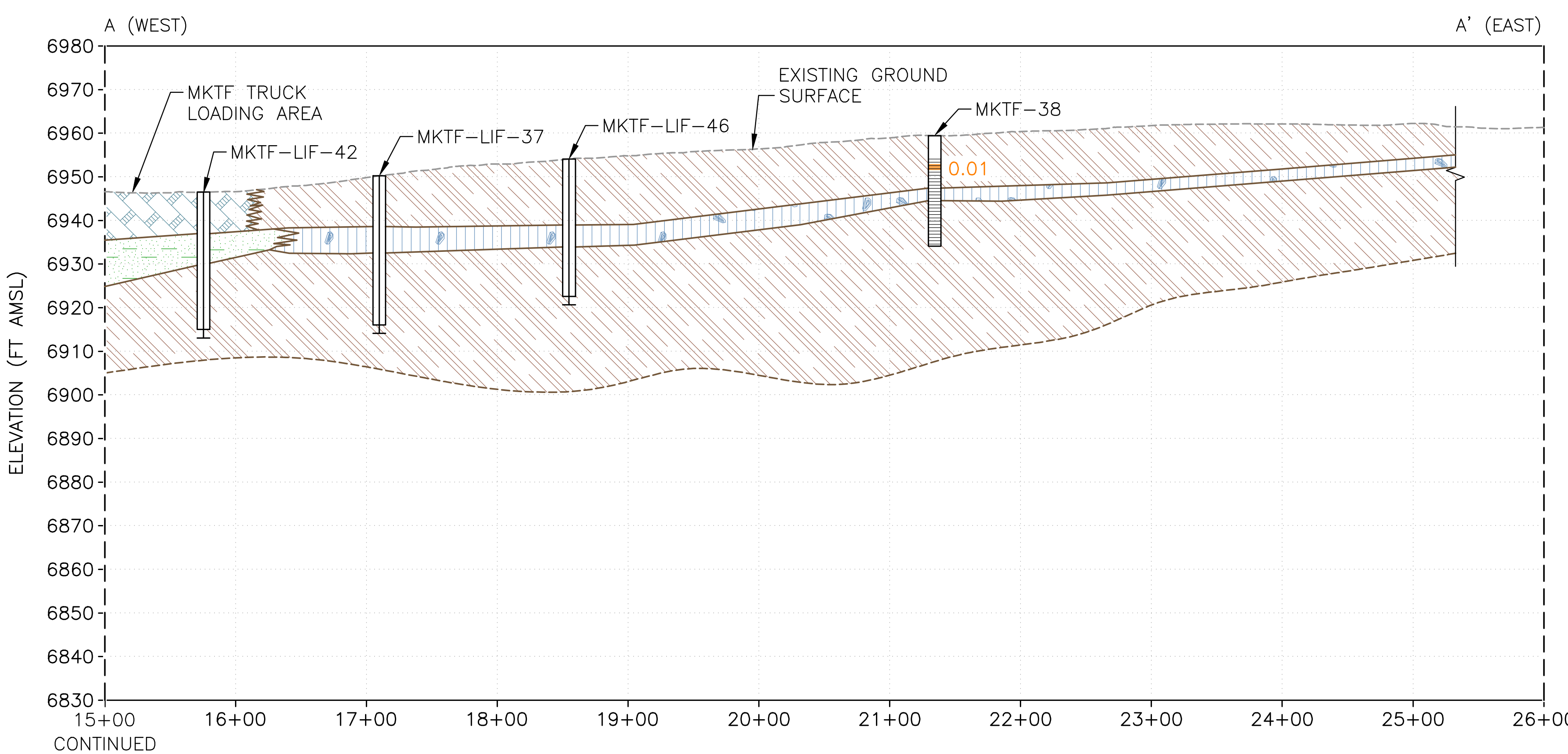
FIGURE 3.3-3

CROSS-SECTION LOCATION MAP

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: KEJ	Checked By: MS	Scale: 1 " = 160 '	Date: 8/13/21	File: 3-2_XSect_Fig3-2_Dsize.mxd





EXPLANATION

MKTF-LIF-46 — DESIGNATION

WELL OR BORING

SCREENED INTERVAL

GEOLOGIC CONTACT (DASHED WHERE INFERRED)

0.01 — HISTORICAL MAXIMUM SPH THICKNESS (SHOWN IN FEET, NOT TO SCALE)

FT AMSL — FEET ABOVE MEAN SEA LEVEL

SPH — SEPARATE PHASE HYDROCARBONS

SILTY CLAY

SANDY CLAY

CLAYEY SAND

SANDY GRAVEL

CLAY

CLAYEY SILT

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FIGURE 3.3-4A

CROSS SECTION A-A'
WITH MAXIMUM HISTORICAL THICKNESS OF SEPARATE PHASE HYDROCARBONS

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: REP	Checked By: WG	Scale: AS SHOWN	Date: 10/18/21	File: 697-XSEC-A-SPH-202107

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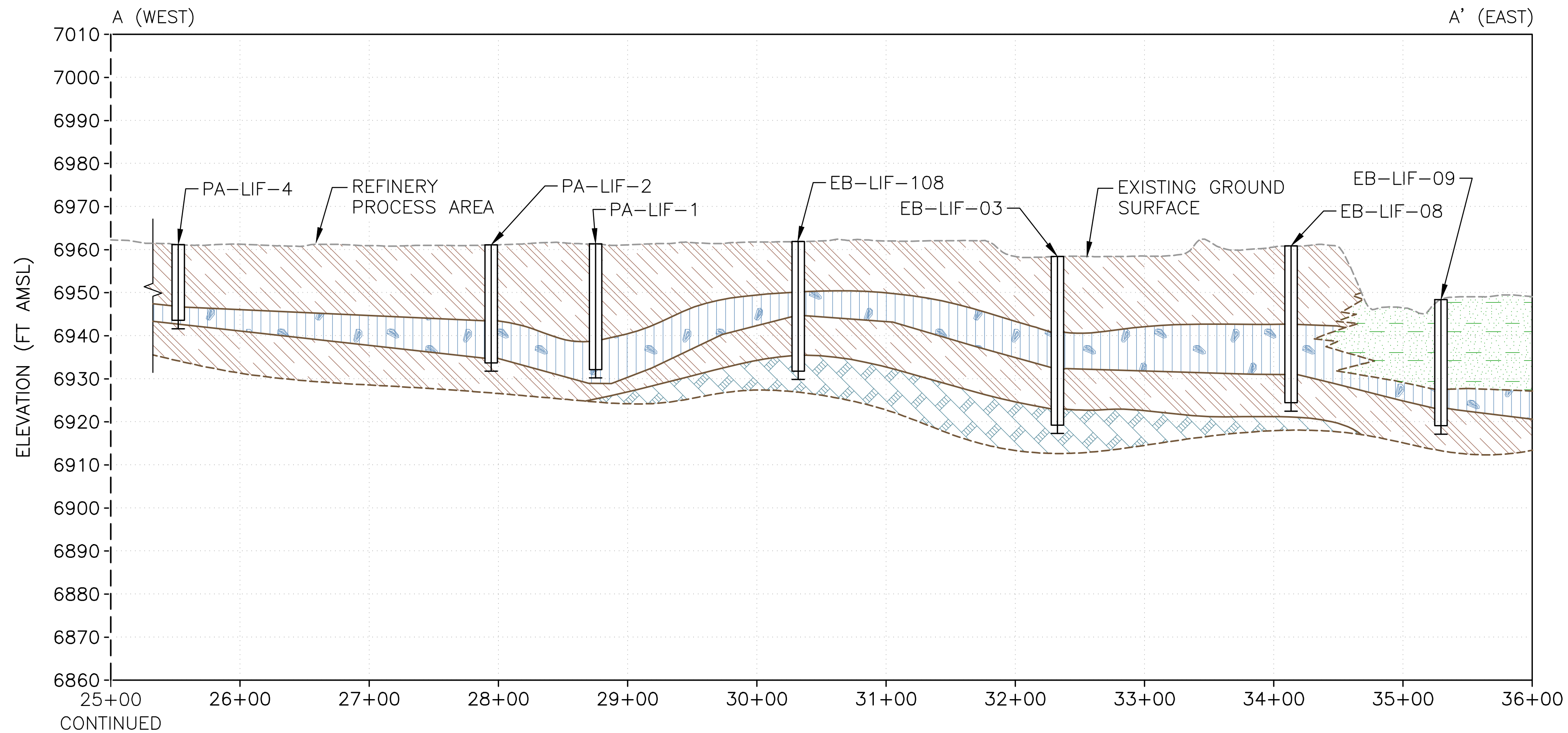

EXPLANATION

EB–LIF–108	DESIGNATION
	WELL OR BORING
	SCREENED INTERVAL
	GEOLOGIC CONTACT (DASHED WHERE INFERRED)
FT AMSL	FEET ABOVE MEAN SEA LEVEL
	SILTY CLAY
	CLAYEY SAND
	SANDY GRAVEL
	CLAYEY SILT

0 120'
HORIZONTAL SCALE

0 36'
VERTICAL SCALE

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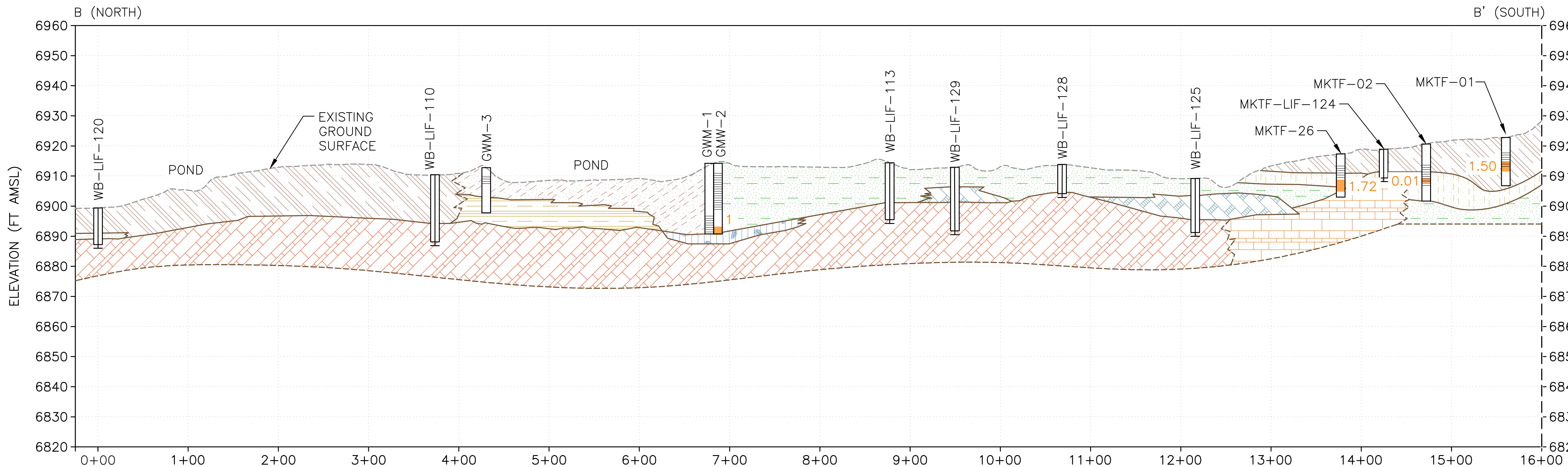
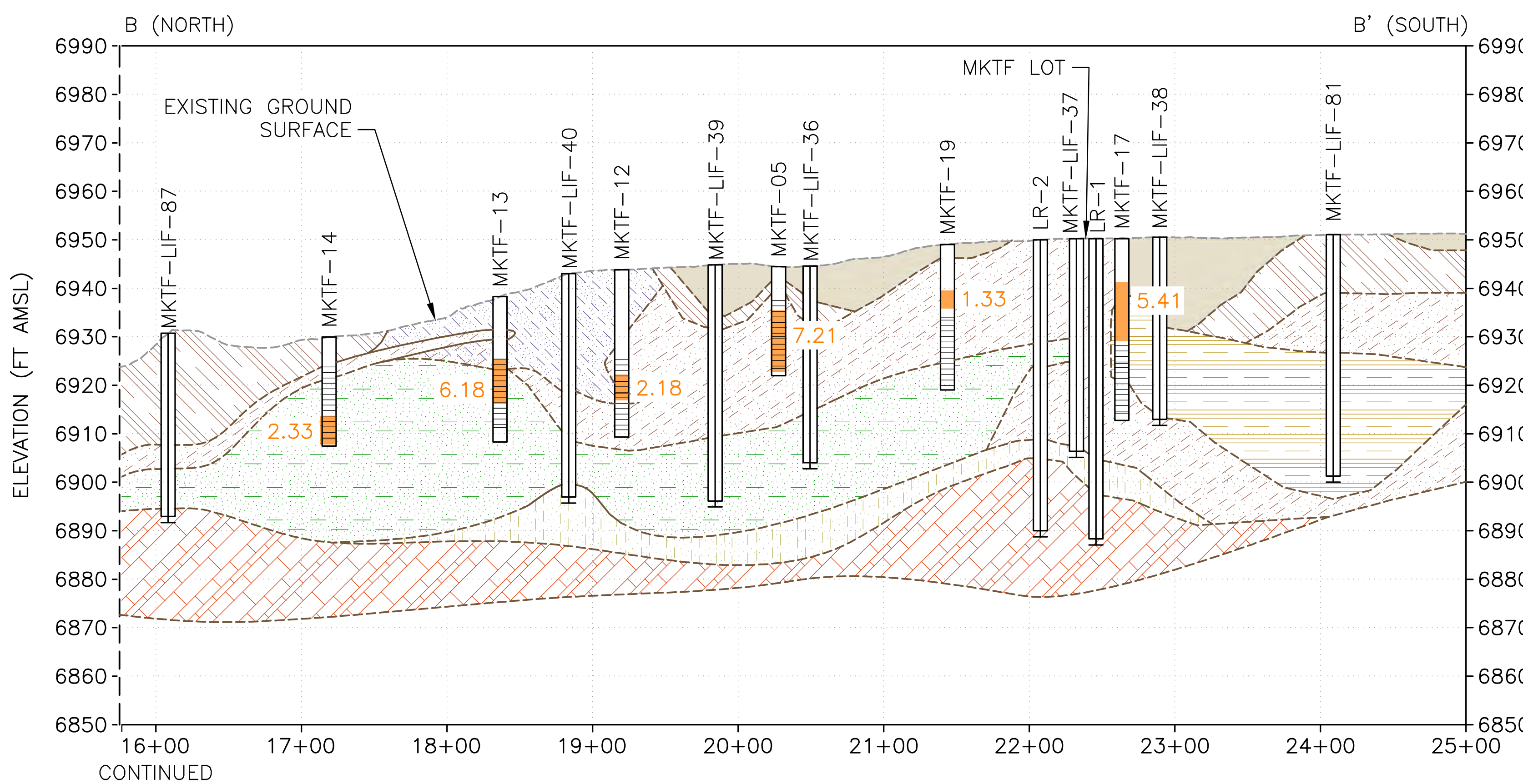
FIGURE 3.3-4B

CROSS SECTION A-A' (CONTINUED) WITH MAXIMUM HISTORICAL THICKNESS OF SEPARATE PHASE HYDROCARBONS

WESTERN REFINING SOUTHWEST LLC MARATHON GALLUP REFINERY GALLUP, NEW MEXICO

Drawn By: REP	Checked By: WG	Scale: AS SHOWN	Date: 10/18/21	File: 697-XSEC-A-SPH-202107





EXPLANATION

0 120'
HORIZONTAL SCALE

0 36'
VERTICAL SCALE

MKTF-LIF-81 — DESIGNATION

WELL OR BORING

SCREENED INTERVAL

GEOLOGIC CONTACT (DASHED WHERE INFERRED)

5.41 — HISTORICAL MAXIMUM SPH THICKNESS (SHOWN IN FEET, NOT TO SCALE)

FT AMSL — FEET ABOVE MEAN SEA LEVEL

SPH — SEPARATE PHASE HYDROCARBONS

- FILL
- SILTY CLAY
- SANDY CLAY
- CLAYEY SAND
- SANDY CLAY/ WEATHERED BEDROCK
- SHALE/ MUDSTONE
- CLAY
- SANDY SILT
- CLAYEY SILT
- SILTSTONE
- SANDY GRAVEL

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FIGURE 3.3-5

CROSS SECTION B-B' WITH MAXIMUM HISTORICAL THICKNESS OF SEPARATE PHASE HYDROCARBONS

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: REP	Checked By: WG	Scale: AS SHOWN	Date: 11/2/21	File: 697-XSEC-B-SPH-202107

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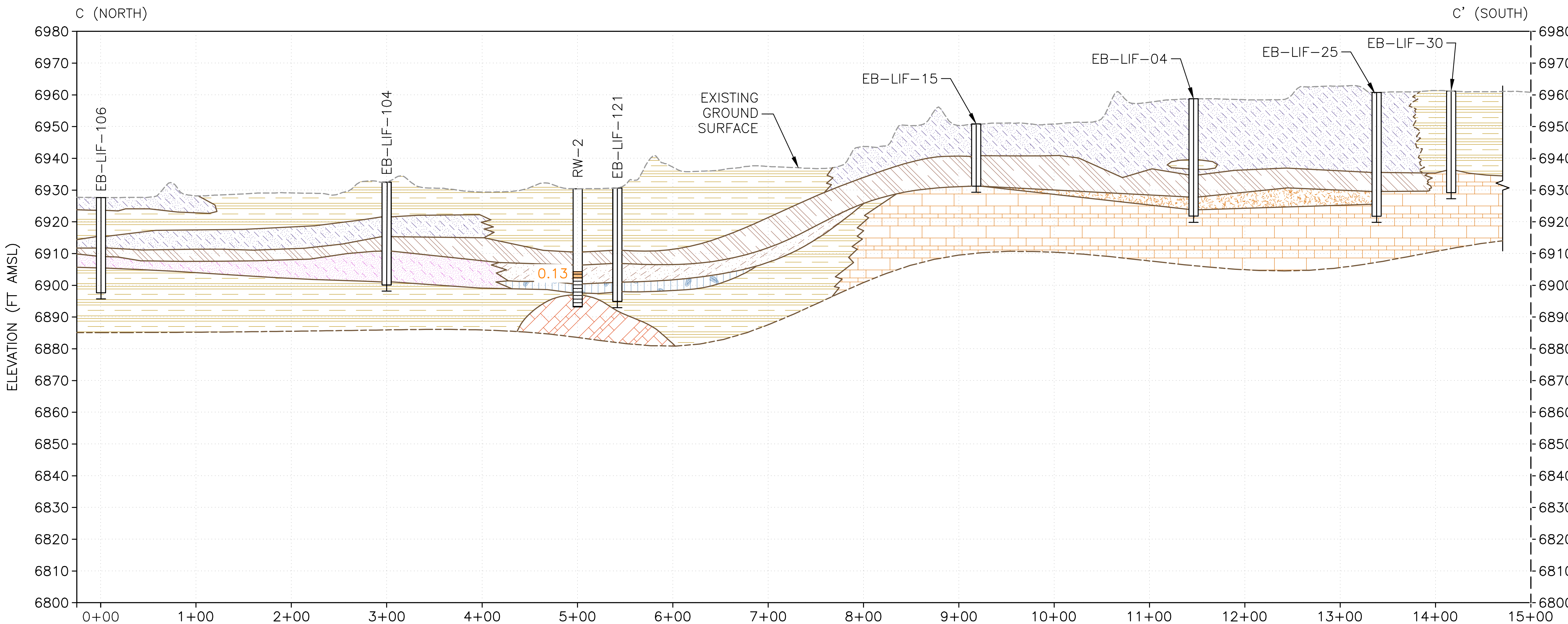

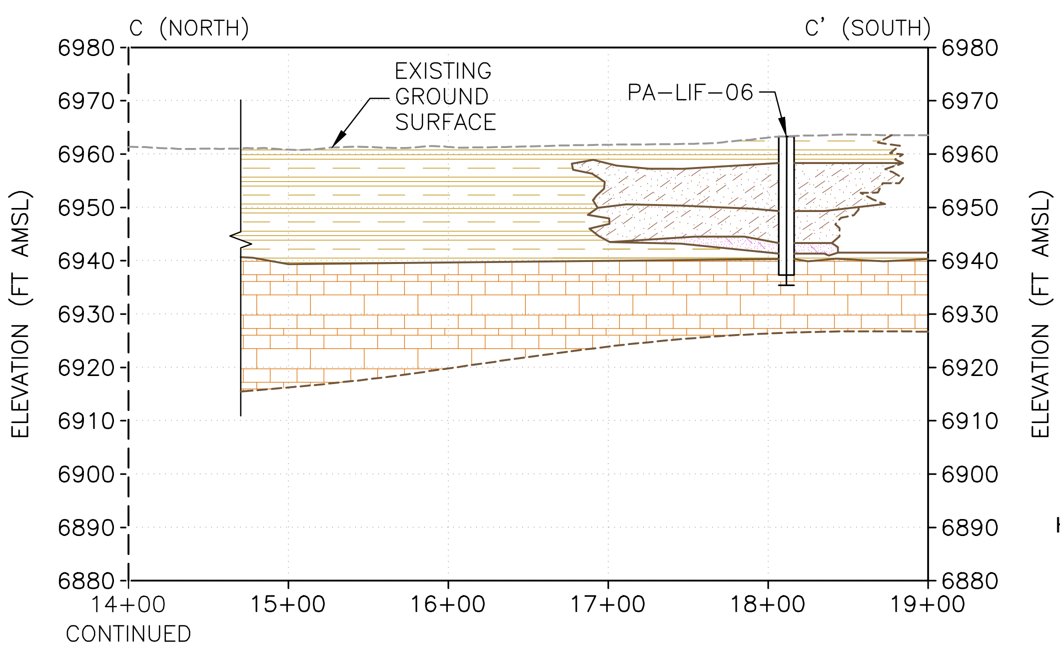

0 120'
HORIZONTAL SCALE

0 36'
VERTICAL SCALE

EB-LIF-121 ← DESIGNATION

WELL OR BORING

SCREENED INTERVAL

GEOLOGIC CONTACT (DASHED WHERE INFERRED)

0.13 HISTORICAL MAXIMUM SPH THICKNESS (SHOWN IN FEET, NOT TO SCALE)

FT AMSL FEET ABOVE MEAN SEA LEVEL

SPH SEPARATE PHASE HYDROCARBONS

EXPLANATION

- SILTY CLAY
- SANDY CLAY
- SANDY GRAVEL
- SHALE/ MUDSTONE
- CLAY
- SANDY SILT
- SILTY SAND
- SILT
- SILTSTONE

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FIGURE 3.3-6

CROSS SECTION C-C' WITH MAXIMUM HISTORICAL THICKNESS OF SEPARATE PHASE HYDROCARBONS

WESTERN REFINING SOUTHWEST LLC MARATHON GALLUP REFINERY GALLUP, NEW MEXICO

Drawn By: REP	Checked By: WG	Scale: AS SHOWN	Date: 10/18/21	File: 697-XSEC-C-SPH-202107

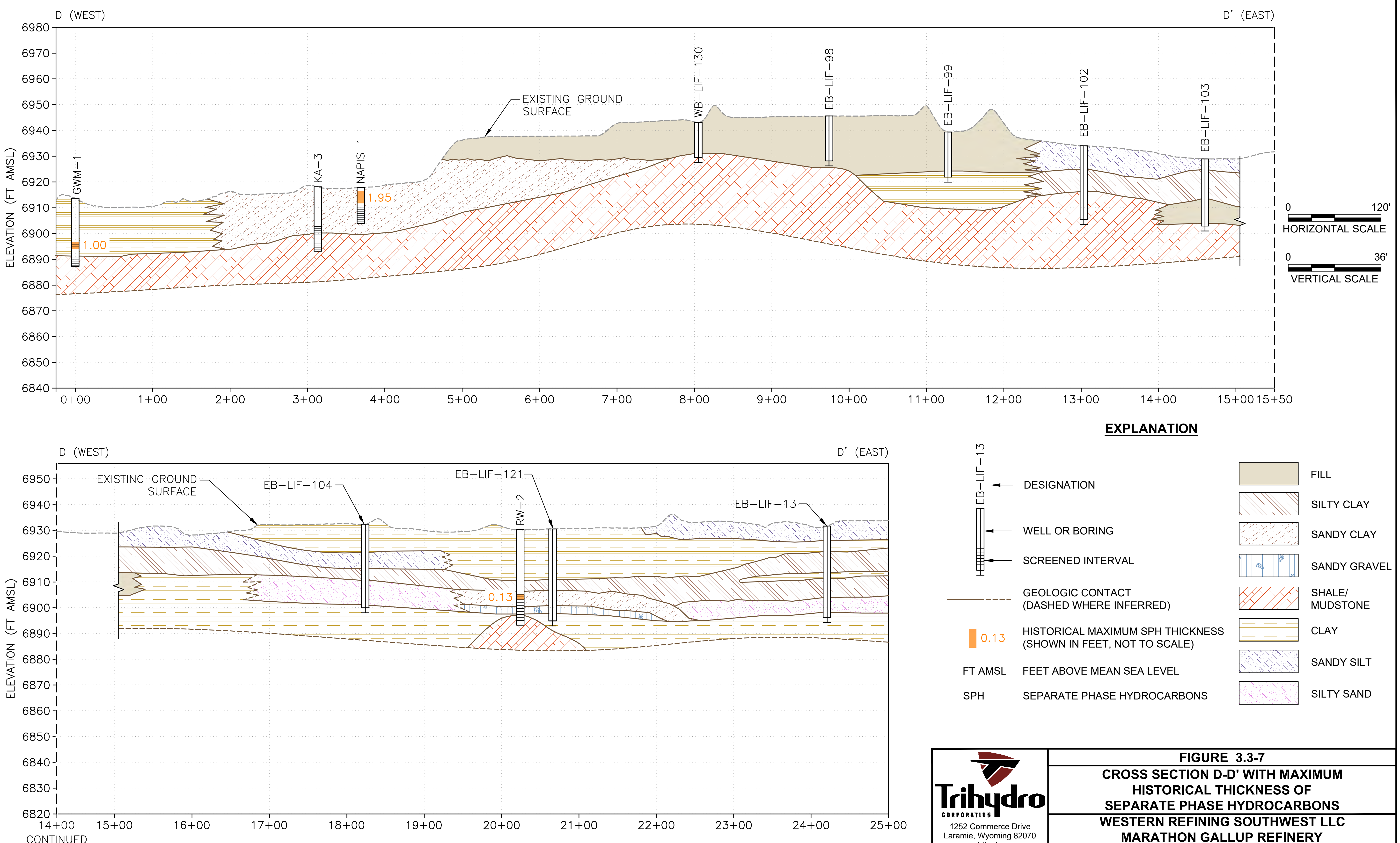

FIGURE 3.3-7
CROSS SECTION D-D' WITH MAXIMUM HISTORICAL THICKNESS OF SEPARATE PHASE HYDROCARBONS
WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

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Drawn By: REP	Checked By: WG	Scale: AS SHOWN	Date: 10/18/21	File: 697-XSEC-D-SPH-202107

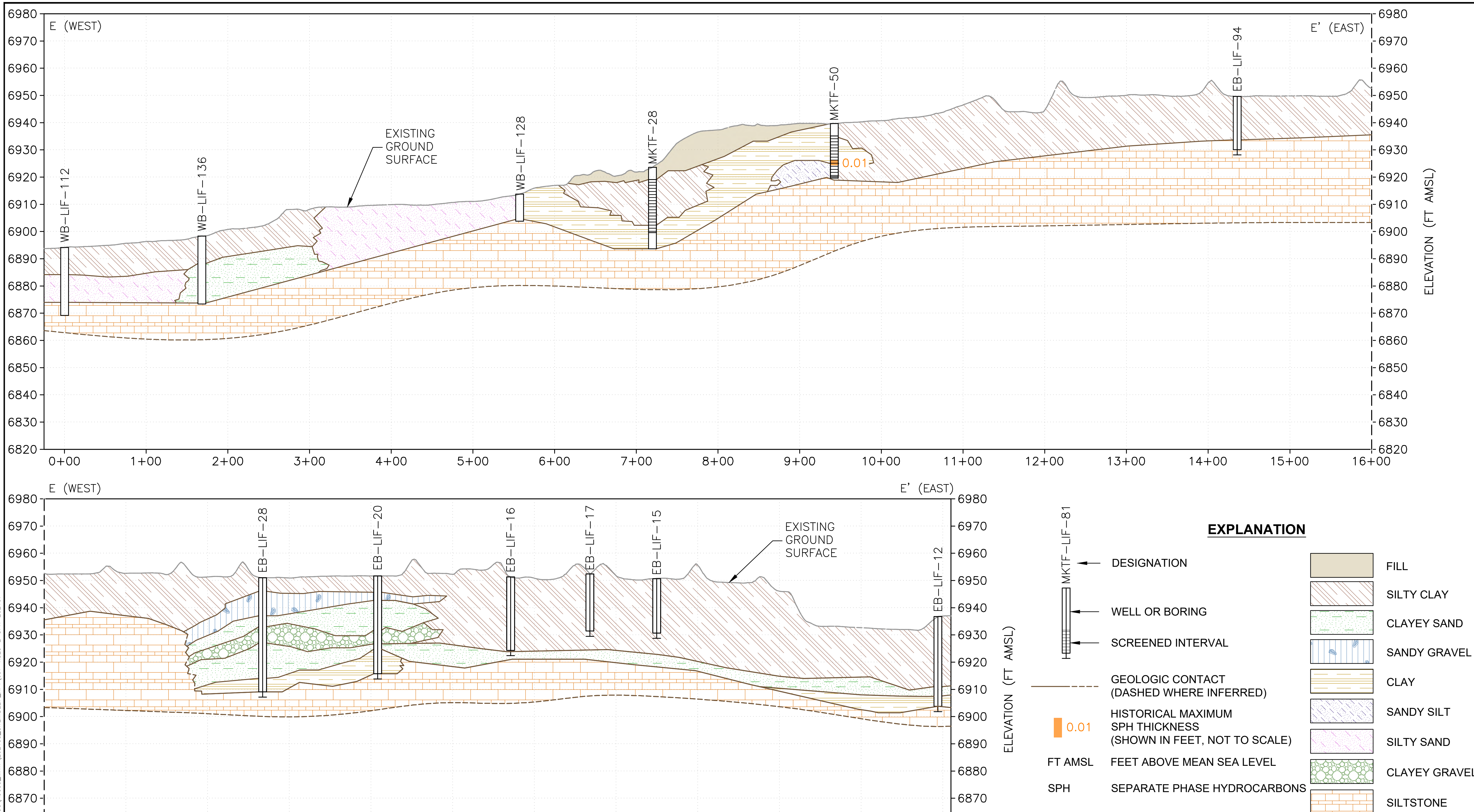

FIGURE 3.3-8

CROSS SECTION E-E' WITH MAXIMUM HISTORICAL THICKNESS OF SEPARATE PHASE HYDROCARBONS

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MARATHON GALLUP REFINERY
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Drawn By: REP	Checked By: WG	Scale: AS SHOWN	Date: 10/18/21	File: 697-XSEC-E-SPH-202107

EXPLANATION

● BW-5A DRY — MONITORING WELL AND DESIGNATION (SHOWING GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL)

N

0 400'

NOTE:

1. GROUNDWATER ELEVATIONS SURFACE GENERATED USING 3RD QUARTER ANNUAL MONITORING EVENT.

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FIGURE 3.3-9

ALLUVIAL / FLUVIAL UPPER SAND AQUIFER GROUNDWATER ELEVATIONS MAP (2020)

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: SB	Checked By: CF	Scale: 1" = 400'	Date: 7/27/21	File: 697-G-GW_PS-MAPALLUVIAL-202009

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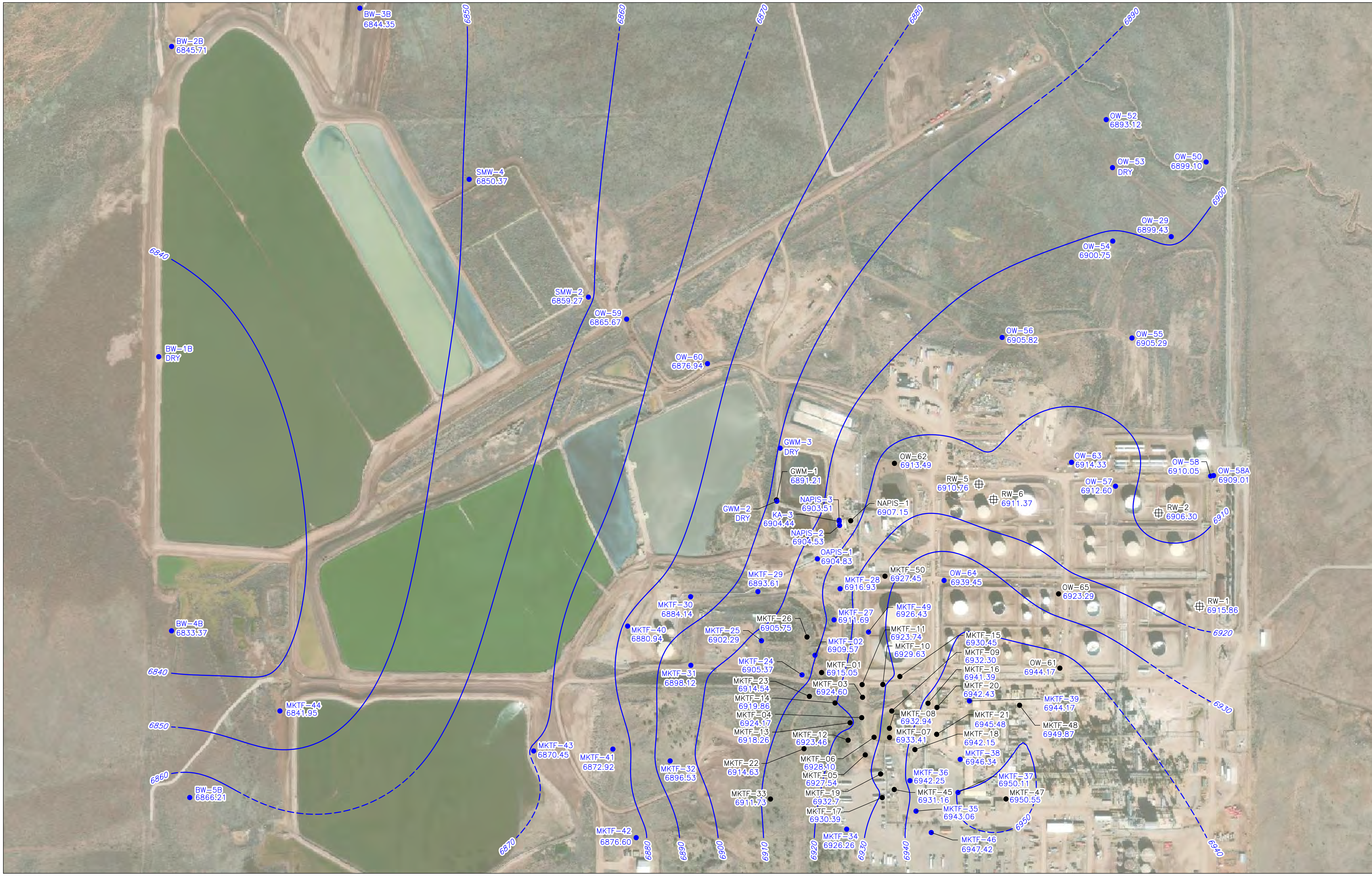

EXPLANATION

BW-5B 6866.21	CHINLE / ALLUVIUM INTERFACE WELL AND DESIGNATION (ELEVATION IN FEET ABOVE MEAN SEA LEVEL)
MKTF-06	SPH MONITORING WELL AND DESIGNATION
RW-1	RECOVERY WELL
6875	LINE OF EQUAL ELEVATION OF POTENTIOMETRIC SURFACE (FEET ABOVE MEAN SEA LEVEL, DASHED WHERE INFERRED)
SPH	SEPARATE-PHASE HYDROCARBON

NOTE:

1. POTENTIOMETRIC SURFACE GENERATED USING 3RD QUARTER ANNUAL MONITORING EVENT.

N

0 300' 600'

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FIGURE 3.3-10

CHINLE/ALLUVIUM INTERFACE AQUIFER POTENTIOMETRIC SURFACE MAP (2020)

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: SB	Checked By: CF	Scale: 1" = 200'	Date: 8/17/2021	File:697-G-GW_PS-MAPCHINLE-202009

M:\TON\MARATHON\CADD\GALLUP_REPORTS\2020_ANNUALREPORT\697-G-GW_PS-MAPCHINLE-202009

NOTE:

1. POTENTIOMETRIC SURFACE GENERATED USING 3RD QUARTER ANNUAL MONITORING EVENT.
2. OW-01 AND OW-10 NOT INCLUDED IN CONTOUR DUE TO ARTESIAN CONDITIONS PRESENT.

N

0 600'

EXPLANATION

BW-5C 6872.49	MONITORING WELL AND DESIGNATION (SHOWING GROUNDWATER ELEVATION IN FT AMSL)
PW-4	RAW WATER PRODUCTION WELL AND DESIGNATION
6875	LINE OF EQUAL ELEVATION OF POTENTIOMETRIC SURFACE (FEET ABOVE MEAN SEA LEVEL, DASHED WHERE INFERRED)
NM	NOT MEASURED

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FIGURE 3.3-11

SONSELA AQUIFER POTENTIOMETRIC SURFACE MAP (2020)

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: SB	Checked By: CF	Scale: 1" = 600'	Date: 8/17/21	File: 697-G-GW_PS-MAPSONSELA-202009

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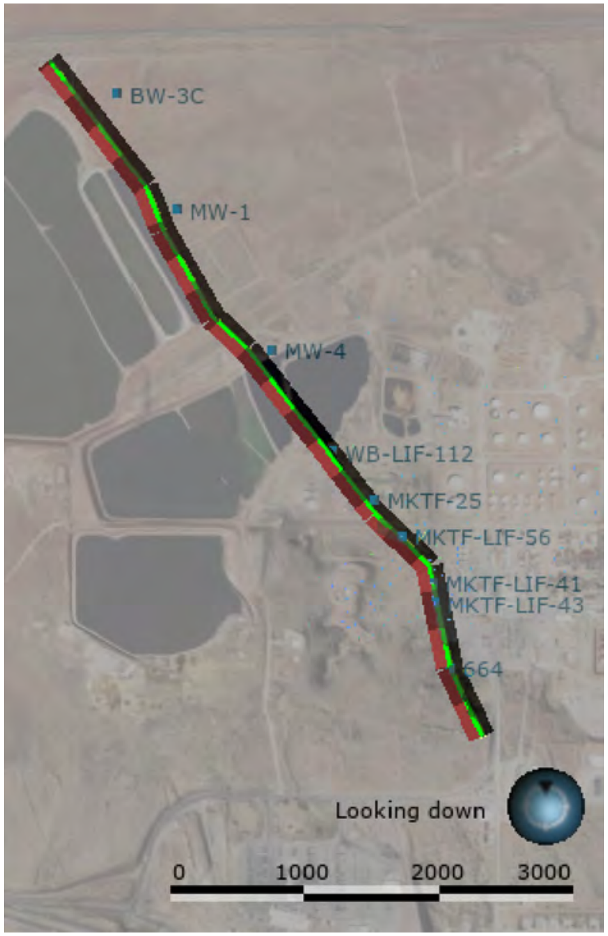

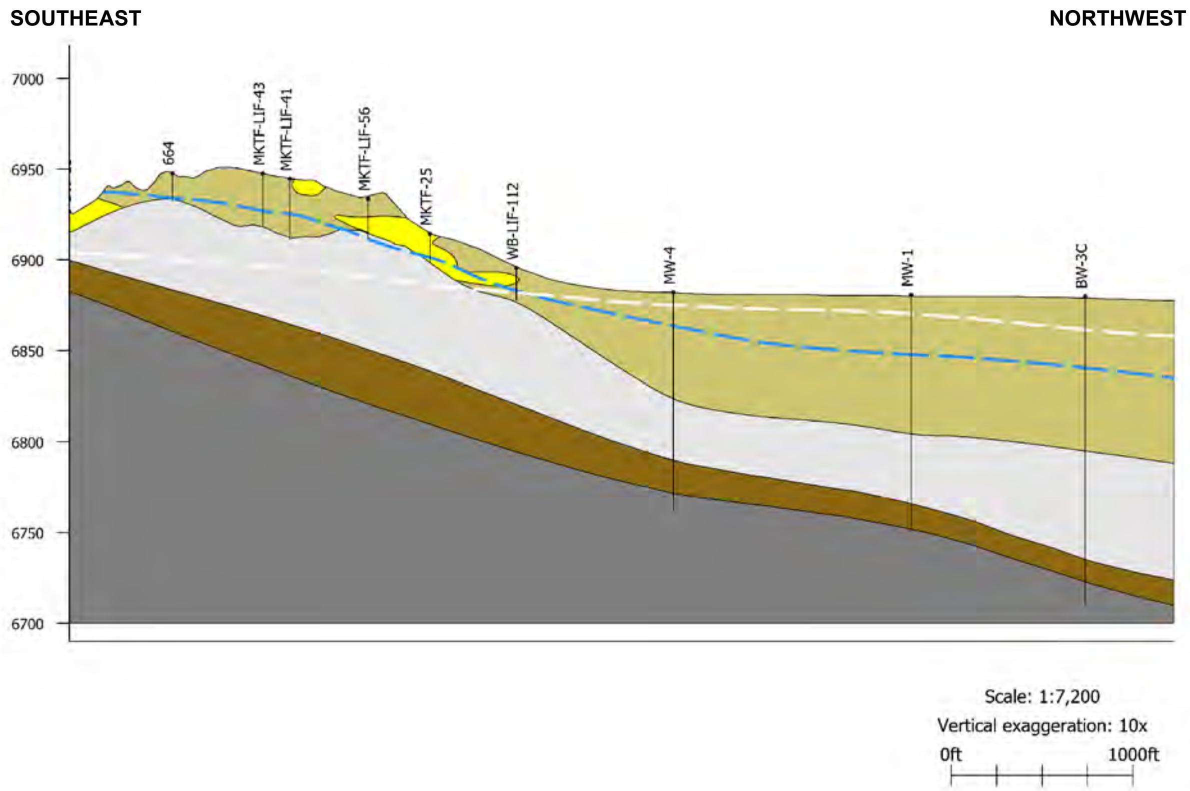

EXPLANATION

MKTF-25 — BORING ID

DEPTH OF CASING

SONSELA AQUIFER POTENTIOMETRIC SURFACE

CHINLE/ALLUVIUM POTENTIOMETRIC SURFACE

LITHOLOGY

- CHINLE / ALLUVIUM (COARSE)
- CHINLE / ALLUVIUM (FINE)
- PETRIFIED FOREST MEMBER, UPPER
- SONSELA SANDSTONE
- PETRIFIED FOREST MEMBER, LOWER

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FIGURE 3.3-12

HYDRAULIC CROSS SECTION

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: TM	Checked By: BS	Scale: AS SHOWN	Date: 11/2/21	File: 3.3-12_HydraulicXSect.mxd

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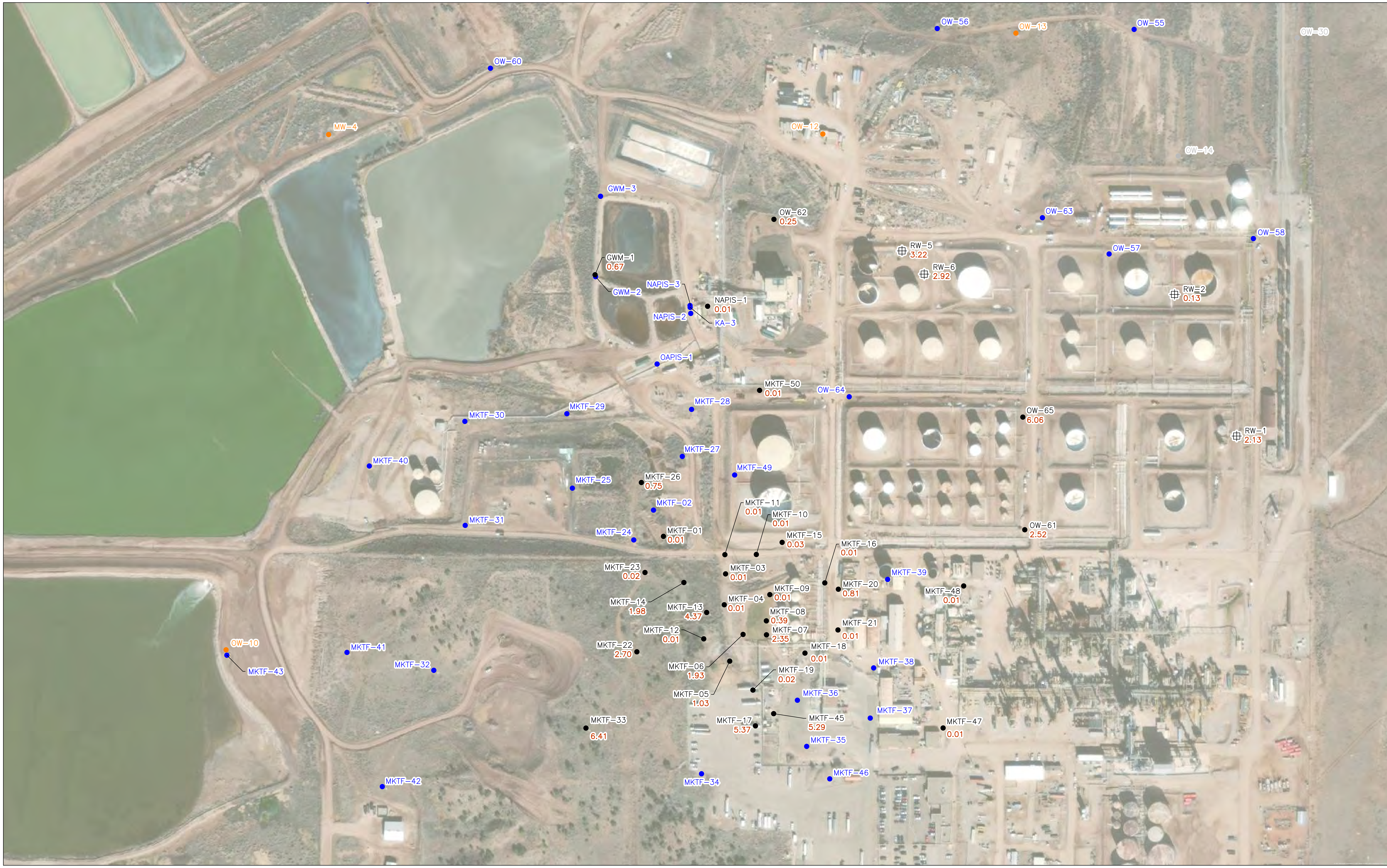

EXPLANATION

MKTF-06 6.57	SPH MONITORING WELL AND DESIGNATION (SHOWING SPH THICKNESS IN FEET)
MKTF-17	CHINLE / ALLUVIUM INTERFACE WELL AND DESIGNATION
OW-10	SONSELA WELL AND DESIGNATION
BW-4A	ALLUVIAL/FLUVIAL UPPER SAND WELL AND DESIGNATION
RW-1	RECOVERY WELL
SPH	SEPARATE-PHASE HYDROCARBON

NOTES:

1. WELLS NOT MEASURED IN THIS EVENT ARE SHOWN IN GRAY COLOR.
2. WELL BW-4B IS APPROXIMATELY 2,175 FEET WEST OF WELL MKTF-40.

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FIGURE 3.4-1

SPH THICKNESS MAP (2020)
3RD QUARTER 2020

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: REP	Checked By: CF	Scale: 1" = 200'	Date: 8/17/2021	File: 697-G-GW_SPH-ISOCONT-202009

EXPLANATION

ARSENIC SURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 1.45 - 5
- 5 - 8
- 8 - 12
- 12 - 15
- 15 - 17.5

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR ARSENIC IS 7.07 mg/kg AND THE ISSL IS 35.9 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

N

0 100 200'

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FIGURE 3.6-1

MEAN ARSENIC CONCENTRATIONS IN SURFACE SOIL

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MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: BR	Checked By: LA	Scale: 1" = 100'	Date: 11/12/21	File: 3.6-1_As_Soil_Surf_Dsize

EXPLANATION

ARSENIC SUBSURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 1.30 - 7
- 7 - 12
- 12 - 16
- 16 - 21
- 21 - 25

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR ARSENIC IS 7.07 mg/kg AND THE ISSL IS 35.9 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

N

0 150 300'

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FIGURE 3.6-2

MEAN ARSENIC CONCENTRATIONS IN SUBSURFACE SOIL

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 150'	Date: 11/12/21	File: 3.6-2_As_Soil_SurfSurf_Dsize

EXPLANATION

BENZENE SURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 0 - 0.7
- 0.7 - 1.4
- 1.4 - 2.1
- 2.1 - 2.8
- 2.8 - 3.6

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR BENZENE IS 17.8 mg/kg AND THE ISSL IS 87.2 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

N

0 100 200'

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FIGURE 3.6-3

MEAN BENZENE CONCENTRATIONS IN SURFACE SOIL

WESTERN REFINING SOUTHWEST LLC MARATHON GALLUP REFINERY GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 100'	Date: 11/12/21	File: 3.6-3_Benz_Soil_Surf_Dsize

EXPLANATION

BENZENE SUBSURFACE SOIL SAMPLE LOCATIONS FOLLOWED BY CONCENTRATIONS (mg/kg)

- 0 - 0.4
- 0.4 - 0.8
- 0.8 - 1.2
- 1.2 - 1.6
- 1.6 - 2.09

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR BENZENE IS 17.8 mg/kg AND THE ISSL IS 87.2 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

N

0 150 300'

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FIGURE 3.6-4

MEAN BENZENE CONCENTRATIONS IN SUBSURFACE SOIL

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 150'	Date: 11/12/21	File: 3.6-4_Benz_Soil_SubSurf_Dsize

EXPLANATION

BTEXN SURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 0 - 18
- 18 - 34
- 34 - 50
- 50 - 68
- 68 - 86

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-BTEXN - BENZENE TOLUENE ETHYLBENZENE XYLENES AND NAPHTHALENE
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.

N

0 100 200'

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FIGURE 3.6-5

MEAN BTEXN CONCENTRATIONS IN SURFACE SOIL

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MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: BR	Checked By: LA	Scale: 1" = 100'	Date: 11/12/21	File: 3.6-5_BTEXN_Soil_Surf_Dsize

EXPLANATION

BTEXN SUBSURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 2.73 - 270
- 270 - 540
- 540 - 810
- 810 - 1080
- 1080 - 1350

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-BTEXN - BENZENE TOLUENE ETHYLBENZENE XYLENES AND NAPHTHALENE
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.

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FIGURE 3.6-6

MEAN BTEXN CONCENTRATIONS IN SUBSURFACE SOIL

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: BR	Checked By: LA	Scale: 1" = 150'	Date: 11/12/21	File: 3.6-6_BTEXN_Soil_SubSurf_Dsize

EXPLANATION

LEAD SURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 1 - 15
- 15 - 30
- 15 - 45
- 45 - 60
- 60 - 71

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR LEAD IS 400 mg/kg AND THE ISSL IS 800 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

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FIGURE 3.6-7

MEAN LEAD CONCENTRATIONS IN SURFACE SOIL

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: BR	Checked By: LA	Scale: 1" = 100'	Date: 11/12/21	File: 3.6-7_Pb_Soil_Surf_Dsize

EXPLANATION

LEAD SUBSURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 0- 40
- 40 - 80
- 80 - 120
- 120 - 160
- 160 - 200

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR LEAD IS 400 mg/kg AND THE ISSL IS 800 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

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FIGURE 3.6-8

MEAN LEAD CONCENTRATIONS IN SUBSURFACE SOIL

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 150'	Date: 11/12/21	File: 3.6-8_Pb_Soil_SubSurf_Dsize

EXPLANATION

PHENANTHRENE SURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 0 - 38
- 38 - 76
- 76 - 114
- 114 - 152
- 152 - 190

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR PHENANTHRENE IS 1740 mg/kg AND THE ISSL IS 25300 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

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FIGURE 3.6-9

MEAN PHENANTHRENE CONCENTRATIONS IN SURFACE SOIL

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: BR	Checked By: LA	Scale: 1" = 100'	Date: 11/12/21	File: 3.6-9_Phen_Soil_Surf_Dsize

EXPLANATION

PHENANTHRENE SUBSURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 0 - 32
- 32 - 64
- 64 - 96
- 96 - 128
- 128 - 160

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR PHENANTHRENE IS 1740 mg/kg AND THE ISSL IS 25300 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

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FIGURE 3.6-10

MEAN PHENANTHRENE CONCENTRATIONS IN SUBSURFACE SOIL

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 150'	Date: 11/12/21	File: 3.6-10_Phen_Soil_SubSurf_Dsize

EXPLANATION

TPH-DRO SURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 0 - 26,000
- 26,000 - 52,000
- 52,000 - 78,000
- 78,000 - 104,000
- 104,000 - 130,000

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-TPH-DRO - TOTAL PETROLEUM HYDROCARBON - DIESEL RANGE ORGANICS
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR TPH-DRO IS 1000 mg/kg AND THE ISSL IS 3000 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

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FIGURE 3.6-11

MEAN TPH-DRO CONCENTRATIONS IN SURFACE SOIL

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: BR	Checked By: LA	Scale: 1" = 100'	Date: 11/12/21	File: 3.6-11_TPHDRO_Soil_Surf_Dsize

EXPLANATION

TPH-DRO SUBSURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 0 - 28,000
- 28,000 - 56,000
- 56,000 - 84,000
- 84,000 - 112,000
- 112,000 - 140,000

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-TPH-DRO - TOTAL PETROLEUM HYDROCARBON - DIESEL RANGE ORGANICS
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR TPH-DRO IS 1000 mg/kg AND THE ISSL IS 3000 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

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FIGURE 3.6-12

MEAN TPH-DRO CONCENTRATIONS IN SUBSURFACE SOIL

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GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 150'	Date: 11/12/21	File: 3.6-12_TPHDRO_Soil_SubSurf_Dsize

EXPLANATION

TPH-GRO SURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 2 - 190
- 191 - 380
- 381 - 570
- 571 - 760
- 761 - 955

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-TPH-GRO - TOTAL PETROLEUM HYDROCARBON - GASOLINE RANGE ORGANICS
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR TPH-GRO IS 100 mg/kg AND THE ISSL IS 500 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

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FIGURE 3.6-13

MEAN TPH-GRO CONCENTRATIONS IN SURFACE SOIL

WESTERN REFINING SOUTHWEST LLC
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Drawn By: BR	Checked By: LA	Scale: 1" = 100'	Date: 11/12/21	File: 3.6-13_TPHGRO_Soil_Surf_Dsize

EXPLANATION

TPH-GRO SUBSURFACE SOIL SAMPLE LOCATION FOLLOWED BY CONCENTRATIONS (mg/kg)

- 2.7 - 275
- 275 - 550
- 550 - 800
- 800 - 1,000
- 1,000 - 1,350

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-TPH-GRO - TOTAL PETROLEUM HYDROCARBON - GASOLINE RANGE ORGANICS
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT RSSL FOR TPH-GRO IS 100 mg/kg AND THE ISSL IS 500 mg/kg. REFERENCE: NEW MEXICO ENVIRONMENT DEPARTMENT, RISK ASSESSMENT GUIDANCE FOR SITE INVESTIGATIONS AND REMEDIATION, VOLUME I, SOIL SCREENING GUIDANCE FOR HUMAN HEALTH RISK ASSESSMENTS, JUNE 2019.

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FIGURE 3.6-14

MEAN TPH-GRO CONCENTRATIONS IN SUBSURFACE SOIL

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Drawn By: BR	Checked By: LA	Scale: 1" = 150'	Date: 11/12/21	File: 3.6-14_TPHGRO_Soil_SubSurf_Dsize

Maxar, Microsoft

EXPLANATION

- ARSENIC ALLUVIAL/CHINLE AQUIFER SAMPLE LOCATION
- MEAN ARSENIC CONCENTRATION CONTOUR, 2016 - 2021

INTERPOLATED MEAN ARSENIC CONCENTRATIONS (mg/L)

0.0272494

0.001175

NOTE:

-mg/L - MILLIGRAMS PER LITER
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-* WELLS HAD MEASURABLE SEPARATE PHASE HYDROCARBON
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR ARSENIC IS 0.01 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

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FIGURE 3.6-15

MEAN ARSENIC CONCENTRATIONS IN ALLUVIAL/CHINLE AQUIFER, 2016 - 2021

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MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 250'	Date: 11/12/21	File: 3.6-15_As_GW_Shallow_Dsize

EXPLANATION

ARSENIC SONSELA AQUIFER SAMPLE LOCATION FOLLOWED BY CONCENTRATION (mg/L)

- 0 - 0.00150
- 0.00150 - 0.00200
- 0.00200 - 0.00250
- 0.00250 - 0.00300
- 0.00300 - 0.00350

NOTE:

-mg/L - MILLIGRAMS PER LITER
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR ARSENIC IS 0.01 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

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FIGURE 3.6-16

MEAN ARSENIC CONCENTRATIONS IN SONSELA AQUIFER, 2016 - 2021

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 300'	Date: 11/12/21	File: 3.6-16_As_GW_Deep_Dsize

Maxar, Microsoft

EXPLANATION

- BENZENE ALLUVIAL/CHINLE AQUIFER SAMPLE LOCATION
- MEAN BENZENE CONCENTRATION CONTOUR, 2016 - 2021

INTERPOLATED MEAN BENZENE CONCENTRATIONS (mg/L)

41.1818

0.001

NOTE:

-mg/L - MILLIGRAMS PER LITER
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-* WELLS HAD MEASURABLE SEPARATE PHASE HYDROCARBON
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR BENZENE IS 0.005 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

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FIGURE 3.6-17

MEAN BENZENE CONCENTRATIONS IN ALLUVIAL/CHINLE AQUIFER, 2016 - 2021

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: BR	Checked By: LA	Scale: 1" = 250'	Date: 11/12/21	File: 3.6-17_Benz_GW_Shallow_Dsize

EXPLANATION

BENZENE SONSELA AQUIFER SAMPLE LOCATION FOLLOWED BY CONCENTRATION (mg/L)

- 0.001 - 0.003
- 0.003 - 0.004
- 0.004 - 0.005
- 0.005 - 0.006
- 0.006 - 0.008

NOTE:

-mg/L - MILLIGRAMS PER LITER
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR BENZENE IS 0.005 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

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FIGURE 3.6-18

MEAN BENZENE CONCENTRATIONS IN SONSELA AQUIFER, 2016 - 2021

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 300'	Date: 11/12/21	File: 3.6-18_Benz_GW_Deep_Dsize

Maxar, Microsoft

EXPLANATION

- BTEXN ALLUVIAL/CHINLE AQUIFER SAMPLE LOCATION
- MEAN BTEXN CONCENTRATION CONTOUR, 2016 - 2021

INTERPOLATED MEAN BTEXN CONCENTRATIONS (mg/L)

50.8091

0.00575003

NOTE:

-mg/L - MILLIGRAMS PER LITER
-BTEXN - BENZENE TOLUENE ETHYLBENZENE XYLENES AND NAPHTHALENE
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-* WELLS HAD MEASURABLE SEPARATE PHASE HYDROCARBON

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FIGURE 3.6-19

MEAN BTEXN CONCENTRATIONS IN ALLUVIAL/CHINLE AQUIFER, 2016 - 2021

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: BR	Checked By: LA	Scale: 1" = 250'	Date: 11/12/21	File: 3.6-19_BTEXN_GW_Shallow_Dsize

EXPLANATION

BTEXN SONSELA AQUIFER SAMPLE LOCATION FOLLOWED BY CONCENTRATION (mg/L)

- 0.006 - 0.009
- 0.009 - 0.012
- 0.012 - 0.015
- 0.015 - 0.018
- 0.018 - 0.023

NOTE:

-mg/L - MILLIGRAMS PER LITER
-BTEXN - BENZENE TOLUENE ETHYLBENZENE XYLENES AND NAPHTHALENE
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.

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FIGURE 3.6-20

MEAN BTEXN CONCENTRATIONS IN SONSELA AQUIFER, 2016 - 2021

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 300'	Date: 11/12/21	File: 3.6-20_BTEXN_GW_Deep_Dsize

Maxar, Microsoft

EXPLANATION

- MTBE ALLUVIAL/CHINLE AQUIFER SAMPLE LOCATION
- MEAN MTBE CONCENTRATION CONTOUR, 2016 - 2021

INTERPOLATED MEAN MTBE CONCENTRATIONS (mg/L)

9.3875

0.001

NOTE:

-mg/L - MILLIGRAMS PER LITER
-MTBE - METHYL TERTIARY-BUTYL ETHER
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-* WELLS HAD MEASURABLE SEPARATE PHASE HYDROCARBON

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FIGURE 3.6-21

MEAN MTBE CONCENTRATIONS IN ALLUVIAL/CHINLE AQUIFER, 2016 - 2021

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 250'	Date: 11/12/21	File: 3.6-21_MTBE_GW_Shallow_Dsize

EXPLANATION

MTBE SONSELA AQUIFER SAMPLE LOCATION FOLLOWED BY CONCENTRATION (mg/L)

- 0.001- 0.014
- 0.014 - 0.028
- 0.028 - 0.042
- 0.042 - 0.056
- 0.056 - 0.070

NOTE:

-mg/kg - MILLIGRAMS PER KILOGRAM
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.

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FIGURE 3.6-22

MEAN MTBE CONCENTRATIONS IN SONSELA AQUIFER, 2016 - 2021

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: BR	Checked By: LA	Scale: 1" = 300'	Date: 11/12/21	File: 3.6-22_MTBE_GW_Deep_Dsize

Maxar, Microsoft

EXPLANATION

- LEAD ALLUVIAL/CHINLE AQUIFER SAMPLE LOCATION
- MEAN LEAD CONCENTRATION CONTOUR, 2016 - 2021

INTERPOLATED MEAN LEAD CONCENTRATIONS (mg/L)

0.04

0

NOTE:

-mg/L - MILLIGRAMS PER LITER
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-* WELLS HAD MEASURABLE SEPARATE PHASE HYDROCARBON
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR LEAD IS 0.015 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

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FIGURE 3.6-23

MEAN LEAD CONCENTRATIONS IN ALLUVIAL/CHINLE AQUIFER, 2016 - 2021

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
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Drawn By: BR	Checked By: LA	Scale: 1" = 250'	Date: 11/12/21	File: 3.6-23_Pb_GW_Shallow_Dsize

EXPLANATION

LEAD SONSELA AQUIFER SAMPLE LOCATION FOLLOWED BY CONCENTRATION (mg/L)

- 0.0005 - 0.0020
- 0.0020 - 0.0035
- 0.0035 - 0.0050
- 0.0050 - 0.0065
- 0.0065 - 0.0085

NOTE:

-mg/L - MILLIGRAMS PER LITER
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR LEAD IS 0.015 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

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FIGURE 3.6-24

MEAN LEAD CONCENTRATIONS IN SONSELA AQUIFER, 2016 - 2021

WESTERN REFINING SOUTHWEST LLC MARATHON GALLUP REFINERY GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 300'	Date: 11/12/21	File: 3.6-24_Pb_GW_Deep_Dsize

Maxar, Microsoft

EXPLANATION

- PHENANTHRENE ALLUVIAL/CHINLE AQUIFER SAMPLE LOCATION
- MEAN PHENANTHRENE CONCENTRATION CONTOUR, 2016 - 2021

INTERPOLATED MEAN PHENANTHRENE CONCENTRATIONS (mg/L)

0.362999

0.0005

NOTE:

-mg/L - MILLIGRAMS PER LITER
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-* WELLS HAD MEASURABLE SEPARATE PHASE HYDROCARBON
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR PHENANTHRENE IS 0.17 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

N

0 250 500'

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FIGURE 3.6-25

MEAN PHENANTHRENE CONCENTRATIONS IN ALLUVIAL/CHINLE AQUIFER, 2016 - 2021

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 250'	Date: 11/12/21	File: 3.6-25_Phen_GW_Shallow_Dsize

EXPLANATION

PHENANTHRENE SONSELA AQUIFER SAMPLE LOCATION FOLLOWED BY CONCENTRATION (mg/L)

- 0.003 - 0.005
- 0.005 - 0.006
- 0.006 - 0.007
- 0.007 - 0.008
- 0.008 - 0.010

NOTE:

-mg/L - MILLIGRAMS PER LITER
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR PHENANTHRENE IS 0.17 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

N

0 200 400'

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FIGURE 3.6-26

MEAN PHENANTHRENE CONCENTRATIONS IN SONSELA AQUIFER, 2016 - 2021

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 200'	Date: 11/12/21	File: 3.6-26_Phen_GW_Deep_Dsize

Maxar, Microsoft

EXPLANATION

TPH-DRO ALLUVIAL/CHINLE AQUIFER SAMPLE LOCATION

MEAN TPH-DRO CONCENTRATION CONTOUR, 2016 - 2021

INTERPOLATED MEAN THP-DRO CONCENTRATIONS (mg/L)

988.667

0.2555

NOTE:

-mg/L - MILLIGRAMS PER LITER
-TPH-DRO - TOTAL PETROLEUM HYDROCARBON - DIESEL RANGE ORGANICS
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-* WELLS HAD MEASURABLE SEPARATE PHASE HYDROCARBON
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR TPH-DRO IS 0.0167 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

N

0 250 500'

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FIGURE 3.6-27

MEAN TPH-DRO CONCENTRATIONS IN ALLUVIAL/CHINLE AQUIFER, 2016 - 2021

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 250'	Date: 11/12/21	File: 3.6-27_TPHDRO_GW_Shallow_Dsize

EXPLANATION

TPH-DRO SONSELA AQUIFER SAMPLE LOCATION FOLLOWED BY CONCENTRATION (mg/L)

- 0.69 - 0.72
- 0.72 - 0.76
- 0.76 - 0.80
- 0.80 - 0.84
- 0.84 - 0.88

NOTE:

-mg/L - MILLIGRAMS PER LITER
-TPH-DRO - TOTAL PETROLEUM HYDROCARBON - DIESEL RANGE ORGANICS
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR TPH-DRO IS 0.0167 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

N

0 300 600'

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FIGURE 3.6-28

MEAN TPH-DRO CONCENTRATIONS IN SONSELA AQUIFER, 2016 - 2021

**WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO**

Drawn By: BR	Checked By: LA	Scale: 1" = 300'	Date: 11/12/21	File: 3.6-28_TPHDRO_GW_Deep_Dsize

EXPLANATION

⌖ TPH-GRO ALLUVIAL/CHINLE AQUIFER SAMPLE LOCATION

MEAN TPH-GRO CONCENTRATION CONTOUR, 2016 - 2021

INTERPOLATED MEAN TPH-GRO CONCENTRATIONS (mg/L)

127.455

0.05

NOTE:

-mg/L - MILLIGRAMS PER LITER
-TPH-GRO - TOTAL PETROLEUM HYDROCARBON - GASOLINE RANGE ORGANICS
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-* WELLS HAD MEASURABLE SEPARATE PHASE HYDROCARBON
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR TPH-GRO IS 0.0101 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

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FIGURE 3.6-29

MEAN TPH-GRO CONCENTRATIONS IN ALLUVIAL/CHINLE AQUIFER, 2016 - 2021

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 250'	Date: 11/12/21	File: 3.6-29_TPHGRO_GW_Shallow_Dsize

EXPLANATION

TPH-GRO SONSELA AQUIFER SAMPLE LOCATION FOLLOWED BY CONCENTRATION (mg/L)

- 0.05 - 0.06
- 0.06 - 0.08
- 0.08 - 0.10
- 0.10- 0.12
- 0.12 - 0.14

NOTE:

-mg/L - MILLIGRAMS PER LITER
-TPH-GRO - TOTAL PETROLEUM HYDROCARBON - GASOLINE RANGE ORGANICS
-NON DETECT RESULTS WERE REPLACED WITH THE REPORTING LIMIT WHEN CALCULATING MEANS. RESULTS ROUNDED TO 3 SIGNIFICANT DIGITS.
-THE NEW MEXICO ENVIRONMENT DEPARTMENT GW CLEANUP LEVEL FOR TPH-GRO IS 0.0101 mg/L. REFERENCE: NMED GW CLEANUP LEVELS - NEW MEXICO ENVIRONMENT DEPARTMENT GROUNDWATER CLEANUP LEVELS, NEW MEXICO ADMINISTRATIVE CODE 20.6.2.3103.

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FIGURE 3.6-30

MEAN TPH-GRO CONCENTRATIONS IN SONSELA AQUIFER, 2016 - 2021

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: BR	Checked By: LA	Scale: 1" = 300'	Date: 11/12/21	File: 3.6-30_TPHGRO_GW_Deep_Dsize

EXPLANATION

- 05/2021 LIF BORING LOCATION
- 04/2021 LIF BORING LOCATION
- 02/2021 LIF BORING LOCATION
- 11/2019 LIF BORING LOCATION
- MONITORING WELL

SPH OCCURRENCE

- DIESEL
- GASOLINE
- NAPHTHA
- RESIDUAL/NO RESPONSE
- DECEMBER 2020 GROUNDWATER ELEVATION IN FT AMSL, DASHED WHERE INFERRED

NOTES:

-LIF - LASER-INDUCED FLORESCENCE
-SPH - SEPARATE PHASE HYDROCARBON
-FT AMSL - FEET ABOVE MEAN SEA LEVEL

N

0 160 320'

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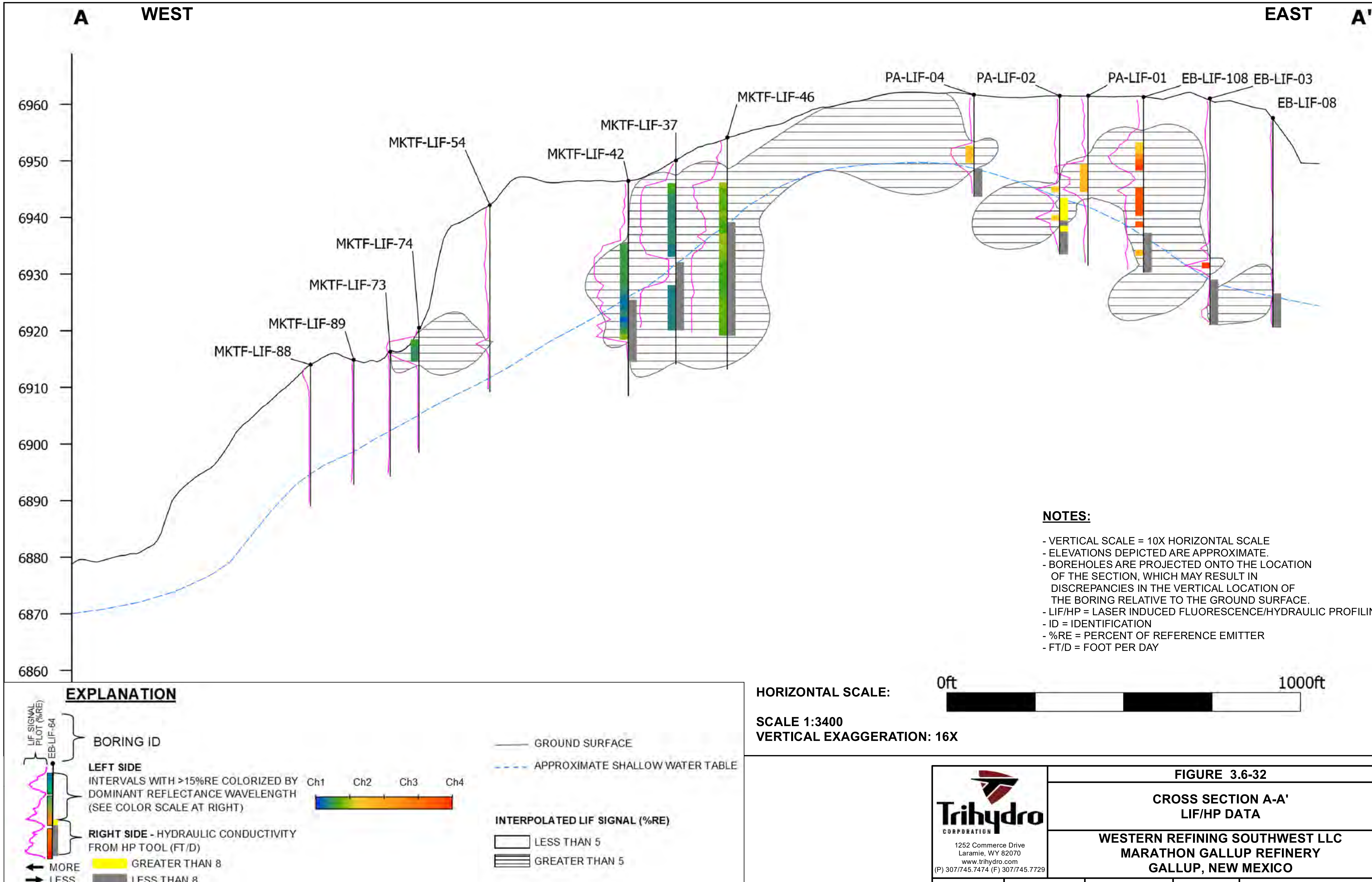
FIGURE 3.6-31

2019 AND 2021 LIF SAMPLE LOCATIONS AND RESIDUAL PRODUCT TYPE

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: KEJ	Checked By: MS	Scale: 1" = 160'	Date: 11/2/21	File: 3.6-31_Sitewide_LIF_Results_Dsize



NOTES:

- VERTICAL SCALE = 10X HORIZONTAL SCALE
- ELEVATIONS DEPICTED ARE APPROXIMATE.
- BOREHOLES ARE PROJECTED ONTO THE LOCATION OF THE SECTION, WHICH MAY RESULT IN DISCREPANCIES IN THE VERTICAL LOCATION OF THE BORING RELATIVE TO THE GROUND SURFACE.
- LIF/HP = LASER INDUCED FLUORESCENCE/HYDRAULIC PROFILING
- ID = IDENTIFICATION
- %RE = PERCENT OF REFERENCE EMITTER
- FT/D = FOOT PER DAY

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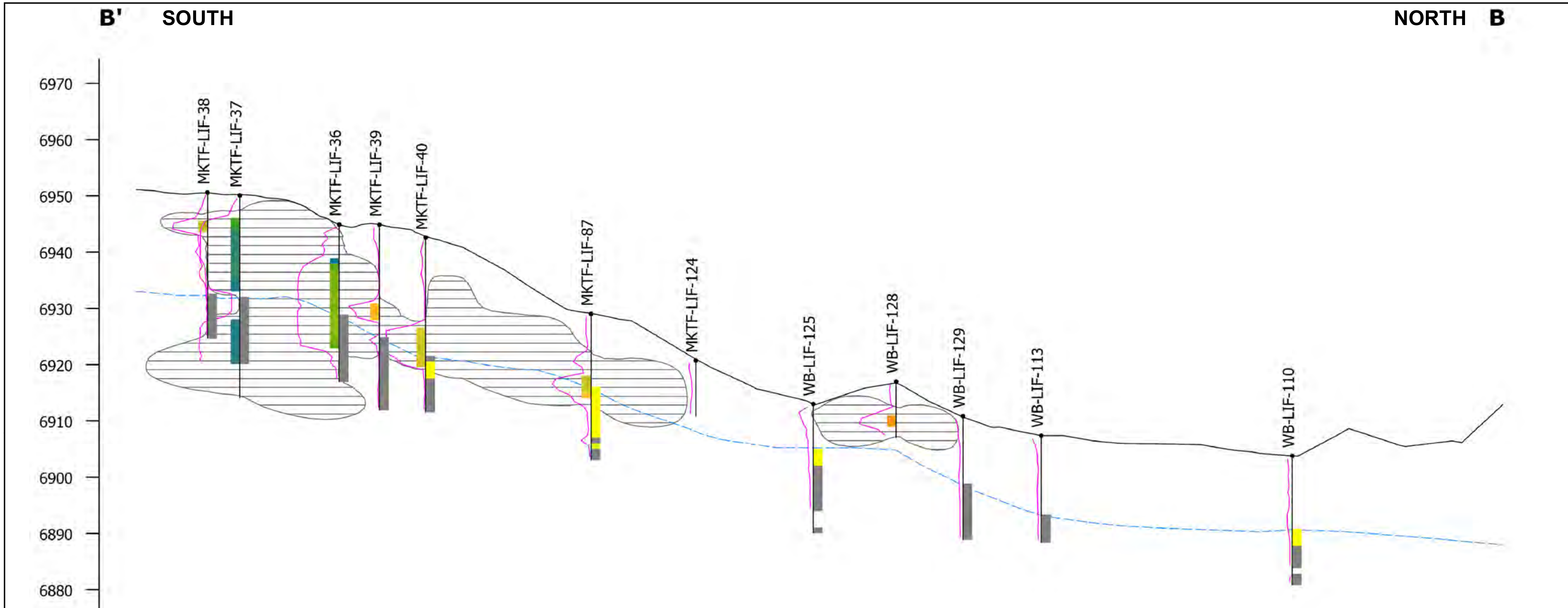
FIGURE 3.6-32

CROSS SECTION A-A'
LIF/HP DATA

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: TM	Checked By: BS	Scale: AS SHOWN	Date: 11/2/21	File: 3.6-32_LIF_HP_XSect_A.mxd



NOTES:

- VERTICAL SCALE = 10X HORIZONTAL SCALE
- ELEVATIONS DEPICTED ARE APPROXIMATE.
- BOREHOLES ARE PROJECTED ONTO THE LOCATION OF THE SECTION, WHICH MAY RESULT IN DISCREPANCIES IN THE VERTICAL LOCATION OF THE BORING RELATIVE TO THE GROUND SURFACE.
- LIF/HP - LASER INDUCED FLUORESCENCE/HYDRAULIC PROFILING
- ID - IDENTIFICATION
- %RE - PERCENT OF REFERENCE EMITTER
- FT/D - FOOT PER DAY

0ft 1000ft

SCALE 1:2400
VERTICAL EXAGGERATION: 10X

EXPLANATION

LIF SIGNAL PLOT (%RE)
EB-LIF-64
BORING ID

LEFT SIDE
INTERVALS WITH >15%RE COLORIZED BY DOMINANT REFLECTANCE WAVELENGTH (SEE COLOR SCALE AT RIGHT)

Ch1 Ch2 Ch3 Ch4

RIGHT SIDE - HYDRAULIC CONDUCTIVITY FROM HP TOOL (FT/D)
GREATER THAN 8
LESS THAN 8

← MORE
→ LESS

GROUND SURFACE
APPROXIMATE SHALLOW WATER TABLE

INTERPOLATED LIF SIGNAL (%RE)
LESS THAN 5
GREATER THAN 5

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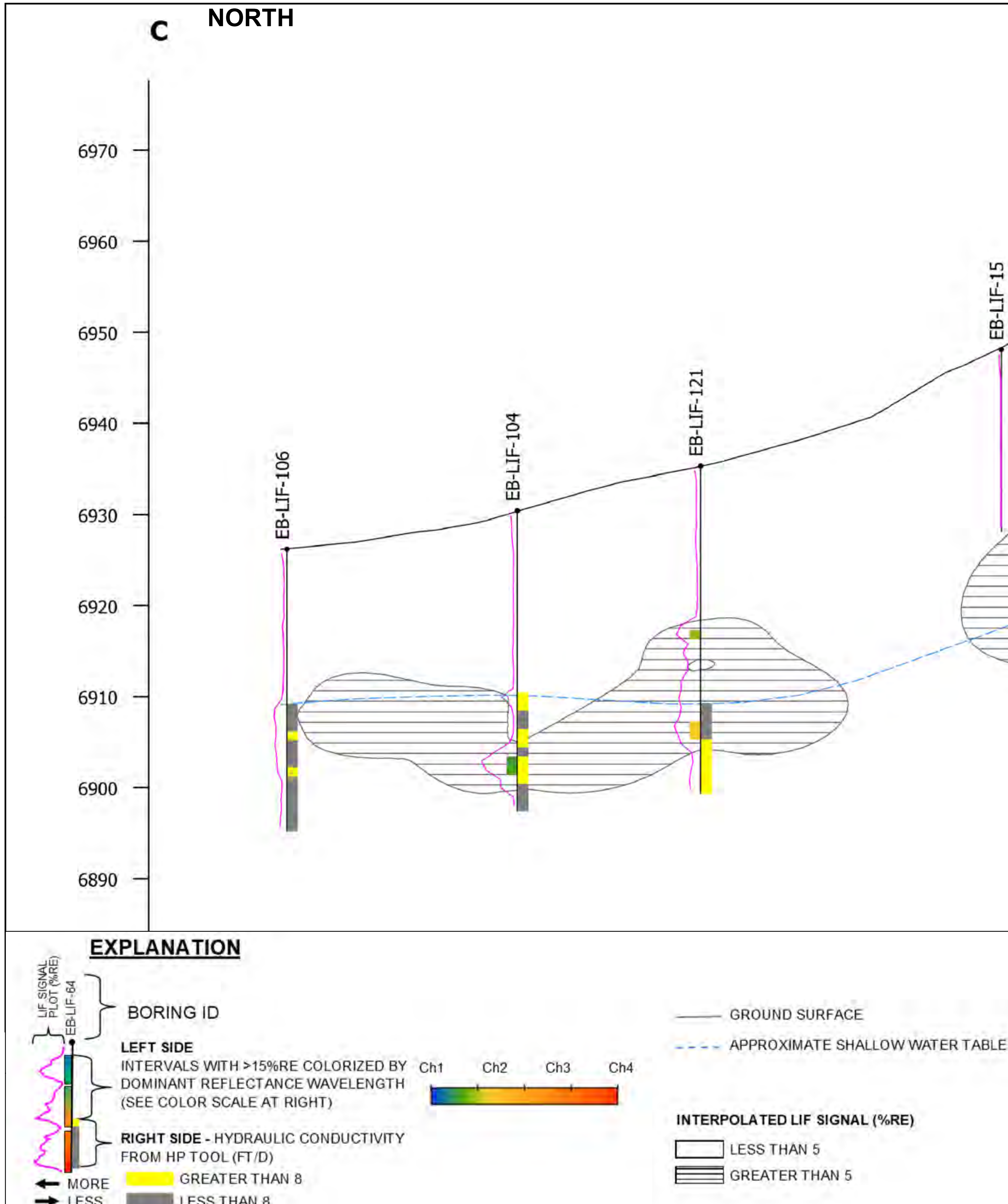
FIGURE 3.6-33

CROSS SECTION B-B'
LIF/HP DATA

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: TM	Checked By: BS	Scale: AS SHOWN	Date: 11/2/21	File: 3.6-33_LIF_HP_XSect_B.mxd



NOTES:

- VERTICAL SCALE = 10X HORIZONTAL SCALE
- ELEVATIONS DEPICTED ARE APPROXIMATE.
- BOREHOLES ARE PROJECTED ONTO THE LOCATION OF THE SECTION, WHICH MAY RESULT IN DISCREPANCIES IN THE VERTICAL LOCATION OF THE BORING RELATIVE TO THE GROUND SURFACE.
- LIF/HP - LASER INDUCED FLUORESCENCE/HYDRAULIC PROFILING
- ID - IDENTIFICATION
- %RE - PERCENT OF REFERENCE EMITTER
- FT/D - FOOT PER DAY

SCALE 1:2100
VERTICAL EXAGGERATION: 12X

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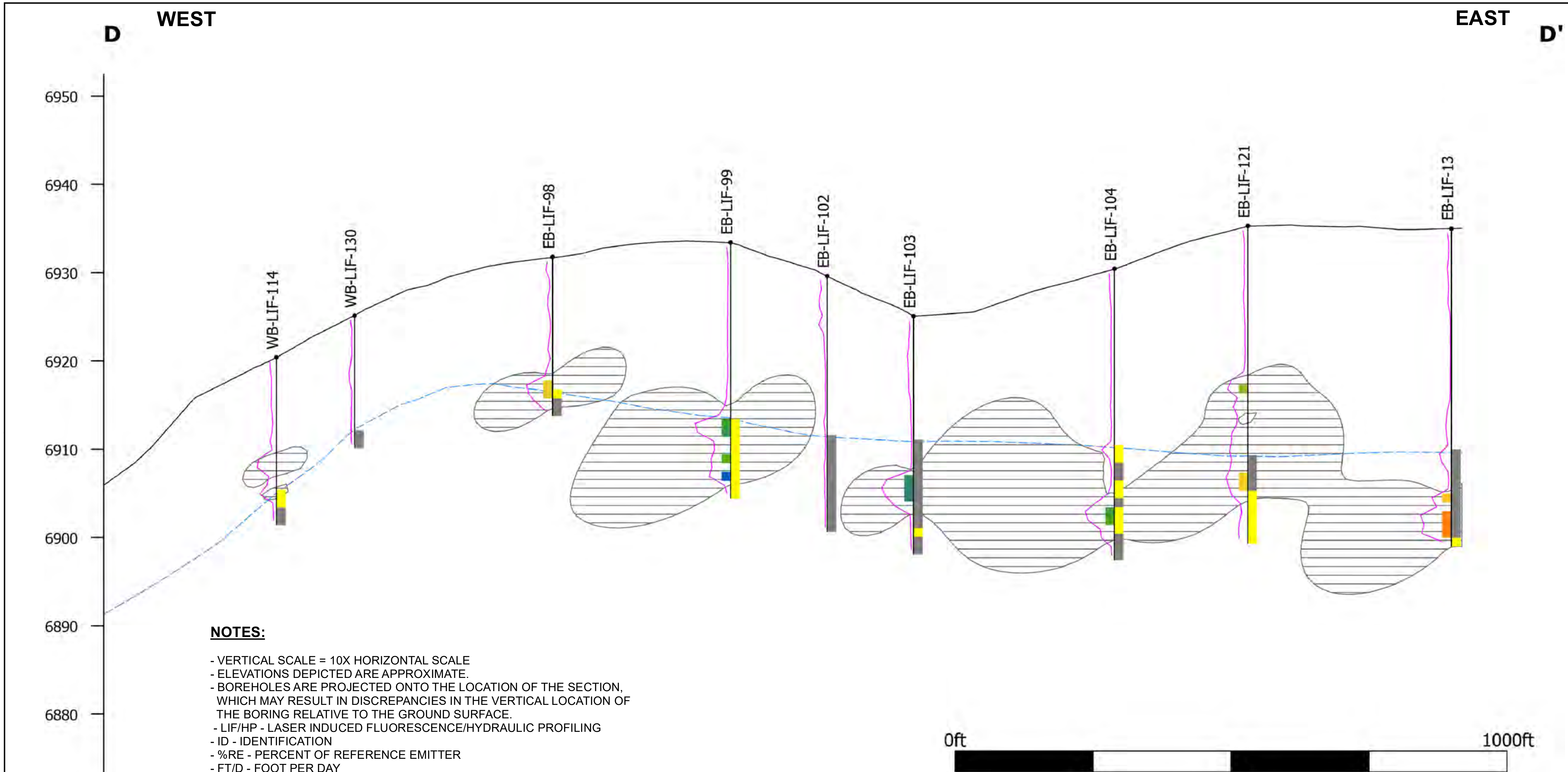
FIGURE 3.6-34

CROSS SECTION C-C'
LIF/HP DATA

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: TM	Checked By: BS	Scale: AS SHOWN	Date: 11/2/21	File: 3.6-34_LIF_HP_XSect_C.mxd

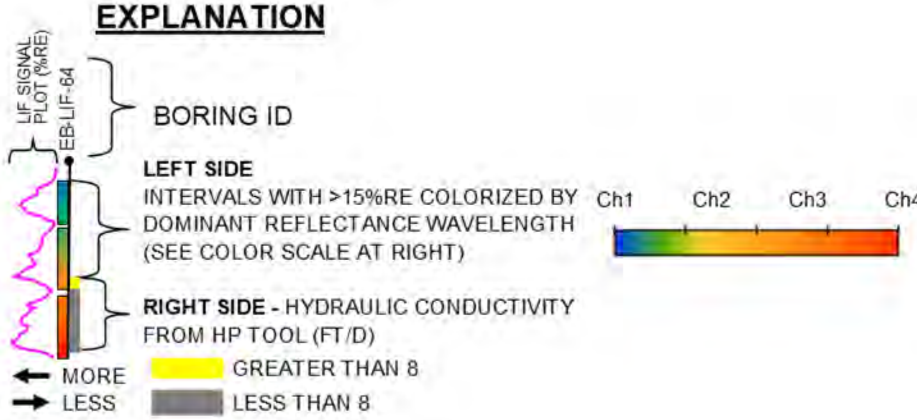


NOTES:

- VERTICAL SCALE = 10X HORIZONTAL SCALE
- ELEVATIONS DEPICTED ARE APPROXIMATE.
- BOREHOLES ARE PROJECTED ONTO THE LOCATION OF THE SECTION, WHICH MAY RESULT IN DISCREPANCIES IN THE VERTICAL LOCATION OF THE BORING RELATIVE TO THE GROUND SURFACE.
- LIF/HP - LASER INDUCED FLUORESCENCE/HYDRAULIC PROFILING
- ID - IDENTIFICATION
- %RE - PERCENT OF REFERENCE EMITTER
- FT/D - FOOT PER DAY

SCALE 1:2400
VERTICAL EXAGGERATION: 16X

EXPLANATION



BORING ID

LEFT SIDE
INTERVALS WITH >15%RE COLORIZED BY DOMINANT REFLECTANCE WAVELENGTH (SEE COLOR SCALE AT RIGHT)

RIGHT SIDE - HYDRAULIC CONDUCTIVITY FROM HP TOOL (FT/D)
GREATER THAN 8
LESS THAN 8

GROUND SURFACE
APPROXIMATE SHALLOW WATER TABLE

INTERPOLATED LIF SIGNAL (%RE)
LESS THAN 5
GREATER THAN 5

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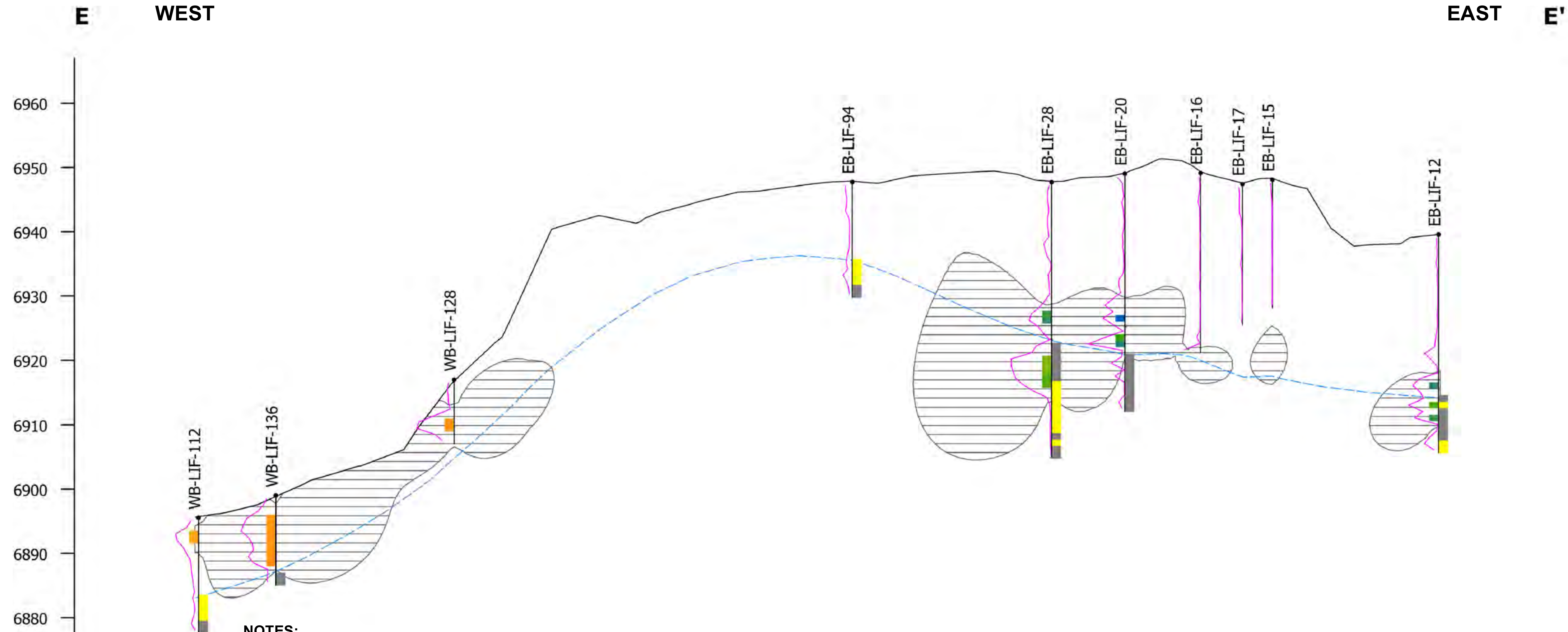
FIGURE 3.6-35

CROSS SECTION D-D'
LIF/HP DATA

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: TM	Checked By: BS	Scale: AS SHOWN	Date: 11/2/21	File: 3.6-35_LIF_HP_XSect_D.mxd



NOTES:

- VERTICAL SCALE = 10X HORIZONTAL SCALE
- ELEVATIONS DEPICTED ARE APPROXIMATE.
- BOREHOLES ARE PROJECTED ONTO THE LOCATION OF THE SECTION, WHICH MAY RESULT IN DISCREPANCIES IN THE VERTICAL LOCATION OF THE BORING RELATIVE TO THE GROUND SURFACE.
- LIF/HP - LASER INDUCED FLUORESCENSCE/HYDRAULIC PROFILING
- ID - IDENTIFICATION
- %RE - PERCENT OF REFERENCE EMITTER
- FT/D - FOOT PER DAY

EXPLANATION

LIF SIGNAL PLOT (%RE)
EB-LIF-64
BORING ID

LEFT SIDE
INTERVALS WITH >15%RE COLORIZED BY DOMINANT REFLECTANCE WAVELENGTH (SEE COLOR SCALE AT RIGHT)

Ch1 Ch2 Ch3 Ch4

RIGHT SIDE - HYDRAULIC CONDUCTIVITY FROM HP TOOL (FT/D)
GREATER THAN 8
LESS THAN 8

← MORE
→ LESS

GROUND SURFACE
APPROXIMATE SHALLOW WATER TABLE

INTERPOLATED LIF SIGNAL (%RE)
LESS THAN 5
GREATER THAN 5

0ft 1000ft

SCALE 1:3000
VERTICAL EXAGGERATION: 14X

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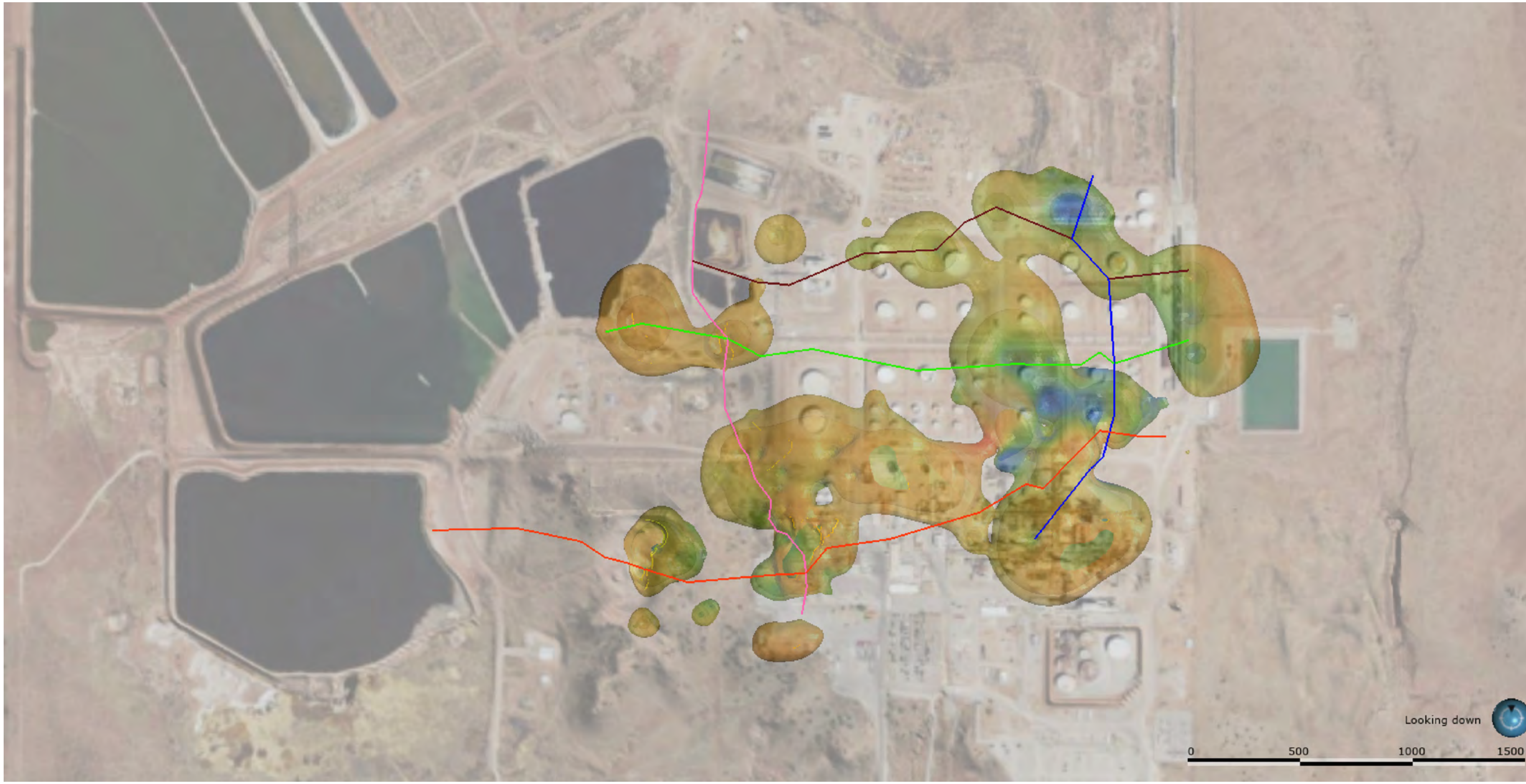
FIGURE 3.6-36

CROSS SECTION E-E'
LIF/HP DATA

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: TM	Checked By: BS	Scale: AS SHOWN	Date: 11/2/21	File: 3.6-36_LIF_HP_XSect_E.mxd

VIEW - LOOKING DOWN



EXPLANATION

- CROSS SECTION A
- CROSS SECTION B
- CROSS SECTION C
- CROSS SECTION D
- CROSS SECTION E

INTERPOLATED ISOCOUNTOR OF LIF SIGNAL (15 %RE)
DOMINANT LIF SIGNAL WAVELENGTH

Ch1 Ch2 Ch3 Ch4

NOTES:

- IMAGE SHOWS NAIP 2019 AERIAL PHOTO.
- 3D INTERPOLATED ISOCONTOURS OF LIF SIGNALINTENSITY (%RE) ARE COLORIZED BY DOMINANT WAVELENGTH.
- LOWEST ISOCONTOUR DEPICTED IS 15% RE.
- LIF - LASER INDUCED FLUORESCENCE
- %RE - PERCENT OF REFERENCE EMITTER

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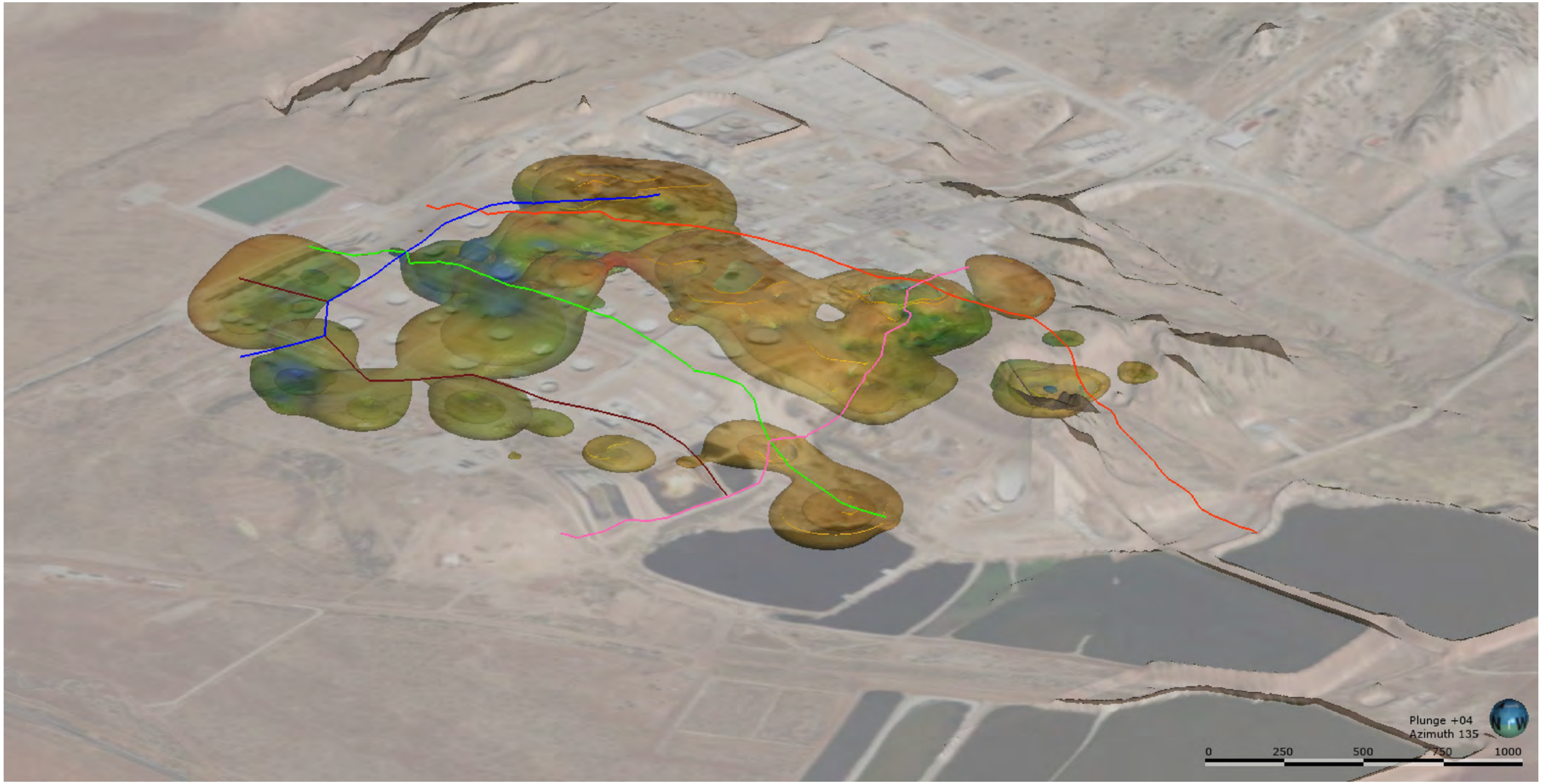
FIGURE 3.6-37

AERIAL VIEW OF SPH PRESENCE IN SUBSURFACE

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: TM	Checked By: BS	Scale: AS SHOWN	Date: 11/2/21	File: 3.6-37_Aerial_SPH.mxd

VIEW - OBLIQUE ANGLE LOOKING SOUTHEAST



EXPLANATION

- CROSS SECTION A
- CROSS SECTION B
- CROSS SECTION C
- CROSS SECTION D
- CROSS SECTION E

INTERPOLATED ISOCOUNTOR OF LIF SIGNAL (15 %RE)
DOMINANT LIF SIGNAL WAVELENGTH

Ch1 Ch2 Ch3 Ch4

NOTES:

- IMAGE SHOWS OBLIQUE VIEW OF NAIP 2019 AERIAL PHOTO DRAPED OVER USGS NED 1/3 ARC SECOND DIGITAL ELEVATION MODEL.
- CROSS SECTION LINES ARE IDENTIFIED ON IMAGE.
- 3D INTERPOLATED ISOCONTOURS OF LIF SIGNALINTENSITY (%RE) ARE COLORIZED BY DOMINANT WAVELENGTH.
- LOWEST ISOCONTOUR DEPICTED IS 15% RE.
- LIF - LASER INDUCED FLUORESCENCE
- %RE - PERCENT OF REFERENCE EMITTER

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FIGURE 3.6-38

OBLIQUE VIEW OF SPH PRESENCE IN SUBSURFACE

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: TM	Checked By: BS	Scale: AS SHOWN	Date: 11/2/21	File: 3.6-38_Oblique_SPH.mxd

Received by OCD: 3/3/2022 10:47:49 AM

Tables

Released to Imaging: 11/23/2022 9:51:56 AM

TABLE 3.5-1. DETECTION FREQUENCIES IN SOIL FOR SELECTED ANALYTES
WESTERN REFINING SOUTHWEST LLC, MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Analyte	Detects	Non-detects	Detection Frequency (%)	Maximum Detected Concentration (mg/kg)	Mean Detected Concentration (mg/kg)	Screening Levels: NMED Industrial SSL[1]	Screening Levels: NMED Residential SSL[2]	Screening Levels: USEPA RSL Industrial Soil HQ 0.1[3]
1,2-Dichloroethane	15	1060	1%	0.4995	0.159	4.07E+01	8.32E+00	2.00E+00
2-Methylnaphthalene	517	1223	30%	4100	42.3	3.37E+03	2.32E+02	3.00E+02
Acenaphthene	11	818	1%	41	14.7	5.05E+04	3.48E+03	4.50E+03
Anthracene	26	803	3%	88	8.49	2.53E+05	1.74E+04	2.30E+04
Arsenic, Total	222	545	29%	540	8.19	3.59E+01	7.07E+00	3.00E+00
Benzene	426	881	33%	2400	14.9	8.72E+01	1.78E+01	5.10E+00
Benzo(a)anthracene	28	801	3%	320	15.3	3.23E+01	1.53E+00	2.10E+01
Benzo(a)pyrene	34	795	4%	130	7.52	2.36E+01	1.12E+00	2.10E+00
Benzo(b)fluoranthene	40	789	5%	16	0.867	3.23E+01	1.53E+00	2.10E+01
Benzo(k)fluoranthene	19	810	2%	1.3	0.289	3.23E+02	1.53E+01	2.10E+02
Chrysene	99	730	12%	570	15.8	3.23E+03	1.53E+02	2.10E+03
cis-1,2-Dichloroethene	18	895	2%	0.75	0.214	2.60E+03	1.56E+02	2.30E+02
Dibenzo(a,h)anthracene	11	818	1%	1	0.265	3.23E+00	1.53E-01	2.10E+00
Ethylbenzene	423	682	38%	730	19.7	3.68E+02	7.51E+01	2.50E+01
Lead, Total	729	42	95%	290	9.26	8.00E+02	4.00E+02	8.00E+02
Motor Oil	45	126	26%	170000	9630	NA	NA	NA
MTBE	66	893	7%	1.1	0.141	NA	NA	2.10E+02
Naphthalene	445	1308	25%	1100	12.8	2.41E+02	4.97E+01	1.70E+01
Nitrogen, Nitrate	114	53	68%	10000	108	NA	NA	NA
Oil & Grease, Total Recoverable	1	NA	0%	210000	210000	NA	NA	NA
Phenanthrene	208	621	25%	1200	40.7	2.53E+04	1.74E+03	NA
Pyrene	100	729	12%	430	24.5	2.53E+04	1.74E+03	2.30E+03
Selenium, Total	40	727	5%	14	6.11	6.49E+03	3.91E+02	5.80E+02
Sulfate	182	8	96%	8800	856	NA	NA	NA
Tetrachloroethene	4	1071	0%	2.3	1.29	6.29E+02	3.37E+02	3.90E+01
Toluene	527	578	48%	2800	52.4	6.13E+04	5.23E+03	4.70E+03
Total Petroleum Hydrocarbons	111	38	74%	140000	5530	NA	NA	NA
TPH DRO	800	338	70%	590000	15200	3.00E+03	1.00E+03	NA
TPH GRO	469	673	41%	59000	1250	5.00E+02	1.00E+02	NA
Trichloroethene	0	1079	0%	0	0	3.65E+01	1.55E+01	1.90E+00
Vinyl Chloride	0	1071	0%	0	0	2.84E+01	7.42E-01	1.70E+00
Xylenes, Total	497	608	45%	4000	97.1	4.28E+03	8.71E+02	2.50E+02

Notes:
mg/kg - milligrams per kilogram
NA - Not applicable
% - percent
[1] NMED Residential SSL - New Mexico Environmental Department Residential Soil Screening Level, June 2019.
[2] NMED Industrial SSL- New Mexico Environmental Department Industrial Soil Screening Level, June 2019.
[3] USEPA RSL Industrial Soil HQ0.1 - United States Environmental Protection Agency Regional Screening Level Industrial Soil Hazard Quotient 0.1, May 2021.

TABLE 3.5-2. DETECTION FREQUENCIES IN GROUNDWATER FOR SELECTED ANALYTES
WESTERN REFINING SOUTHWEST LLC, MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

						Screening Levels			
Analyte	Detects	Non-detects	Detection Frequency (%)	Maximum Detected Concen-tration (mg/L)	Mean Detected Concen-tration (mg/L)	NMED GW Cleanup Levels[1]	40 CFR 141.62[2]	NMED Tap Water[3]	USEPA RSL Tap Water HQ 1.0[4]
1,2-Dichloroethane	339	2841	11%	0.45	0.00975	5.00E-03	NA	1.71E-03	1.70E-04
2-Methylnaphthalene	1250	3681	25%	800	2.32	NA	NA	3.51E-02	NA
Acenaphthene	93	1731	5%	0.084	0.0101	NA	NA	5.35E-01	NA
Anthracene	4	1820	0%	0.005	0.00174	NA	NA	1.72E+00	NA
Arsenic, Total	2063	787	72%	5	0.0243	1.00E-02	1.00E-02	8.55E-04	1.00E-02
Benzene	3698	3280	53%	59000	38	5.00E-03	NA	4.55E-03	4.60E-04
Benzo(a)anthracene	9	1815	0%	1.3	0.181	NA	NA	1.20E-04	NA
Benzo(a)pyrene	2	1822	0%	0.62	0.315	2.00E-04	NA	2.51E-04	2.00E-04
Benzo(b)fluoranthene	2	1822	0%	0.01	0.01	NA	NA	3.43E-04	NA
Benzo(k)fluoranthene	0	1824	0%	0	0	NA	NA	3.43E-03	NA
Chrysene	6	1818	0%	1.8	0.338	NA	NA	3.43E-02	NA
cis-1,2-Dichloroethene	290	2869	9%	0.1	0.0175	7.00E-02	NA	3.65E-02	3.60E-02
Dibenzo(a,h)anthracene	0	1824	0%	0	0	NA	NA	3.43E-05	NA
Ethylbenzene	1721	5008	26%	5700	13.1	7.00E-01	NA	1.50E-02	1.50E-03
Lead, Total	1413	1433	50%	5	0.0319	1.50E-02	NA	NA	1.50E-02
Motor Oil	8	346	2%	88	23.1	NA	NA	NA	NA
MTBE	1334	5288	20%	12	0.78	NA	NA	1.43E-01	1.40E-02
Naphthalene	1647	3345	33%	2100	4.2	3.00E-02	NA	1.65E-03	NA
Nitrogen, Nitrate	372	622	37%	1400	8.4	NA	NA	NA	NA
Oil & Grease, Total Recoverable	11	2	85%	420	52.7	NA	NA	NA	NA
Phenanthrene	132	1692	7%	25	0.39	NA	NA	1.70E-01	NA
Pyrene	23	1801	1%	4.8	0.343	NA	NA	1.17E-01	NA
Selenium, Total	1530	1329	54%	1	0.0192	5.00E-02	5.00E-02	9.87E-02	5.00E-02
Sulfate	4565	132	97%	57000	930	NA	NA	NA	NA
Tetrachloroethene	74	3106	2%	3.7	0.0649	5.00E-03	NA	1.13E-01	1.10E-02
Toluene	2342	4387	35%	26000	63.1	1.00E+00	NA	1.09E+00	1.10E+00
Total Petroleum Hydrocarbons	9	3	75%	3000	369	NA	NA	NA	NA
TPH DRO	2591	2498	51%	15000	29.7	NA	NA	NA	NA
TPH GRO	1197	628	66%	640	19.6	NA	NA	NA	NA
Trichloroethene	181	3017	6%	0.3	0.0164	5.00E-03	NA	2.59E-03	4.90E-04
Vinyl Chloride	114	3066	4%	0.1	0.0207	2.00E-03	NA	3.24E-04	1.90E-05
Xylenes, Total	1732	4997	26%	33000	70.9	6.20E-01	NA	1.93E-01	1.90E-01

Notes:
[1] NMED GW Cleanup Levels - New Mexico Environment Department Groundwater Cleanup Levels, New Mexico Administrative Code 20.6.2.3103.
[2] 40 CFR 141.62 - Code of Federal Regulations, Chapter 40, Section 141.62 Maximum Contaminant Levels.
[3] NMED Tap Water - New Mexico Environment Department, Risk Assessment Guidance, Table A-1, Tap Water, March 2017.
[4] USEPA RSL Tap Water HQ 1.0 - United States Environmental Protection Agency Regional Screening Levels, Hazardous Quotient 1.0, November 2019.
NA - Not applicable
mg/L - milligrams per liter
% - percent

TABLE 3.9-1. SPH CONCERNS AND GOALS
WESTERN REFINING SOUTHWEST LLC, MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Concern	Goal
SPH saturation-based concerns	
SPH occurrence in wells	Reduce mobile SPH saturation
Potential SPH migration	Reduce potential for SPH migration
SPH composition-based concerns	
Groundwater impacts from an SPH source	Decrease dissolved phase impacts from SPH sources
Receptor-based concerns	
Proximity to receptors	Prevent receptor contact with SPH

Note:
SPH - separate phase hydrocarbons

Appendix A - Relevant Figures from Other Documents

EXPLANATION

⊕ MONITORING WELL LOCATION

NOTES:

AL - AERATION LAGOON
EP - EVAPORATION POND
SWMU - SOLID WASTE MANAGEMENT UNIT

N

0 80'

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FIGURE A-1

SWMU 1 AERIAL PHOTO (MAY 2018)

WESTERN REFINING SOUTHWEST, LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: KEJ	Checked By: CF	Scale: 1" = 80'	Date: 10/15/21	File: 1-2_SWMU1_Fig1-2

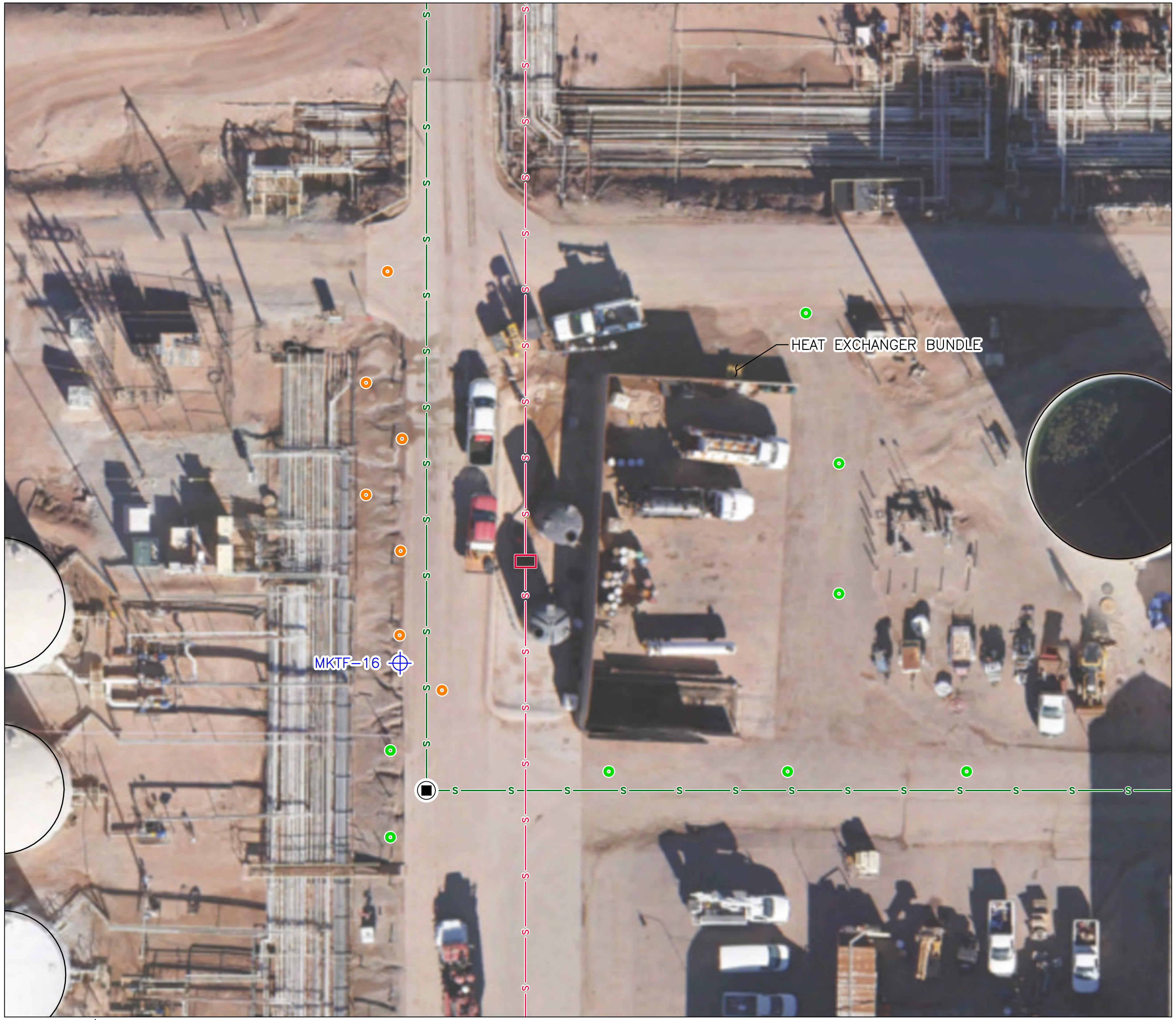

Image Cite: USDA /fsa – Aerial Photography Field Office, NAIP MrSID – Publication: 2014

2 PROPOSED SOIL BORING LOCATIONS
SCALE: 1" = 30'

Image Cite: USDA /fsa – Aerial Photography Field Office, NAIP MrSID – Publication: 2014

1 KEY MAP
SCALE: 1" = 800'

EXPLANATION

MKTF-16	CHINLE/ALLUVIUM INTERFACE WELL AND DESIGNATION
	PROPOSED BUNDLE PAD INVESTIGATION SOIL BORING LOCATION
	PROPOSED SOUR NAPHTHA INVESTIGATION SOIL BORING LOCATION
	MANHOLE LOCATION
s	SEWER LINE
s	PROCESS SEWER LINE
	BUNDLE PAD SUMP
	TANK

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FIGURE A-2

HEAT EXCHANGER BUNDLE PAD INVESTIGATION PROPOSED SOIL BORING LOCATIONS

WESTERN REFINING SOUTHWEST, LLC MARATHON GALLUP REFINERY GALLUP, NEW MEXICO

Drawn By: REP | Checked By: PH | Scale: AS SHOWN | Date: 5/12/21 | File: 697-BP-SOILLOCS-202109

M:\TON\MARATHON\CADD\GALLUP_REPORTS\SWMU\SWMU 3_HXBUNDLEPAD\697-BP-SOILLOCS-202109

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

N

0 200
SCALE IN FEET

NEW MEXICO
GALLUP SITE LOCATION

LEGEND

- PROPOSED PERMANENT MONITORING WELL LOCATION
- PROPOSED SOIL BORING LOCATION
- PROPOSED TEMPORARY MONITORING WELL LOCATION
- NDD-1 SOIL BORING LOCATION AND IDENTIFICATION NUMBER
- A1 SURFACE WATER SAMPLE LOCATION AND IDENTIFICATION NUMBER
- NDD-1 TEMPORARY MONITORING WELL LOCATION AND IDENTIFICATION NUMBER
- OW-14 ALLUVIUM / CHINLE GP MONITORING WELL LOCATION AND IDENTIFICATION NUMBER
- NDD-5 HAND AUGER LOCATION AND IDENTIFICATION NUMBER

MARATHON
MARATHON PETROLEUM COMPANY
GALLUP REFINERY

PROJ. NO.:Marathon	DATE: 09/18/19	FILE: Mathon–dB213

FIGURE A-3
PROPOSED
BORING LOCATION MAP

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

Image Cite: USDA /fsa – Aerial Photography Field Office, NAIP MrSID – Publication: 2014

2 **PROPOSED SOIL BORING LOCATIONS**
SCALE: 1" = 60'

N

0 60'

Image Cite: USDA /fsa – Aerial Photography Field Office, NAIP MrSID – Publication: 2014

1 **KEY MAP**
SCALE: 1" = 800'

N

0 800'

EXPLANATION

	TANK
	SOUR NAPHTHA RELEASE
	UNDERGROUND PRODUCT PIPELINE
	SOUR NAPHTHA RELEASE EXCAVATION EXTENT AREA
MKTF–LIF–66	LIF BORING LOCATION AND DESIGNATION
MKTF–16	CHINLE/ALLUVIUM INTERFACE WELL AND DESIGNATION
	HISTORICAL SOIL SAMPLE LOCATIONS
	PROPOSED SOIL BORING LOCATION
LIF	LASER-INDUCED FLORESCENCE

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FIGURE A-4

PROPOSED SOIL BORING LOCATIONS

GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: REP | Checked By: BM | Scale: AS SHOWN | Date: 6/22/21 | File: 697-SOURNAPHTHARELEASE-202106

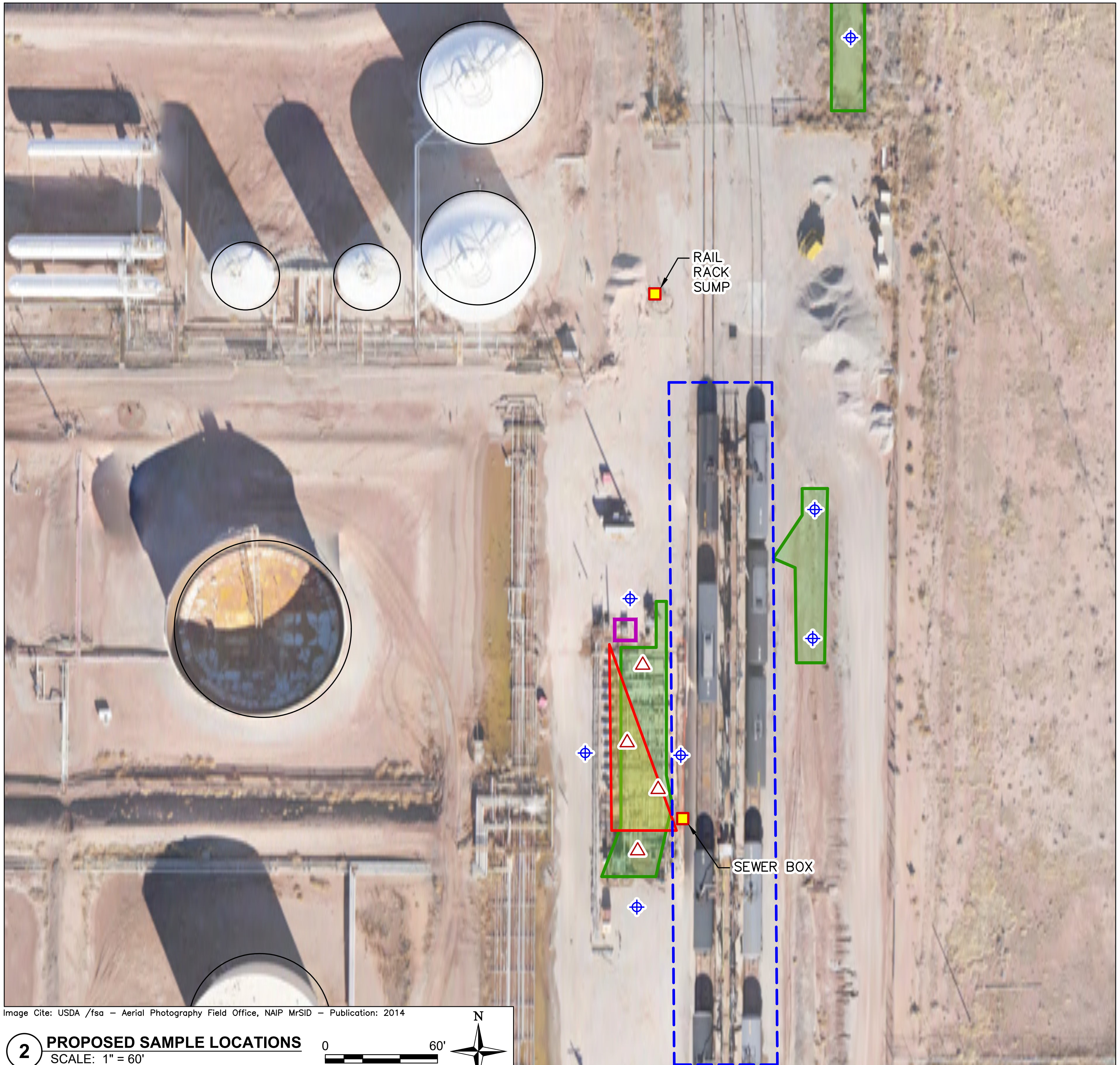

Image Cite: USDA /fsa – Aerial Photography Field Office, NAIP MrSID – Publication: 2014

2 PROPOSED SAMPLE LOCATIONS
SCALE: 1" = 60'

0 60'
N

EXPLANATION

- PROPOSED SOIL BORING
- PROPOSED SOIL SAMPLE
- TANK
- RAIL CAR LOADING AREA
- DIESEL RELEASE EXTENT (MARCH 13, 2019)
- GASOLINE RELEASE EXTENT (MAY 7, 2017)
- DGS 105 ADDITIVE TANK
- RAIL RACK SUMP OR SEWER BOX

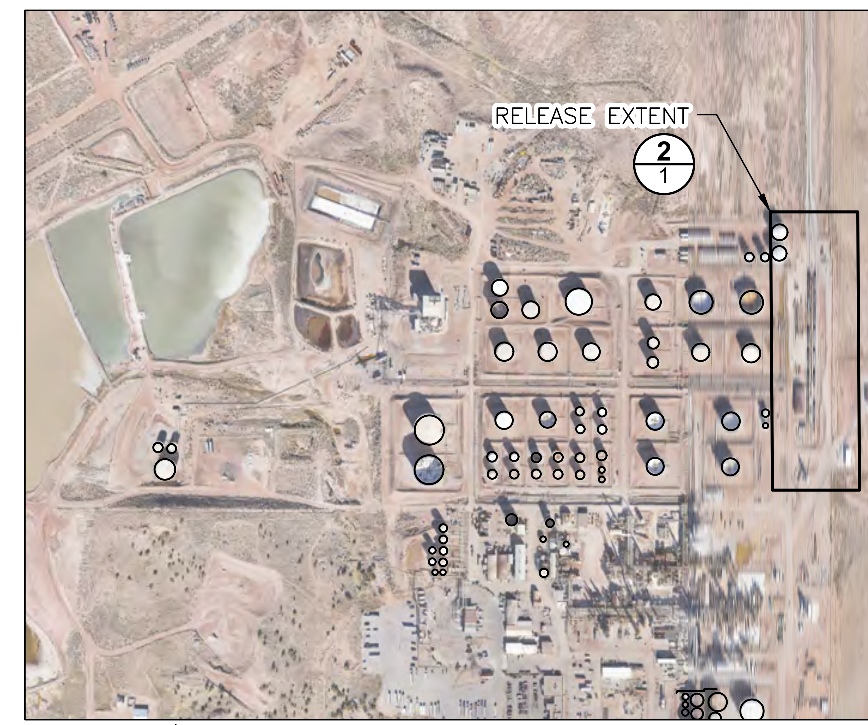

Image Cite: USDA /fsa – Aerial Photography Field Office, NAIP MrSID – Publication: 2014

1 KEY MAP
SCALE: 1" = 800'

0 800'
N

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FIGURE A-5

PROPOSED SAMPLE LOCATIONS

MARATHON PETROLEUM CORP.
GALLUP REFINING DIVISION
GALLUP, NEW MEXICO

Drawn By: REP	Checked By: PH	Scale: AS SHOWN	Date: 12/9/20	File: 697-RAILCARLOADINGRACK-RELEASE-202012

\\TRIHYDRO.COM\CLIENTS\TON\MARATHON\CADD\GALLUP_REPORTS\RELEASES\RAILCARLOADINGRACK\697-RAILCARLOADINGRACK-RELEASE-202012

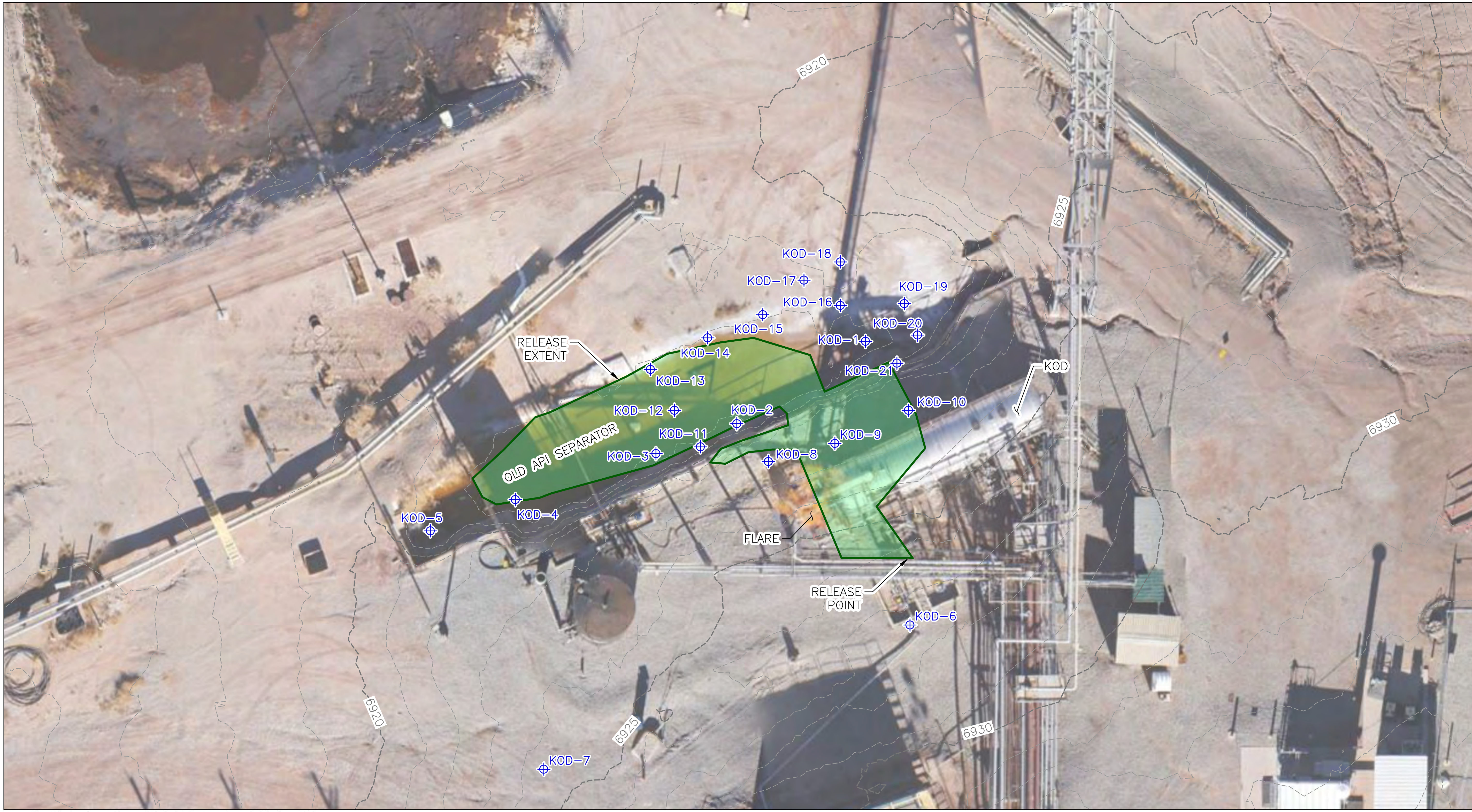

Image Cite: Trihydro Corporation - UAS Aerial Photography - Publication: 2018

\\TRIHYDRO.COM\CLIENTS\TON\MARATHON\CADD\GALLUP_REPORTS\RELEASES\FLARE_KODRELEASE\697-KOD-SAMPLOC-202108

EXPLANATION

KOD-7	SOIL SAMPLE AND DESIGNATION
	EXTENT OF SOIL IMPACTS
6935	EXISTING CONTAINMENT ELEVATION CONTOURS (INTERVAL = 1')
API	AMERICAN PETROLEUM INSTITUTE
KOD	KNOCKOUT DRUM

N

0 20'

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FIGURE A-6

SAMPLE LOCATIONS
FLARE KOD CAUSTIC RELEASE INVESTIGATION

WESTERN REFINING SOUTHWEST LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: REP	Checked By: EC	Scale: 1" = 20'	Date: 9/27/2021	File: 697-KOD-SAMPLOC-202108

Image Cite: DigitalGlobe © CNES (2020) Distribution Airbus DS © Microsoft Corporation, BING Imagery

EXPLANATION

- OW–65 MONITORING WELL AND DESIGNATION (APPROXIMATE)
- FRENCH DRAIN
- SD–2 STORM DRAIN AND DESIGNATION

N

0 200'

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FIGURE A-7

FRENCH DRAIN LOCATION

MARATHON PETROLEUM CORP.
GALLUP REFINING DIVISION
GALLUP, NEW MEXICO

Drawn By: REP	Checked By: JP	Scale: 1" = 200'	Date: 9/14/20	File: 697-FD-FRENCHDRAINLOC_202009

\\TRIHYDRO.COM\CLIENTS\TON\MARATHON\CADD\GALLUP_REPORTS\FRENCHDRAIN\WP\697-FD-FRENCHDRAINLOC_202009

EXPLANATION

- MONITORING WELL
- ESTIMATED LOCATION OF THE SANITARY PIPELINE
- PREVIOUSLY EXCAVATED PIPELINE
- SITE FEATURE

N

0 100 '

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FIGURE A-8

OVERVIEW SANITARY LAGOON AND PIPELINE LOCATIONS

MARATHON PETROLEUM COMPANY
GALLUP REFINING DIVISION
GALLUP, NEW MEXICO

Drawn By: KEJ	Checked By: BM	Scale: 1 " = 100 '	Date: 3/18/21	File: 2_Overview_SanitaryLagoon_Fig2.mxd

Image Cite: DigitalGlobe © CNES (2020) Distribution Airbus DS © Microsoft Corporation, BING Imagery

EXPLANATION

MKTF-34	EXISTING MONITORING WELL LOCATION AND DESIGNATION		AOC 35 BOUNDARY
			OILY WATER DRAIN LINE
□	EXISTING SUMP LOCATION	SS	SANITARY SEWER LINE

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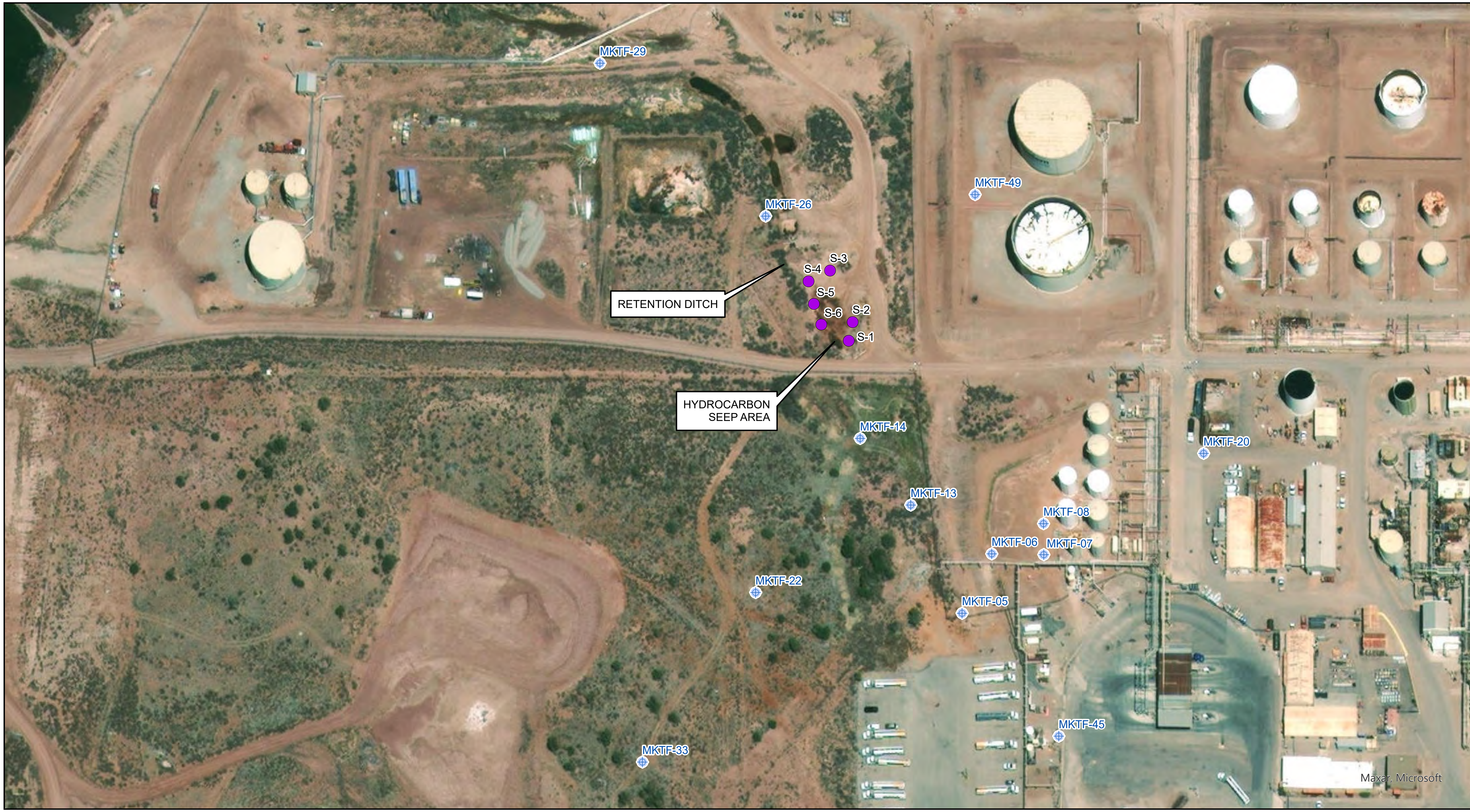
FIGURE A-9

AOC 35 MAP

WESTERN REFINING SOUTHWEST, LLC.
MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Drawn By: REP	Checked By: MS	Scale: 1" = 140'	Date: 8/23/2021	File: 697-GALLUPAOC35-SITEMAP_2021

M:\TON\MARATHON\CADD\GALLUP_REPORTS\AOC\AOC35-RTC\697-GALLUPAOC35-SITEMAP_2021



EXPLANATION

- HYDROCARBON SEEP SUMPS
- MONITORING WELLS WITH ONGOING SPH EXTRACTIONS

N

0 140'

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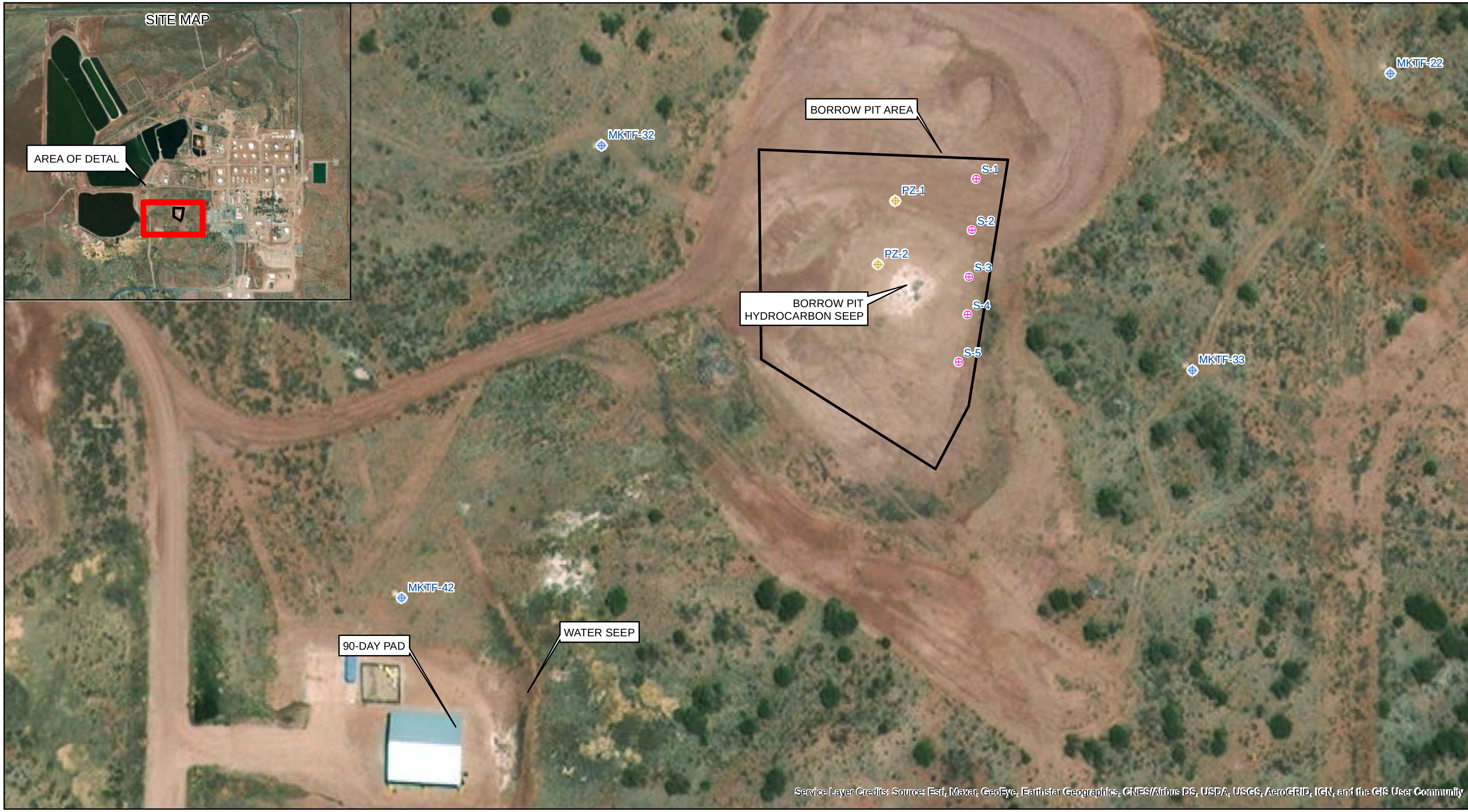
FIGURE A-10

HYDROCARBON SEEP AREA

WESTERN REFINING SOUTHWEST, LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

Drawn By: KEJ	Checked By: BM	Scale: 1" = 140'	Date: 10/12/21	File: 1_HydrocarbonSeepArea_Fig1

M:\ITONMARATHON\GIS\GALLUP\MAPPING\SITEWIDE FIGURES\HYDROCARBONSEEPAREA\QUARTERLYSEEPREPORTS\2021\3Q2021\3Q2021 HYDROCARBONSEEPAREA.APRX



EXPLANATION

- LOCATION OF SUMP
- PIEZOMETER LOCATION
- MONITORING WELL
- SITE FEATURE

N

0 80 '

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FIGURE A-11

BORROW PIT SUMPS

WESTERN REFINING SOUTHWEST, LLC
MARATHON GALLUP REFINERY
GALLUP, NEW MEXICO

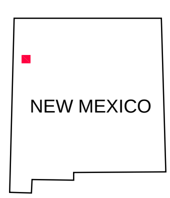
Drawn By: KEJ	Checked By: MS	Scale: 1 " = 80 '	Date: 7/26/21	File: 2_SumpPiez_BorrowPit_Fig2.mxd

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

0 500
SCALE IN FEET

LEGEND

SAMPLE LOCATION
FLOW DIRECTION
UNDERGROUND LINE



SITE LOCATION

MARATHON

MARATHON PETROLEUM COMPANY
GALLUP REFINERY

PROJ. NO.: Marathon	DATE: 06/26/19	FILE: Mathon–dA162

FIGURE A-12
EVAPORATION PONDS
FLOW PATH OF WASTEWATER
AND SAMPLING LOCATIONS

DiSorbo
Environmental Consulting Firm

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

Appendix B - Soil Moisture and Gravity Data

APPENDIX B1. SOIL GRAVITY DATA
WESTERN REFINING SOUTHWEST LLC, MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Location	Date Sampled	Sample Start Depth (ft)	Sample End Depth (ft)	Lab Result (g/cc)	Method
SATS S-V4 (Potentially Pyrophoric)	12/14/2019	0.00	0.00	4.14	SM20 2710 F
SWMU 1-1	1/15/2020	0.00	0.00	1.21	SM20 2710 F
SWMU 1-1	1/15/2020	0.50	3.00	1.12	SM20 2710 F
SWMU 1-1	1/15/2020	5.00	5.00	2.04	SM20 2710 F
SWMU 1-10	1/16/2020	4.50	5.00	2.01	SM20 2710 F
SWMU 1-10	1/16/2020	4.00	4.50	1.27	SM20 2710 F
SWMU 1-10	1/16/2020	0.00	0.00	1.20	SM20 2710 F
SWMU 1-11 (berm)	1/13/2020	1.50	1.50	1.71	SM20 2710 F
SWMU 1-11 (berm)	1/13/2020	5.00	5.00	2.15	SM20 2710 F
SWMU 1-11 (berm)	1/13/2020	2.50	2.50	2.04	SM20 2710 F
SWMU 1-11 (berm)	1/13/2020	7.50	7.50	1.85	SM20 2710 F
SWMU 1-11 (toe)	1/15/2020	2.50	2.50	1.96	SM20 2710 F
SWMU 1-11 (toe)	1/15/2020	0.00	0.00	1.09	SM20 2710 F
SWMU 1-12 (berm)	1/13/2020	2.50	2.50	2.11	SM20 2710 F
SWMU 1-12 (berm)	1/13/2020	5.00	5.00	2.09	SM20 2710 F
SWMU 1-12 (berm)	1/13/2020	1.50	1.50	1.88	SM20 2710 F
SWMU 1-12 (berm)	1/13/2020	7.50	7.50	1.82	SM20 2710 F
SWMU 1-12 (toe)	1/15/2020	0.00	0.00	1.03	SM20 2710 F
SWMU 1-12 (toe)	1/15/2020	3.00	3.00	1.91	SM20 2710 F
SWMU 1-12 (toe)	1/15/2020	2.50	2.50	1.98	SM20 2710 F
SWMU 1-13 (berm)	1/13/2020	9.00	9.00	2.11	SM20 2710 F
SWMU 1-13 (berm)	1/13/2020	7.50	7.50	2.05	SM20 2710 F
SWMU 1-13 (berm)	1/13/2020	2.50	2.50	2.11	SM20 2710 F
SWMU 1-13 (berm)	1/13/2020	5.00	5.00	2.06	SM20 2710 F
SWMU 1-13 (berm)	1/13/2020	5.00	5.00	2.13	SM20 2710 F
SWMU 1-13 (berm)	1/13/2020	1.50	1.50	2.08	SM20 2710 F
SWMU 1-13 (toe)	1/14/2020	0.00	0.00	1.77	SM20 2710 F
SWMU 1-13 (toe)	1/14/2020	0.00	0.00	1.77	SM20 2710 F
SWMU 1-13 (toe)	1/14/2020	3.00	3.00	1.97	SM20 2710 F
SWMU 1-14 (berm)	1/14/2020	1.50	1.50	2.07	SM20 2710 F
SWMU 1-14 (berm)	1/14/2020	5.00	5.00	1.64	SM20 2710 F
SWMU 1-14 (berm)	1/14/2020	7.50	7.50	1.89	SM20 2710 F
SWMU 1-14 (berm)	1/14/2020	5.00	5.00	2.15	SM20 2710 F
SWMU 1-14 (berm)	1/14/2020	2.50	2.50	1.82	SM20 2710 F
SWMU 1-14 (toe)	1/14/2020	0.00	0.00	1.39	SM20 2710 F
SWMU 1-14 (toe)	1/14/2020	3.00	3.00	1.97	SM20 2710 F
SWMU 1-14 (toe)	1/14/2020	2.50	2.50	1.39	SM20 2710 F
SWMU 1-15 (berm)	1/13/2020	2.50	2.50	1.76	SM20 2710 F
SWMU 1-15 (berm)	1/13/2020	1.50	1.50	2.02	SM20 2710 F
SWMU 1-15 (toe)	1/16/2020	4.00	5.00	1.20	SM20 2710 F

APPENDIX B1. SOIL GRAVITY DATA
WESTERN REFINING SOUTHWEST LLC, MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Location	Date Sampled	Sample Start Depth (ft)	Sample End Depth (ft)	Lab Result (g/cc)	Method
SWMU 1-15 (toe)	1/16/2020	0.00	0.00	1.25	SM20 2710 F
SWMU 1-15 (toe)	1/16/2020	3.00	3.00	1.92	SM20 2710 F
SWMU 1-15 (toe)	1/16/2020	0.00	0.00	1.29	SM20 2710 F
SWMU 1-16 (berm)	1/13/2020	1.50	1.50	2.14	SM20 2710 F
SWMU 1-16 (berm)	1/13/2020	2.50	2.50	1.77	SM20 2710 F
SWMU 1-16 (berm)	1/13/2020	1.50	1.50	2.18	SM20 2710 F
SWMU 1-16 (toe)	1/16/2020	4.00	4.50	1.88	SM20 2710 F
SWMU 1-16 (toe)	1/16/2020	2.50	2.50	1.19	SM20 2710 F
SWMU 1-16 (toe)	1/16/2020	0.00	0.00	1.10	SM20 2710 F
SWMU 1-16 (toe)	1/16/2020	0.00	0.00	1.13	SM20 2710 F
SWMU 1-17 (berm)	1/13/2020	2.50	2.50	2.01	SM20 2710 F
SWMU 1-17 (berm)	1/13/2020	1.50	1.50	2.21	SM20 2710 F
SWMU 1-17 (toe)	1/16/2020	0.00	0.00	1.29	SM20 2710 F
SWMU 1-17 (toe)	1/16/2020	2.50	2.50	1.64	SM20 2710 F
SWMU 1-17 (toe)	1/16/2020	4.50	5.00	1.92	SM20 2710 F
SWMU 1-18 (berm)	1/13/2020	2.50	2.50	1.70	SM20 2710 F
SWMU 1-18 (berm)	1/13/2020	1.50	1.50	2.11	SM20 2710 F
SWMU 1-18 (toe)	1/16/2020	5.00	5.00	1.94	SM20 2710 F
SWMU 1-18 (toe)	1/16/2020	0.00	0.00	1.34	SM20 2710 F
SWMU 1-18 (toe)	1/16/2020	2.50	2.50	1.26	SM20 2710 F
SWMU 1-19 (berm)	1/13/2020	1.50	1.50	2.04	SM20 2710 F
SWMU 1-19 (berm)	1/13/2020	2.50	2.50	1.86	SM20 2710 F
SWMU 1-19 (toe)	1/16/2020	0.00	0.00	1.39	SM20 2710 F
SWMU 1-19 (toe)	1/16/2020	0.00	0.00	1.36	SM20 2710 F
SWMU 1-19 (toe)	1/16/2020	6.00	6.50	1.90	SM20 2710 F
SWMU 1-19 (toe)	1/16/2020	0.50	6.00	1.37	SM20 2710 F
SWMU 1-2	1/15/2020	3.00	3.50	1.90	SM20 2710 F
SWMU 1-2	1/15/2020	0.00	0.00	1.12	SM20 2710 F
SWMU 1-2	1/15/2020	0.00	0.00	1.16	SM20 2710 F
SWMU 1-2	1/15/2020	2.00	2.50	1.20	SM20 2710 F
SWMU 1-20 (berm)	1/14/2020	2.50	2.50	1.93	SM20 2710 F
SWMU 1-20 (toe)	1/15/2020	0.00	0.00	1.58	SM20 2710 F
SWMU 1-20 (toe)	1/15/2020	5.00	5.00	1.92	SM20 2710 F
SWMU 1-20 (toe)	1/15/2020	5.00	5.00	1.91	SM20 2710 F
SWMU 1-20 (toe)	1/14/2020	1.50	1.50	2.10	SM20 2710 F
SWMU 1-20 (toe)	1/15/2020	0.50	3.00	1.18	SM20 2710 F
SWMU 1-21 (berm)	1/14/2020	1.50	1.50	2.08	SM20 2710 F
SWMU 1-21 (toe)	1/14/2020	2.50	2.50	1.90	SM20 2710 F
SWMU 1-21 (toe)	1/14/2020	0.00	0.00	1.81	SM20 2710 F
SWMU 1-21 (toe)	1/14/2020	5.00	5.00	2.04	SM20 2710 F

APPENDIX B1. SOIL GRAVITY DATA
WESTERN REFINING SOUTHWEST LLC, MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Location	Date Sampled	Sample Start Depth (ft)	Sample End Depth (ft)	Lab Result (g/cc)	Method
SWMU 1-22 (berm)	1/14/2020	5.00	5.00	1.58	SM20 2710 F
SWMU 1-22 (berm)	1/14/2020	2.50	2.50	1.95	SM20 2710 F
SWMU 1-22 (berm)	1/14/2020	1.50	1.50	2.17	SM20 2710 F
SWMU 1-22 (toe)	1/16/2020	3.50	4.00	1.99	SM20 2710 F
SWMU 1-22 (toe)	1/16/2020	2.50	2.50	1.36	SM20 2710 F
SWMU 1-22 (toe)	1/16/2020	0.00	0.00	1.36	SM20 2710 F
SWMU 1-3	1/14/2020	0.50	3.00	1.27	SM20 2710 F
SWMU 1-3	1/14/2020	3.00	3.00	1.85	SM20 2710 F
SWMU 1-3	1/14/2020	0.00	0.50	1.36	SM20 2710 F
SWMU 1-4	1/14/2020	0.00	0.00	1.16	SM20 2710 F
SWMU 1-4	1/14/2020	3.00	3.50	1.92	SM20 2710 F
SWMU 1-4	1/14/2020	3.00	3.00	1.12	SM20 2710 F
SWMU 1-5	1/17/2020	2.50	5.00	1.20	SM20 2710 F
SWMU 1-5	1/17/2020	0.00	0.00	1.28	SM20 2710 F
SWMU 1-5	1/17/2020	5.50	6.00	1.78	SM20 2710 F
SWMU 1-6	1/17/2020	0.00	5.50	1.25	SM20 2710 F
SWMU 1-6	1/17/2020	5.50	6.00	1.95	SM20 2710 F
SWMU 1-7	1/17/2020	4.00	5.00	1.97	SM20 2710 F
SWMU 1-7	1/17/2020	0.00	0.00	1.58	SM20 2710 F
SWMU 1-7	1/17/2020	0.00	0.00	1.56	SM20 2710 F
SWMU 1-7	1/17/2020	2.50	2.50	1.15	SM20 2710 F
SWMU 1-8	1/16/2020	0.00	0.00	1.35	SM20 2710 F
SWMU 1-8	1/16/2020	2.50	2.50	1.42	SM20 2710 F
SWMU 1-8	1/16/2020	5.00	5.50	1.92	SM20 2710 F
SWMU 1-9	1/16/2020	0.00	0.00	1.51	SM20 2710 F
SWMU 1-9	1/16/2020	4.50	4.50	1.24	SM20 2710 F
SWMU 1-9	1/16/2020	5.50	6.00	1.92	SM20 2710 F

Notes:
ft - feet
g/cc - gram per cubic centimeter

APPENDIX B2. SOIL MOISTURE DATA
WESTERN REFINING SOUTHWEST LLC, MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Location	Date Sampled	Sample Start Depth (ft)	Sample End Depth (ft)	Lab Result (%)	Lab Limit	Method
Filter Cake	12/20/2016	0	0	58	1	D2216
NDD-10	5/19/2016	0	0.5	14	1	D2216
NDD-10	5/19/2016	1.5	2	13	1	D2216
NDD-11	5/23/2016	0	0.5	6.4	1	D2216
NDD-11	5/23/2016	1.5	2	15	1	D2216
NDD-11	5/23/2016	12	14	15	1	D2216
NDD-12	5/19/2016	0	0.5	16	1	D2216
NDD-12	5/19/2016	1.5	2	8.3	1	D2216
NDD-13	5/19/2016	0	0.5	25	1	D2216
NDD-13	5/19/2016	1.5	2	26	1	D2216
NDD-14	5/19/2016	0	0.5	26	1	D2216
NDD-14	5/19/2016	1.5	2	21	1	D2216
NDD-15	5/19/2016	0	0.5	19	1	D2216
NDD-15	5/19/2016	1.5	2	18	1	D2216
NDD-16	5/24/2016	0	0.5	26	1	D2216
NDD-16	5/24/2016	1.5	2	24	1	D2216
NDD-16	5/24/2016	14	16	16	1	D2216
NDD-16	5/24/2016	22	24	17	1	D2216
NDD-17	5/19/2016	0	0.5	16	1	D2216
NDD-17	5/19/2016	1.5	2	20	1	D2216
NDD-4	5/23/2016	0	0.5	12	1	D2216
NDD-4	5/23/2016	1.5	2	8.7	1	D2216
NDD-4	5/23/2016	8	10	15	1	D2216
NDD-4	5/23/2016	18	20	18	1	D2216
NDD-5	5/19/2016	0	0.5	17	1	D2216
NDD-5	5/19/2016	1.5	2	20	1	D2216
NDD-6	5/23/2016	0	0.5	28	1	D2216
NDD-6	5/23/2016	1.5	2	22	1	D2216
NDD-6	5/23/2016	4	6	19	1	D2216
NDD-6	5/23/2016	10	12	15	1	D2216
NDD-7	5/19/2016	0	0.5	23	1	D2216
NDD-7	5/19/2016	1.5	2	25	1	D2216
NDD-8	5/19/2016	0	0.5	28	1	D2216
NDD-8	5/19/2016	1.5	2	26	1	D2216
NDD-9	5/19/2016	0	0.5	20	1	D2216
NDD-9	5/19/2016	1.5	2	19	1	D2216
OW-54	5/25/2016	14	16	1.5	1	D2216
OW-55	5/24/2016	16	18	18	1	D2216
OW-55	5/24/2016	30	32	17	1	D2216
SB01	10/19/2015	0	0.5	7.2	1	D2216

APPENDIX B2. SOIL MOISTURE DATA
WESTERN REFINING SOUTHWEST LLC, MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Location	Date Sampled	Sample Start Depth (ft)	Sample End Depth (ft)	Lab Result (%)	Lab Limit	Method
SB02	10/19/2015	0	0.5	15	1	D2216
SB03	10/19/2015	0	0.5	13	1	D2216
SB04	10/19/2015	0	0.5	12	1	D2216
SB05	10/19/2015	0	0.5	15	1	D2216
SB06	10/19/2015	0	0.5	3.2	1	D2216
SB07	10/19/2015	0	0.5	5.1	1	D2216
SB08	10/19/2015	0	0.5	6.8	1	D2216
SB09	10/19/2015	0	0.5	22	1	D2216
SB10	10/19/2015	0	0.5	19	1	D2216
SB11	10/19/2015	0	0.5	19	1	D2216
SB12	10/19/2015	0	0.5	11	1	D2216
SB13	10/19/2015	0	0.5	23	1	D2216
SB14	10/19/2015	0	0.5	17	1	D2216
SB15	10/19/2015	0	0.5	3.7	1	D2216
SB16	10/19/2015	0	0.5	6.7	1	D2216
SWMU 10-1	4/28/2015	2	4	19	1	D2216
SWMU 10-1	4/28/2015	4	6	21	1	D2216
SWMU 10-1	4/28/2015	18	20	15	1	D2216
SWMU 10-10	4/30/2015	2	4	12	1	D2216
SWMU 10-10	4/30/2015	4	6	18	1	D2216
SWMU 10-10	4/30/2015	18	20	15	1	D2216
SWMU 10-11	5/12/2015	4	6	11	1	D2216
SWMU 10-11	5/12/2015	8	10	17	1	D2216
SWMU 10-11	5/12/2015	18	20	12	1	D2216
SWMU 10-12	5/12/2015	6	8	14	1	D2216
SWMU 10-12	5/12/2015	20	22	8.9	1	D2216
SWMU 10-13	5/13/2015	2	4	6	1	D2216
SWMU 10-13	5/13/2015	6	8	15	1	D2216
SWMU 10-13	5/13/2015	18	20	9.1	1	D2216
SWMU 10-14	5/12/2015	6	8	11	1	D2216
SWMU 10-14	5/12/2015	21	23	9.5	1	D2216
SWMU 10-15	5/13/2015	2	4	16	1	D2216
SWMU 10-15	5/13/2015	4	6	15	1	D2216
SWMU 10-15	5/13/2015	18	20	7.9	1	D2216
SWMU 10-16	5/13/2015	8	9	10	1	D2216
SWMU 10-16	5/13/2015	2	4	11	1	D2216
SWMU 10-16	5/13/2015	4	5.5	9.9	1	D2216
SWMU 10-17	5/13/2015	6	8	13	1	D2216
SWMU 10-18	5/16/2016	2	2.5	17	1	D2216
SWMU 10-18	5/16/2016	8	10	16	1	D2216

APPENDIX B2. SOIL MOISTURE DATA
WESTERN REFINING SOUTHWEST LLC, MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Location	Date Sampled	Sample Start Depth (ft)	Sample End Depth (ft)	Lab Result (%)	Lab Limit	Method
SWMU 10-18	5/16/2016	18	20	14	1	D2216
SWMU 10-19	5/17/2016	2	2.5	17	1	D2216
SWMU 10-19	5/17/2016	12	14	14	1	D2216
SWMU 10-19	5/17/2016	18	20	12	1	D2216
SWMU 10-2	5/4/2015	0	2	16	1	D2216
SWMU 10-2	5/4/2015	2	4	13	1	D2216
SWMU 10-20	5/17/2016	2	2.5	17	1	D2216
SWMU 10-20	5/17/2016	8	10	21	1	D2216
SWMU 10-20	5/17/2016	10	12	21	1	D2216
SWMU 10-20	5/17/2016	16	18	16	1	D2216
SWMU 10-20	5/17/2016	20	22	12	1	D2216
SWMU 10-21	5/18/2016	2	2.5	7.7	1	D2216
SWMU 10-21	5/18/2016	12	14	19	1	D2216
SWMU 10-21	5/18/2016	20	22	12	1	D2216
SWMU 10-22	5/18/2016	2	2.5	19	1	D2216
SWMU 10-22	5/18/2016	8	9	17	1	D2216
SWMU 10-23	9/19/2016	2	2.5	11	1	D2216
SWMU 10-23	9/19/2016	15	16	12	1	D2216
SWMU 10-24	9/19/2016	2	2.5	2.6	1	D2216
SWMU 10-24	9/19/2016	6	8	20	1	D2216
SWMU 10-24	9/19/2016	8	10	16	1	D2216
SWMU 10-24	9/19/2016	15	16	12	1	D2216
SWMU 10-25	9/19/2016	2	2.5	13	1	D2216
SWMU 10-25	9/19/2016	10	12	18	1	D2216
SWMU 10-25	9/19/2016	16.5	18	12	1	D2216
SWMU 10-3	4/28/2015	2	4	16	1	D2216
SWMU 10-3	4/28/2015	6	8	19	1	D2216
SWMU 10-3	4/28/2015	18	20	17	1	D2216
SWMU 10-4	4/29/2015	0	2	11	1	D2216
SWMU 10-4	4/29/2015	2	4	21	1	D2216
SWMU 10-4	4/29/2015	6	8	16	1	D2216
SWMU 10-4	4/29/2015	18	20	13	1	D2216
SWMU 10-5	4/29/2015	0	2	16	1	D2216
SWMU 10-5	4/29/2015	2	4	31	1	D2216
SWMU 10-5	4/29/2015	4	6	50	1	D2216
SWMU 10-5	4/29/2015	14	16	49	1	D2216
SWMU 10-5	4/29/2015	22	24	12	1	D2216
SWMU 10-6	5/4/2015	2	4	9.6	1	D2216
SWMU 10-6	5/4/2015	10	12	16	1	D2216
SWMU 10-7	5/1/2015	2	4	16	1	D2216

APPENDIX B2. SOIL MOISTURE DATA
WESTERN REFINING SOUTHWEST LLC, MARATHON GALLUP REFINERY, GALLUP, NEW MEXICO

Location	Date Sampled	Sample Start Depth (ft)	Sample End Depth (ft)	Lab Result (%)	Lab Limit	Method
SWMU 10-7	5/1/2015	4	6	16	1	D2216
SWMU 10-7	5/1/2015	18	20	15	1	D2216
SWMU 10-8	4/30/2015	2	4	12	1	D2216
SWMU 10-8	4/30/2015	4	6	14	1	D2216
SWMU 10-8	4/30/2015	18	20	14	1	D2216
SWMU 10-9	4/30/2015	4	6	17	1	D2216
SWMU 10-9	4/30/2015	18	20	14	1	D2216
SWMU 10-9	4/30/2015	2	4	14	1	D2216
WWTP Primary Filter	10/19/2017	0	0	50	1	D2216

Notes:
ft - feet
% - percent

District I
1625 N. French Dr., Hobbs, NM 88240
Phone:(575) 393-6161 Fax:(575) 393-0720
District II
811 S. First St., Artesia, NM 88210
Phone:(575) 748-1283 Fax:(575) 748-9720
District III
1000 Rio Brazos Rd., Aztec, NM 87410
Phone:(505) 334-6178 Fax:(505) 334-6170
District IV
1220 S. St Francis Dr., Santa Fe, NM 87505
Phone:(505) 476-3470 Fax:(505) 476-3462

State of New Mexico
Energy, Minerals and Natural Resources
Oil Conservation Division
1220 S. St Francis Dr.
Santa Fe, NM 87505

CONDITIONS

Action 85932

CONDITIONS

Operator:	OGRID:
Western Refining Southwest LLC 539 South Main Street Findlay, OH 45840	267595
	Action Number: 85932
	Action Type: [UF-DP] Discharge Permit (DISCHARGE PERMIT)

CONDITIONS

Created By	Condition	Condition Date
jburdine	Accepted for Record Retention Purposes-Only	11/23/2022