FINAL

Final
Corrective Action Study (CAS)
Former Coastal Refinery, El Dorado, KS

El Paso Merchant Energy-Petroleum Company
Houston, Texas

July 2014

FINAL
CORRECTIVE ACTION STUDY
(CAS)

for the

FORMER COASTAL REFINERY
EL DORADO, KANSAS

Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

ACL	Alternate Cleanup Level
AHA	Asphalt Handling Area
AOC	Area of concern
API	American Petroleum Institute
ARAR	Applicable or relevant and appropriate requirement
AS	Air sparge
AST	Aboveground storage tank
bcy	Bank cubic yard
BER	Bureau of Environmental Remediation
BERA	Baseline Ecological Risk Assessment
bgs	Below ground surface
BMP	Best Management Practice
BOW	Bureau of Water
BWM	Bureau of Waste Management
CA	Cascade aerator
CAD	Corrective Action Decision
CAG	Corrective action goal
CAP	Corrective Action Plan
CAS	Corrective Action Study
CD	Compact disk
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CI	Comprehensive Investigation
COC	Contaminant of concern
CPEP	Corrugated polyethylene pipe
CVOC	Chlorinated volatile organic compound
cy	Cubic yards
DPE	Dual-phase extraction
DRO	Diesel-range organics
EPA	Environment Protection Agency
EPME-PC	El Paso Merchant Energy-Petroleum Company
ES	Extraction sump
EUC	Environmental Use Control
EWP	Excavation Work Plan
°F	Degrees Fahrenheit
Fina	American Petrofina Oil and Chemical Company
FML	Flexible membrane liner
FS	Furnace slag
GAC	Granular activated carbon
gpm	Gallons per minute
GPS	Global positioning system

GRO	Gasoline-range organics
GTS	Groundwater Treatment System
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCS	Hydraulic control structure
HDPE	High-density polyethylene
HF	Hydrofluoric
HHRA	Human Health Risk Assessment
HI	Hazard index
HMW	High molecular weight
HQ	Hazard Quotient
HSP	Health and Safety Plan
IRM	Interim remedial measures
ISCO	In-situ chemical oxidation
IT	Interceptor Trench
KDHE	Kansas Department of Health and Environment
KDOT	Kansas Department of Transportation
LNAPL	Light non-aqueous phase liquid
LOAEL	Lowest-observed-adverse-effects level
LOCP	Landfarm Operation and Closure Plan
LTM	Long-term groundwater monitoring
MCL	Maximum Contaminant Level
mg/kg	Milligrams per kilogram
MNA	Monitored natural attenuation
MPA	Main Process Area
MPE	Multi-phase extraction
MTBE	Methyl tert-butyl ether
MWH	MWH Americas, Inc
NCP	National Contingency Plan
NGVD	National Geodetic Vertical Datum
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
NSZD	Natural source zone depletion
O&M	Operation and maintenance
OCM	Organo-clay media
OSA	Off-site area
OSHA	Occupational Safety and Health Administration
OWS	Oil-water separator
PAH	Polycyclic aromatic hydrocarbon
PC	Portland cement
Pester	Pester Refining Company
PID	Photoionization detector
PSB	Precipitation and Settling Basin
QAPP	Quality Assurance Project Plan
RAO	Remedial action objectives

RBC	Risk-based concentration
RBSL	Risk-based screening level
RCC	Recycled crushed concrete
RME	Reasonable maximum exposure
ROSE	Residual Oil Supercritical Extraction
RSK	KDHE Risk-Based Standards for Kansas
SCM	Site conceptual model
SG	specific gravity
SLERA	Screening Level Ecological Risk Assessment
SPCC	Spill Prevention Controls and Countermeasures Plan
STF	South Tank Farm
SVE	Soil vapor extraction
SWMP	Soil-Waste Management Plan
SWP3	Storm Water Pollution Prevention Plan
T&D	Transportation and Disposal
TCLP	Toxicity characteristic leaching procedure
TPH	Total petroleum hydrocarbons
TRV	Toxicity reference value
UOWS	Underground oil-water separator
VOC	Volatile organic compound
UST	Underground Storage Tank
WBWR	West Branch Walnut River

EXECUTIVE SUMMARY

The purpose of this Corrective Action Study (CAS) is to evaluate and compare remedial alternatives for the former Coastal Refinery located north of the City of El Dorado, Kansas (Site), which is currently owned by El Paso Merchant Energy-Petroleum Company (EPME-PC). Petroleum refining operations began in 1917 and continued through 1993. Final petroleum-related activities ended in 2004 with the termination of asphalt blending operations.

Numerous investigation phases have been completed, leading to creation of a conceptual site model (CSM) and related understanding of the nature and extent of free-phase (free product), sorbed-phase (soil) and dissolved-phase (groundwater) light non-aqueous phase liquid (LNAPL) and its movement, as controlled by the local hydrogeology. The contaminants of concern (COCs) are primarily petroleum-related and include: benzene, naphthalene, total petroleum hydrocarbons (TPH)-gasoline range organics (GRO) and TPH-diesel range organics (DRO). Related isolated lead and arsenic impacts are also present, as well as methyl tert-butyl ether (MTBE) and trichloroethane (TCA) related to activities at a former Site laboratory. Neither chemical was used within the refinery itself. All hydrocarbon impacts are confined to the Site, with the exception of a groundwater plume migrating off-site into a residential area and business. The main plume that historically discharged to a nearby river is now contained.

The first interim remedial measure (IRM) completed at the Site was installation of a Seep Interceptor Trench (IT). This has been successful in preventing further discharge of impacted groundwater to the river. Several other IRMs were also completed, including closure of all refinery process, stormwater and other piping; excavation of a large stormwater channel and basin; installation of an additional IT underlying that basin; consolidation of all asphaltic wastes; closure of all the former wastewater/stormwater ponds, which included stabilization and capping of all sediments and other wastes; and construction of a new wetland-based groundwater treatment system (GTS).

Site-specific human health and ecological risk assessments were completed. They found no significant ecological risks and moderate human health risks. The human health risks were primarily related to select receptors either drinking Site groundwater or being exposed to petroleum vapors (e.g., if an unprotected building was constructed on Site or utility workers entered a trench). Alternative cleanup levels (ACLs) were considered, and while EPME-PC may calculate and request use of them in the future to help assess when active treatment should cease, it was determined ACLs would not impact the CAS alternative costing or change remedy selection. Therefore, the Kansas Department of Health and Environment (KDHE) Risk-Based Standards for Kansas (RSK) are used throughout the CAS to define areas and volumes of interest. For off-site groundwater, Residential standards are used and for both on-site groundwater and soil, the Non-Residential standards are used because proposed institutional controls (Environmental Use Controls [EUCs]) are anticipated to prohibit on-site residents.

The proposed corrective action goals (CAGs) are to 1) address wastes; 2) address practically recoverable LNAPL; 3) control migration of contaminants from soils that hinder achieving groundwater Applicable or Relevant and Appropriate Requirements (ARARs); 4) prevent off-site migration of dissolved-phase plumes or LNAPL; 5) protect the river and creek; 6) prevent exposure to all soil, soil vapors, and groundwater exceeding RBSL; and 7) restore groundwater to its most beneficial use.

The CAGs resulted in the selection of the 12 potentially applicable technologies that were combined into three complete alternatives for each of the four Site areas of concern (AOCs). Each AOC includes a "No Action" alternative (Alternative 1); an alternative that builds on the IRM work, adding protective and remedial components (Alternative 2); and an alternative that adds additional (or different) remedial components to each Alternative 2 to remove more contaminant mass more rapidly. These were each compared against EPA's evaluation criteria.

In addition to the millions of dollars of IRM work already completed, the recommended additional action is Alternative 2 for each AOC, which includes the following shared/common components:

- Long-term monitoring (LTM),
- Monitored natural attenuation (MNA) & natural source zone depletion (NSZD) *if confirmed,*
- Environmental Use Controls (EUCs) and Soil-Waste Management Plan (SWMP),
- LNAPL/Product Skimming,
- Groundwater treatment system (GTS) operation (for Hydraulic Containment),

and the following AOC-specific components:

- **Main Process Area (MPA)**
    - Hydraulic Containment: MPA Channel IT, MPA Basin IT, Seep IT
    - MPA Spring System Continued Operation
    - Phytoremediation
- **Asphalt Handling Area (AHA)**
    - Hydraulic Containment: MPA Spring System and MPA Basin IT
- **South Tank Farm (STF)**
    - Excavate, Stabilize, and Dispose of Known Waste
    - Hydraulic Containment: MPA Basin IT, and STF northeast (NE) Plume IT
    - STF Creek Surface Water Sampling and Contingency Interceptor Trenches
- **Stormwater Pond Area (SPA)**
    - Hydraulic Containment: Seep IT
    - Inspect and Maintain Cap

The above systems provide the primary protection for the off-site areas. In addition, a sub-slab vapor survey will be completed in two homes within the current STF groundwater plume (with contingency vapor abatement as required) and periodic water well surveys will be conducted to provide protection until the off-site plume is contained.

1.0 INTRODUCTION

This document presents a Corrective Action Study (CAS) that was prepared to evaluate and compare remedial alternatives for the former Coastal Refinery located north of the City of El Dorado, Kansas (Site). The Site is currently owned by El Paso Merchant Energy-Petroleum Company (EPME-PC). The purpose of this section is to introduce the Site and CAS Process.

1.1 CAS PROCESS

In accordance with the Kansas Department of Health and Environment (KDHE) Bureau of Environmental Remediation (BER) scope of work (SOW) for a Corrective Action Study (CAS) Report (BER-RS-019), the primary objectives of a CAS are to:

1. Evaluate the feasibility, effectiveness, and cost of at least two potential remedial actions based on the findings of the Comprehensive Investigation (CI), and to compare and contrast those alternatives to each other and the "no action" alternative;
2. recommend and justify a specific corrective action for the Site; and
3. evaluate the health and environmental effects of the remedial action.

BER-RS-019 also states the CAS will include:

1. **Investigations and Risk Assessment**: A summary of the findings of previous environmental investigations, including a risk assessment, if performed. This will include a description of the contaminants of concern (COCs) within each environmental media; an identification of all real and potential human and environmental targets; and an evaluation of all direct and indirect exposure pathways;
2. **Corrective Action Goals (CAGs)**: A description of the site-specific CAGs;
3. **Corrective Action Alternatives (Process Options)**: A description of each corrective action alternative evaluated, including the "no action" alternative;
4. **Detailed Evaluation of Assembled Alternatives**: A detailed discussion of each corrective action alternative evaluated in the context of the prior discussions, any treatability studies completed and their ability to satisfy the following criteria:
    a. overall protection of human health and environment,
    b. compliance with Federal and State applicable, or relevant and appropriate requirements (ARARs),
    c. long-term effectiveness and permanence,
    d. reduction of toxicity, mobility and volume of contamination through treatment,
    e. short-term effectiveness,
    f. implementability,
    g. cost, and
    h. community acceptance.

The “greenness” or overall environmental impact of each technology will be noted under the *overall protection of human health and environment* category.

5. **Recommendation**: A recommendation for corrective action at the site; and
6. **Background**: An appendix containing any background information or literature which was used to evaluate each corrective action alternative.

1.2 SITE DESCRIPTION

The former Coastal Refinery is located north of the City of El Dorado, Kansas in portions of Sections 26, 27, 34, and 35, Township 25 South, Range 5 East, Butler County, Kansas as shown in Figure 1-1. The Site includes 1) a former process area for the refinery, referred to herein as the Main Process Area (MPA); 2) vacant property to the west, referred to herein as the Asphalt Handling Area (AHA); 3) the former tank farm located due south of the refinery, referred to herein as the South Tank Farm (STF); and 4) water treatment wetlands ponds (former wastewater/stormwater) to the east, referred to as the Stormwater Pond Area (SPA), as shown in Figure 1-2. The West Branch Walnut River (WBWR) defines the northeastern boundary of the Site. The Site does not include the adjacent Pester Burn Pond Superfund site, which is located north of the SPA.

North Topeka Street and a residential area are located to the east of the STF. Vacant pasture land abuts the western and northern boundary of the Site and the Site is bounded to the south by residential and commercial properties.

1.3 SITE HISTORY

The refinery was constructed in 1917 for the Pester Refining Company (Pester). Petro Atlas purchased the refinery in 1958, and within six months, sold the refinery to American Petrofina Oil and Chemical Company (Fina). Fina owned the refinery and surrounding property between 1958 and 1977. In 1977, Pester purchased the property from Fina and continued to operate the refinery until filing Chapter 11 bankruptcy on February 25, 1985. The crude unit and most of the other operational units were shut down in March 1985.

On April 10, 1986, Coastal Refining Company purchased the land and equipment at the refinery from Pester, excluding the Burn Pond. At that time, the major process units at the refinery included crude oil distillation, hydrodesulfurization, catalytic reforming, fluid catalytic cracking, hydrofluoric (HF) alkylation, and Residual Oil Supercritical Extraction (ROSE).

The refinery produced regular and unleaded gasoline, #2 fuel oil, #6 fuel oil, propane, and asphalt. An asphalt blending facility was operated at the Site until September 2004. The Site ownership and operational history is summarized in Figure 1-3.

1.4 PROJECT HISTORY

Numerous investigations, reports, evaluations, and designs for interim remedial measures (IRMs) have contributed to the current understanding of the Site conceptual model (SCM) and the abatement of the Site's environmental risks. These data are the foundation for the work remaining and this CAS. A timeline of the Site investigation, risk assessment, and previously completed remediation is included in Figure 1-3. The following is a list of the primary historical documents with abbreviated names noted for reference later in this document. Each has associated work plans, comments, response to comments, and/or draft versions, which for brevity are omitted from this list:

- *Preliminary Field Summary for Investigation of The Pester Refining Company at El Dorado, Kansas*, prepared by Sunbelt Environmental Management, Inc. and MidWest Analytical Labs, Inc., March 1987 (Preliminary Investigation Report)
- *First Phase Comprehensive Investigation Report for the Coastal El Dorado Refinery, El Dorado, Kansas*, Prepared by Brown and Caldwell and Shaw Environmental Inc., January 22, 2004 (First Phase Investigation Report).
- *Second Phase Investigation Report, El Dorado Refinery, El Dorado Kansas,* prepared by MWH, October, 2005 (Second Phase Investigation Report)
- *Seep Interceptor Final Design,* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, February 2006 (Seep IT Design)
- *Seep Interceptor Trench Record Drawings*, El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, February 2007, (Seep IT As-Builts)
- *Sub-slab Vapor Investigation Letter Report,* El Paso Merchant Energy-Petroleum Company 1800 North Topeka Street Residence, El Dorado, Kansas prepared by MWH, March 2009, (Sub-slab Vapor Report)
- *Third Phase Environmental Investigation Report*, El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, September 2009 (Third Phase Investigation Report)
- *Off-site Well Survey*, Appendix I, Third Phase Investigation Report, El Dorado, Kansas, prepared by MWH, September 2009
- *2011 Annual Surface Water Report*, El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, January 2012, (2011 Surface Water Report)
- 2012 *Annual Surface Water Report*, El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, July 2012 (2012 Surface Water Report)

- *Wastewater Pond Sediment Stabilization Treatability Study Status Letter Report,* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, January 2010, (Pond Sediment Stabilization Treatability Study Letter Report)
- *MPA Grading, Sewer, and Basin Design Report,* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, April 2010, (MPA Grading, Sewer, and Basin Design)
- *Asphalt Handling Area Stabilization Treatability Study Letter Report*, El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, September 2010, (AHA Treatability Study)
- *Wastewater/Stormwater Pond Sediment Stabilization Treatability Study Letter Report,* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, September 2010, (Pond Sediment Treatability Study)
- *Final (100%) Water Treatment Design,* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, April 2011, (Water Treatment Design)
- *Final (100%) Wastewater/Stormwater Pond and Asphalt Handling Area Interim Measures Closure Work Plan/Design*, El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, May 2011, (AHA and Pond Closure Design)
- *Final Focused Site-Specific Risk Assessment 40 Acre Tract of South Tank Farm*, Former El Dorado Refinery Site, El Dorado, Kansas, prepared by URS, July 2011 (40-Acre STF HHRA)
- *Final Baseline Ecological Risk Assessment (BERA),* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by URS, June 2011, (MPA and AHA BERA) with January 23, 2012 Response to KDHE Comments letter incorporated by reference.
- *Addition of an Underground Oil/Water Separator (UOWS) to the April 2011, Final (100%) Water Treatment Design,* El Dorado Refinery, El Dorado, Kansas, letter and Technical Memo design prepared by MWH, July 2011 (UOWS Design)
- *OWS Influent and Effluent Water Sample Results Report,* El Paso Merchant Energy-Petroleum Company, Former Coastal Refinery, El Dorado Site, prepared by MWH, August 2011, (OWS Sampling Results Letter Report)
- *Final Human Health Risk Assessment (HHRA),* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by URS, February 2012, (Site-Wide HHRA)

- *Final Baseline Ecological Risk Assessment (BERA) West Branch Walnut River and South Tank Farm,* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by URS, March 2012, (WBWR and STF BERA)
- *MPA Spring Mitigation System Design,* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, June 2012, (MPA Spring Design)
- *Interim Remedial Measures Construction Completion Report,* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, May 2013, (IRM CCR)
- *MPA Spring Tar Treatment System Design,* El Paso Merchant Energy-Petroleum Company, El Dorado Refinery, El Dorado, Kansas, prepared by MWH, October 2013, (MPA Spring Tar Treatment Design)
- *Soil-Waste Management Plan (SWMP),* El Paso Merchant Energy-Petroleum Company, Former Coastal Refinery, El Dorado, Kansas, prepared by MWH, March 2014, (SWMP).

In addition, numerous National Pollutant Discharge Elimination System (NPDES) and quarterly or semi-annual progress reports, such as the "*Second Half 2013 Semi-Annual Combined Interceptor Trench Operation, Maintenance, and Monitoring and Groundwater Monitoring Progress Report, El Dorado Refinery, El Dorado, Kansas, February 2014"* (Semi-annual Report), have been submitted documenting site operation and maintenance (O&M), long-term groundwater monitoring, stormwater sampling, and other Site activities.

1.5 HISTORICAL DATA

Given the long Site history of investigation and remediation, thousands of pages of previously submitted report and design text, tables, figures, and drawings exist. It is not practical to include all potentially relevant historical tables (843 pages) and figures/drawings (235 pages) in this CAS text or even as a hard-copy appendix; therefore, only select representative figures and high level summary tables are included. It is possible that detailed historical data may benefit some reviews; therefore, a compact disk (CD) has been included as Appendix A – Historical and Reference Documents. The CD contains adobe (pdf) copies of the following types of documents for faster reference:

- Historical Reports, Work Plans, and Designs
- Figures – Historical figures and design drawings in a single bookmarked file
- Tables – Historical data tables combined in a single bookmarked file
- Soil Borings – Historical soil boring and well logs
- KDHE Guidance Documents – Many are referenced throughout this report
- CAS – An electronic version of this document

While CAS tables and figures should be sufficient for most needs, additional references to the historical figures and tables are also noted in Section 2 using the report name and report figure/table numbers (e.g., Third Phase Investigation Report Figures 37 - 54 and Tables 7a - 7c and 7e - 7f).

2.0 NATURE AND EXTENT OF CONTAMINATION

This section discusses the geology and hydrogeology of the Site, as well as a summary of past investigations that provide the basis of the nature and extent of contamination in soil and groundwater. Data from these reports and the resulting site conceptual model (SCM) for each main subarea of the Site are summarized to aid in evaluation of the associated remedial alternatives.

2.1 SITE CONDITIONS

The following summary of Site conditions was presented with referenced sources in the Third Phase Investigation Report:

2.1.1 Topography

The Site is located in the Flint Hills Uplands physiographic province. The Flint Hills Uplands are characterized by rolling hills and rocky soil. The highest surface elevations at the Site are approximately 1,339 feet National Geodetic Vertical Datum (NGVD) at the northwest corner of the AHA and 1,336 feet NGVD at the southwest corner of the South Tank Farm (STF). The lowest surface elevation at the Site, 1,287 feet NGVD, is located east of the wastewater/stormwater ponds adjacent to the West Branch of the Walnut River (WBWR). The overall Site topography slopes from west to east, towards the WBWR. The northwest corner of the STF slopes towards the STF Creek to the west. The southern third of the STF slopes towards the STF Creek to the north-northeast.

2.1.2 Soil

Soils in the vicinity of the Site are comprised of valley sediments, which consist primarily of clay, silt, sand, and gravel, in which poorly developed paleo-soils are present a few feet below the modern surface. Modern soils tend to be thick, heavy, and poorly drained in the river valleys, but tend to be thin, variable, and permeable in the uplands. Sediments deposited along the WBWR and its tributaries consist mainly of locally derived material, including pebbles of limestone and chert (Leonard, 1972).

Based on the available information from the Natural Resources Conservation Service (NRCS), nine primary soil series (not including Oil Wasteland) are represented both on-site and in the immediate vicinity (Figure 2-1). Soils on-site are:

- Labette Silty Clay Loam
- Labette-Dwight Complex
- Labette-Sogn Silty Clay Loams
- Norge Silt Loam

- Sogn Soils
- Verdigris Silt Loam, Occasionally Flooded
- Verdigris Soils, Frequently Flooded

Alluvium and weathered bedrock residuum from the surface to the top of bedrock are described in boring logs as predominantly silty clay with a thickness ranging from approximately 0 to 26 feet. Weathered bedrock residuum is typically comprised of limestone fragments and/or clay.

2.1.3 Geology

The Site is underlain by Lower Permian Age bedrock units of the Chase Group, which are comprised of layers of limestone, cherty limestone, dolomitic limestone, dolomite, and shale (Figure 2-2). The groundwater mounding shown in this figure below the various ponds is no longer present because most have been removed and the area of the former Spray Pond is now a groundwater/product interceptor trench. The uplands around El Dorado consist of the Doyle Shale Formation and the Barnestone Limestone Formation. The Towanda Limestone and Holmesville Shale Members of the Doyle Shale Formation outcrop in the Site vicinity. Underlying the Doyle Shale Formation is the Barnestone Limestone Formation, which is comprised of the Fort Riley Limestone, Oketo Shale, and the Florence Limestone Members. Underlying the Barnestone Limestone Formation is the Blue Springs Shale Member of the Matfield Shale. Top of bedrock contours are depicted in Figure 2-3.

2.1.4 Surface Water

The West Branch of the Walnut River (WBWR) abuts the northeastern portion of the Site (Figure 1-2). The river bed is composed of silt, sand, and gravel overlying bedrock, with an average bank height of approximately 15 feet.

An intermittent drainage (STF Creek) crosses the STF area (Figure 1-2) and flows into the WBWR approximately 1,800 feet east of the STF.

Groundwater springs are present 1) at the southeastern corner of the AHA (AHA Spring); 2) at the base of the former catalytic cracking unit in the MPA (MPA Spring shown in Figure 1-2) which was diverted during IRMs; and 3) east of the Pester Ponds, adjacent to the WBWR (Pester Spring).

2.1.5 Hydrogeology

Groundwater includes both unconfined and confined groundwater, as well as areas of localized perched groundwater and has been classified into three zones:

- **Shallow System**: The unconfined shallow groundwater-bearing zone occurs within alluvium, weathered/fractured Doyle Shale and the Fort Riley Limestone and is collectively referred to as the Shallow System. The most transmissive of the Site's water-bearing zones is the highly fractured and weathered upper Fort Riley Limestone underlying residuum and alluvium. (Groundwater Darcy flux: 2.64 ft^3/min)
- **Fort Riley**: The confined to partially confined groundwater encountered within fractures at the base of the Fort Riley Limestone Member (Groundwater Darcy flux: 0.0006539 ft^3/min)
- **Florence**: Confined groundwater within the Florence Limestone Member (Groundwater Darcy flux: 0.6034 ft^3/min)

Site investigations have found that the groundwater flow direction is predominantly east toward the WBWR (Figure 2-4). The groundwater potentiometric surface generally emulates the topographic contours of the Site as well as the structure-contour of the top of bedrock surface (Figure 2-3).

2.2 SITE INVESTIGATION SUMMARY/SITE CONCEPTUAL MODEL

This section summarizes all three phases of Site investigation data. Key figures and tables from past investigation reports are presented within the text and others are attached in Appendix A for reference. The IRMs altered some of the conditions; therefore, where applicable, these changes are noted below.

2.2.1 General Findings

This section summarizes the general findings of historical Site investigations. Figure references and additional details are included in Sections 2.2.2 through 2.2.9.

2.2.1.1 <u>Wastes</u>. Waste-like material was encountered during Site investigation or IRM actions in: 1) the MPA (asphaltic materials), 2) the AHA (soil stabilized asphalt piles and pit materials), 3) the STF (tank-bottom material), and 4) the stormwater ponds. All known waste-like materials, with the exception of the STF materials, were either excavated and disposed of off-site at a KDHE-approved facility or consolidated in the west stormwater ponds, stabilized, and capped during IRM activities.

2.2.1.2 <u>Petroleum-Impacted Soil</u>. There were numerous locations of soil organic impacts above KDHE Tier 2 Non-Residential Risk-Based Screening Levels (KDHE RBSLs) in the MPA, AHA, and the northern portion of the STF. This is indicative of multiple, shallow hydrocarbon releases in these areas. All AHA impacts have since been addresses as part of the IRM.

2.2.1.3 <u>Metals-Impacted Soil</u>. Based on a ProUCL evaluation of shallow soil metals data, the concentrations of the following metals at the Site exceed background levels: arsenic, barium,

cadmium, chromium, lead, magnesium, mercury, nickel, potassium, and zinc. However, except for lead (nineteen samples in the MPA and North-Central STF) and arsenic (two samples), none of these metals were detected at levels greater than RSK RBSLs.

2.2.1.4 Dissolved Phase. Groundwater impacts are largely confined to the Shallow System. The following summarizes the primary contaminants of concern (COCs):

- **Petroleum-related**: Contaminants exceeding KDHE RBSLs include many petroleum-related compounds with wide-spread plumes. However, most of the STF groundwater plumes remain on-site and most of the MPA and former stormwater pond (current wetlands) area plumes are now captured by the combined interceptor trenches (ITs).
- **Chlorinated VOCs**: Chlorinated volatile organic compounds (CVOCs) (primarily vinyl chloride) are present above RBSL screening values in the southern portion of the Stormwater Pond Area (SPA). Historically, 1,1,2 trichloroethane (TCA) has exceeded RBSL screening levels in this same area; however, TCA values have remained below laboratory-reporting limits since 2010. These detections are believed to be from an off-site source located to the south, which are pulled toward the Site and captured by the Seep Interceptor Trench (IT). A minor source area for chlorinated VOCs on the Site may be the former research and testing laboratory at the northeast corner of the STF.
- **MTBE**: Methyl tert-butyl ether (MTBE) is present in the north STF area with a plume extending to the east and northeast and in the south STF where two small plumes extend from former tank locations. A portion of the northern plume is captured by either the MPA Basin IT or the Seep IT. The southern plumes do not extend off Site.
- **Metals**: Arsenic, barium, and manganese have exceeded screening levels at the Site.
- **Aquitard**: The presence of the Oketo Shale between the Fort Riley Limestone and the Florence Limestone units and the upward groundwater gradients in the vicinity of the WBWR between the Florence, Fort Riley, and Shallow System have prevented contaminants from migrating from the Shallow System into deeper formations.
- **Groundwater Flow:** The groundwater potentiometric surface generally emulates the topographic contours of the Site as well as the structure-contour of the top of bedrock surface. The groundwater flow direction is predominantly from the west to east toward the WBWR, except in localized areas of the Site and south of the STF Creek.
- **Groundwater and Bedrock**: The groundwater level is above the top of bedrock in the shallow alluvium/residuum throughout the majority of the MPA and the central portion of the STF. Areas where this occurs are the primary locations of groundwater impact and migration.

2.2.2 Main Process Area (MPA)

Site investigation findings and conceptual model details specific to the MPA are discussed in this section.

2.2.2.1 Waste Materials. Asphaltic materials were encountered during MPA demolition, sewer abandonment, and surface-grading activities. All materials were excavated and disposed of at KDHE-approved facilities and/or consolidated in the western Stormwater Ponds with other waste materials (Figure 2-5).

2.2.2.2 Light Non-aqueous Phase Liquid (LNAPL) Extent/Thickness/Type. A larger LNAPL area was historically located across the current MPA Basin area (the far eastern area shown in Figure 2-6 from 2009). This was partially excavated and LNAPL recovery has been ongoing since installation of the MPA Basin IT. This has decreased the current LNAPL footprint to just a few isolated spots (Figure 2-7 from 2013) where the LNAPL is likely not mobile but if the LNAPL were to migrate, it is within the current MPA Trench IT and MPA Basin IT zone of hydraulic capture as discussed in Section 4.3.

2.2.2.3 Soil Geology and COCs. Bedrock is only approximately 2 to 5 feet below grade on the west side of the MPA, but the clayey overburden thickens to the east and a modest bedrock trough exists in the former Marley/Spray pond (current MPA Basin) area, where bedrock depths approach 20 feet below grade (Figure 2-2). Shallow soil petroleum impacts are scattered, which is indicative of many individual source areas, and deep impacts are more widespread, where the LNAPL encountered groundwater (Third Phase Investigation Report (Figures 37 - 54 [included as Appendix B] and Tables 7a - 7c and 7e - 7f). The primary metal which exceeded RSK RBSLs was surface soil lead, located primarily in the southern portion of the MPA (Figure 2-8 and Third Phase Investigation Report Tables 7d and 7g). As part of the IRM, all lead-impacted soils were consolidated in this southern area and covered with clean soil as summarized in Section 4.2.2. During the IRM, soil was landfarmed across most of the MPA. The landfarm was closed after all surface soils met KDHE requirements.

2.2.2.4 Groundwater Flow and COCs. As with most of the Site, the vast majority of groundwater flow occurs through several feet of weathered limestone immediately above competent bedrock (Figure 2-3). Natural groundwater flow is generally toward the east; however, the IRM MPA Basin groundwater interceptor trench (IT) operation has shifted the groundwater flow direction more toward the southeast corner of the MPA (Figure 2-4). Groundwater contaminants are a range of petroleum-related compounds present in moderate to elevated concentrations across all but the far northern end of the MPA (Figures 2-9 through 2-16). Historic groundwater analytical results are shown in the Third Phase Investigation Report Tables 10a through 10e and current groundwater analytical results are shown in the 2014 Semi-annual Report Tables 4-3 and 4-4. Time-concentration graphs (Appendix C) reveal generally stable dissolved-phase concentrations across the MPA and downgradient SPA. Given the amount of contaminant mass present across the MPA, both as separate phase (free product)

and sorbed phase (soil impacts) LNAPL, it is anticipated that decreases in dissolved-phase concentrations through natural processes (e.g., natural attenuation) would be very gradual.

2.2.3 Asphalt Handling Area (AHA)

Site investigation findings and conceptual model details specific to the AHA are discussed in the following sections.

2.2.3.1 Waste Materials. Historical management of off-spec liquid asphaltic wastes in this area (stabilization, mixing and spreading) is believed to be the source of the petroleum impacts (Figure 2-17 and Third Phase Investigation Report Tables 9a - 9c) in mounded stabilized asphalt soil piles and the AHA Pit where the stabilizing occurred. None of the samples submitted for toxicity characteristic leaching procedure (TCLP) analysis exceeded the maximum toxicity characteristic levels (Third Phase Investigation Report Tables 9e - 9g). All asphalt-soil piles and all excavatable materials, including weathered bedrock, in the AHA pit were excavated, consolidated, stabilized, and capped in the West Stormwater Ponds (former Primary Pond and West Oxidization Pond) area with other petroleum-impacted materials (Figure 2-5).

2.2.3.2 LNAPL Extent/Thickness/Type. LNAPL has been measured in groundwater monitoring wells located downgradient of the former AHA pit in the past (Figure 2-6); however, no wells within the AHA currently contain LNAPL (Figure 2-7).

2.2.3.3 Soil Geology and COC Concentrations. Bedrock (and the overlying weathered zone) is relatively shallow, ranging from surface outcrops on the western side of AHA to depths of up to 6 feet below ground surface on the eastern side (Figure 2-2). Vertical migration of hydrocarbons occurred through fractured bedrock in the vicinity of the AHA liquids pit based on soil/cuttings headspace gas data (Third Phase Investigation Report Figures 37 – 54). During IRM work this pit was excavated and based upon the observed vertical side-walls, is believed to have been a former quarry that was later filled with the partially stabilized asphaltic materials. Tar/asphalt-like material observed in the side-walls of the pit is believed to be the source of the tar/asphalt-like material in the nearby/downgradient MPA Spring water.

2.2.3.4 Groundwater Flow and COC Concentrations. Groundwater flow is toward the east (Figure 2-4) with a small and low concentration petroleum-related plume emanating from the AHA Pit area and flowing into the larger MPA plume (Figures 2-9 through 2-16). Historic groundwater analytical results are shown in the Third Phase Investigation Report Tables 10a-10e, and current groundwater analytical results are shown in the Semi-annual Report 2014 Tables 4-3 and 4-4. The time-concentration graph for OW-39 (Appendix C) and the data for wells immediately downgradient of the AHA reveal concentrations have remained below RSK RBSL standards. This is consistent with the very low solubility and extremely low mobility of the asphaltic components.

2.2.4 South Tank Farm (STF)

For the purposes of this CAS, the STF also includes property owned by EPME-PC, located east of North Topeka Street and immediately south of the MPA, shown in Figure 1-2.

2.2.4.1 Waste Materials. A buried waste area was encountered in the north-central portion of the STF (Figure 2-5) during the Third Phase Investigation. It is approximately 2,000 square feet, 5 feet deep (approximately 400 cubic yards) and contains elevated lead (2,020 mg/kg), total petroleum hydrocarbons (TPH)-diesel range organics (DRO) (27,000 mg/kg), and TPH-gasoline range organics (GRO) (2,900 mg/kg) concentrations. The waste has not leached appreciably into underlying soils.

2.2.4.2 LNAPL Extent/Thickness/Type. There are currently approximately seven isolated and relatively small free-phase LNAPL source areas located across the STF (Figure 2-7). Five of these areas include only one well with a measured LNAPL thickness of less than 0.1 foot. Each source area is associated with a dissolved-phase plume. No evidence of LNAPL migration has been observed (comparison of Figure 2-6 to Figure 2-7).

2.2.4.3 Soil Geology and COCs. STF geology is consistent with the AHA and MPA areas, consisting of lower permeability clayey overburden underlain by a more permeable weathered limestone and then a competent aquitard (Figure 2-2). Soil impacts are scattered within the STF former aboveground storage tanks (ASTs) and pipeline release areas (Third Phase Investigation Report Figures 37 - 54 [included as Appendix B] and Tables 7a - 7c and 7e - 7f). All contamination is petroleum-related with the exception of an MTBE source on the north side of STF at the location of a former petroleum mixing/testing laboratory and a smaller MTBE plume along the southern STF (Figure 2-12 and Third Phase Investigation Report Tables 7a - 7g).

2.2.4.4 Groundwater Flow and COCs. Groundwater flow is generally toward the east (Figure 2-4). In the northern portion of the STF, groundwater flow is east to northeast because of a bedrock channel and the influence of the MPA Basin IT pumping. In the middle of STF, groundwater flow is southeast toward the STF Creek. Depending upon groundwater elevations, a portion of this groundwater discharges into the Creek. Groundwater south of the STF Creek is flowing north-northeast and, depending upon groundwater elevations, discharges into the STF Creek near wells MW-16, MW-97 and MW-98.

Dissolved-phase contaminants are primarily petroleum- and MTBE-related with most plumes exhibiting signs of stability and remaining within the STF boundary (Figures 2-9 and 2-10) with the following exceptions: 1) COC-impacted groundwater appears to periodically discharge to the STF Creek from the south; 2) there is limited migration of TPH-DRO Figures 2-13 and 2-14); and TPH-GRO under North Topeka Street, just north of the STF Creek Figures 2-15 and 2-16); and 3) a larger petroleum and MTBE plume in the northeast STF migrates across the road to EPME-PC-owned property with a small portion of the plume extending onto other property

(Figures 2-9 through 2-16). Trace TCA and vinyl chloride (VC) have also been detected in this plume (Figure 2-18). Historic groundwater analytical results are shown in the Third Phase Investigation Report Tables 10a - 10e and current groundwater analytical results are shown in the 2014 Semi-annual Report Tables 4-3 and 4-4. Time-concentration graphs (Appendix C) reveal generally stable dissolved-phase concentrations across the STF. Given the amount of contaminant mass present across the MPA, both as separate-phase (free product) and sorbed-phase (soil impacts) LNAPL, it is anticipated decreases in dissolved-phase concentrations through natural processes (e.g., natural attenuation) would require many years to become evident.

2.2.4.5 Water Well Survey. A door-to-door water well survey of the 239 residential properties located near the Site was conducted in 2008. Prior to executing the door-to-door water well survey, a notification packet consisting of a notification letter and a response card was delivered to each property owner located in the study area. The notification letter provided an explanation of the upcoming study. One-hundred and twenty (120) response cards (50% of properties) were returned prior to conducting the door-to-door survey. No contact was made with forty-one property owners after sending the initial response card, making two attempts to reach the homeowner at the residence, and placing an additional door hangar at the residence during the survey.

Two active wells were found in the survey area (colored red in Figure 2-19). Well #1 was plugged by EPME-PC in 2011. Well #15 is a lawn and garden well located outside dissolved-phase Site plumes. Monitoring well MW-89 is located between Well #15 and Site groundwater plumes. It has been historically non-detect for all monitored COCs, including VOCs, TPH-GRO, and TPH-DRO. Five properties contained structures that could be water wells. Structures were visually observed during the door-to-door survey, but could not be confirmed as actual wells. All properties in the survey area receive City water for domestic purposes.

2.2.4.6 STF Creek Surface Water Sampling. Except for the chloride sample (450 D mg/L) collected from the SW-CREEK location, all detected parameters in the surface water sample collected from the STF Creek in February 2009 (Figure 2-20) were below their respective Screening Levels (Third Phase Investigation Report Table 5).

Annual surface water sampling was conducted in the STF Creek in 2005, 2009, 2010, and 2012. No benzene concentrations in any sampling events exceeded the Kansas SWQ for benzene (5 ug/L). Low levels of TPH-DRO were detected in the 2005 and 2009 events, low levels of TPH-GRO were detected in the 2005 event, and low levels of MTBE were detected in the 2009 and 2010 events. There are no Kansas SWQs established for TPH-DRO, TPH-GRO, or MTBE. No VOCs or TPH were detected above laboratory-reporting limits in the 2012 surface water sampling events (2012 Surface Water Report Table 1). Based on the results of the April 2012 event, EPME-PC requested, and in November 2012, the KDHE approved, discontinuation of surface water sampling of the STF Intermittent Creek.

2.2.4.7 Sediment Sampling. Four out of five of the sediment samples collected from the STF Creek in February 2009 exceeded Screening Levels for lead and/or nickel (Figure 2-21) (Third Phase Investigation Tables 4a-4d). However, comparable lead and nickel values were also detected in the background sample location. Pyrene (195 µg/kg) was detected above the threshold effect concentration (TEC) in one sediment sample (SED-11). Other analytes detected in the samples included: chloride, sulfate, petroleum hydrocarbons (PHC) as diesel fuel (estimated), PHC as gasoline (estimated), benzene, and MTBE; however, all were below their respective Screening Levels.

2.2.4.8 Sub-Slab Vapor Sampling. A portion of the northeast STF groundwater plume is present beneath a house owned by EPME-PC located at 1800 North Topeka Street. A vapor sampling port was installed inside the basement of the house and a sub-slab sample was collected. The sample was analyzed using EPA Method TO-15 for the volatile compounds identified in the *Sub-Slab Vapor Investigation Work Plan for the El Dorado Refinery, El Dorado, Kansas (November 2008)* with the exception of n-propylbenzene, sec-butylbenzene, and t-butylbenzene. All concentrations were below laboratory-reporting limits; however, the reporting limit for both naphthalene and vinyl chloride were both above the KDHE Tier 2 Level for Indoor Air. All other concentrations were reported below KDHE Indoor Air values, even without applying a typical dilution/attenuation factor of 10 to convert from sub-slab to indoor air (Sub-slab Vapor Report Table 1). As requested by the KDHE, the sub-slab vapor sampling port was left in place in the event future sampling is warranted.

2.2.5 Stormwater Pond Area (SPA)

Site investigation findings and conceptual model details specific to the SPA are discussed in this section.

2.2.5.1 Waste Materials. Sampling of the Marley and Spray Pond sediment (located within the MPA) revealed high concentrations of heavy-end petroleum hydrocarbons and a few lower-end COCs (Figure 2-22 and Third Phase Investigation Report Tables 6a - 6g). Impacted sediments were excavated and consolidated within the stormwater ponds as part of the interim remedial measures (IRMs). The entire area was then over-excavated, the soils were landfarmed across the MPA, and the area is now part of the IRM MPA Stormwater Basin and Groundwater IT (Figure 2-5).

Extensive sediment sampling in the former Stormwater (aka Wastewater) Ponds was completed from a pontoon boat. Results revealed the sediments were impacted but did not fail Toxicity Characteristic Leaching Procedure (TCLP) standards and hence were nonhazardous (Figure 2-22 and Third Phase Investigation Report and Tables 6a - 6g). The thicknesses of petroleum-impacted sediment varied from several inches to several feet across all the Stormwater Ponds. Sediments were consolidated to the West Oxidation Pond. Sediments

were then stabilized with a mixture of cement and fly ash and the area was capped and closed as part of the IRMs.

2.2.5.2 LNAPL Extent/Thickness/Type. LNAPL thickness is non-detectable under the former Stormwater Ponds and along the WBWR – Only slight sheens have been observed. The Seep IT has recovered negligible product since its installation, confirming this observation. Most product appears to be at the residual (immobile) state with occasional fine globules freeing from the river-back (area beyond the interceptor trench) under certain conditions, such as low WBWR stage that result in maximum hydraulic gradients.

2.2.5.3 Soil Geology and COCs. Native overburden soil was 15 to 20 feet thick, although because the pond berms were created using this native soil, some soil thicknesses underlying pond bottoms were less than 10 feet thick (Figure 2-2). Soil petroleum impacts generally extended less than 1 foot into the clayey materials. As part of IRM, the east ponds were clean-closed; therefore, this petroleum-impacted soil was also consolidated within the western ponds. As evidenced by historic product seeps into the WBWR, the area is underlain by deeper historical petroleum product impacts from the MPA area; therefore, with depth, soil petroleum concentrations increase (Third Phase Investigation Report Figures 37 - 54 [included as Appendix B] and Tables 7a - 7c and 7e - 7f).

2.2.5.4 Groundwater Flow and COCs. Similar to the rest of the Site, groundwater and LNAPL flow is primarily eastward toward the river through the weathered bedrock that overlies competent bedrock (Figure 2-2). This zone interfaces with the WBWR stream-bed; therefore, Site groundwater and product historically discharged to the river. The Seep IT was installed in 2006 to address this discharge. Only minor signs of groundwater seepage (iron staining) or petroleum (sheens) have been observed since startup of this system. During the Third Phase Site Investigation, groundwater elevations in clustered well sets adjacent to the WBWR predominantly showed upward gradients between wells screened in the Florence Limestone, the Fort Riley Limestone, and the Shallow System (alluvium and weathered bedrock residuum).

Groundwater contaminants are similar to the MPA (the primary source area for this plume), a range of petroleum-related compounds and MTBE (entrained from the STF) that are present in moderate to elevated concentrations across most of the SPA (Figures 2-9 through 2-16). Historic groundwater analytical results are shown in the Third Phase Investigation Report Tables 10a - 10e and current groundwater analytical results are shown in the 2014 Semi-annual Report Tables 4-3 and 4-4. Time-concentration graphs (Appendix C) reveal generally stable dissolved-phase concentrations across the SPA. Given the amount of contaminant mass present across the immediately upgradient MPA both as separate-phase (free product) and sorbed-phase (soil impacts) LNAPL, it is anticipated decreases in dissolved-phase concentrations through natural processes (e.g., natural attenuation) would require many years.

2.2.6 West Branch Walnut River (WBWR)

Investigation findings for the WBWR are discussed in this section.

2.2.6.1 Surface Water Sampling (Third Phase and Subsequent Events). No VOCs, semi-volatile organic compounds (SVOCs), TPH-DRO, or TPH-GRO were detected above laboratory reporting limits in the surface water samples collected from the WBWR in February 2009 (Figure 2-22 and Third Phase Investigation Report Table 5). The Kansas Surface Water Quality Standards (SWQSs) were exceeded for mercury in three surface water samples and for cyanide in one surface water sample collected in February 2009. However, there were no detections of mercury in the sediment samples collected within the WBWR and there were no detections of mercury in any of the groundwater samples collected during the investigation. Therefore, it is likely that the source of the detected mercury is from upgradient of the Site. Cyanide was not detected in previous surface water sampling events in 2005 or 2006.

Subsequent annual surface water monitoring events were conducted in the WBWR in 2010 and 2011. No VOCs or TPHs were detected above laboratory reporting limits in the 2011 surface water sampling event (2011 Surface Water Report Table 1). Based upon the results, EPME-PC requested, and KDHE approved, discontinuation of WBWR surface water sampling in January 2012.

2.2.6.2 Sediment Sampling. None of the WBWR river sediment samples collected in 2007 (samples SED-01 through SED-05) contained analytes above Screening Levels (Figure 2-23 and Third Phase Investigation Report Tables 4a – 4d).

3.0 RISK ASSESSMENTS

Upon completion of the Third Phase Site Investigation, it was apparent that soil, groundwater, and soil vapor across large portions of the Site would exceed the Risk-Based Standards for Kansas (RSK) Manual (June 2007 – 4th Version) Tier 2 Residential and Non-Residential clean-up values (KDHE RBSLs). The RSK Manual acknowledges that conservative assumptions are used for calculating the Tier 2 values that may not necessarily be true for a specific Site. Therefore, as stated in the RSK Manual, the "*RSK Tier 3 offers the opportunity to determine site-specific risk-based contaminant concentrations that are protective of human health and the environment. Tier 3 involves the substitution of site-specific parameters into the equations used to calculate Tier 2 cleanup values. Tier 3 evaluations can be a substantial increase in effort relative to Tier 2, and must be performed with KDHE/BER oversight, including the submittal of appropriate work plans to perform any necessary additional work. KDHE/BER will not authorize the performance of a Tier 3 analysis for contaminants of concern that are regulated by federal, state or local laws, such as the federal Safe Drinking Water Act which mandates MCLs for drinking water aquifers*." (RSK Manual, Section 3.3)

Site-specific risk assessments were completed with KDHE oversight with the findings summarized in four documents fully-referenced in Section 1.3: 1) the *MPA and AHA Baseline Ecological Risk Assessment (BERA),* 2) the *West Branch Walnut River (WBWR) and STF BERA*, 3) the *40-Acre STF Human Health Risk Assessment (HHRA),* and 4) the Site-*Wide HHRA*. The findings of the *40-acre STF HHRA* were incorporated into the *Site-Wide HHRA*.

3.1 BERA CONCLUSIONS

Sections 3.1.1 - 3.1.6 summarize findings from the *June 2011 MPA and AHA BERA*. Sections 3.1.7 - 3.1.9 are summaries of the *March 2012 WBWR and STF BERA*. Section 3.1.10 is a combined summary from both reports.

3.1.1 Surface Soils in the MPA Pre-Grading

A low level of potential risk to periodically foraging invertivorous mammals from exposure to lead and high molecular weight (HMW) polycyclic aromatic hydrocarbons (PAHs) was indicated for the MPA prior to Site grading. Hazard Quotient lowest-observed-adverse-effects levels (HQLOAELs) slightly exceeded one for lead (1.7) and HMW PAHs (2.0).

3.1.2 Surface Soils in the MPA Post-Grading

Risk estimates for periodically foraging invertivorous mammals exposed to lead were reduced when the IRM soil consolidation and covering was incorporated into the risk assumptions. The HQLOAEL for lead was reduced to less than one; the HQLOAEL for HMW PAHs was slightly reduced to 1.9. No risks were identified for other vertebrate receptors.

Due to conservative assumptions applied in the evaluation, the likelihood that potential risks are actually present is considered low.

3.1.3 Surface/Subsurface Soil in the Asphalt Handling Area

In the AHA, HQLOAELs for all receptors were less than one. Potential risks to periodically foraging birds and mammals in the AHA are considered low.

3.1.4 Topsoil in the STF

The HQupper slightly exceeded one for invertivorous mammals exposed to HMW PAHs (1.2). All other HQupper results were less than one for all receptors. As a result of the conservative assumptions applied in the evaluation, the likelihood that potential risks are present is considered low.

3.1.5 STF Sediments

Risk estimates for sediment-dwelling organisms were low (HQupper≤1) for all COCs. However, HQlow results were greater than one for benzene (7.9) and xylenes (3.3). These were based on a lower-bound toxicity reference value (TRV) derived from a chronic water quality criterion. Therefore, potential risks to the viability and function of the macroinvertebrate community may be present in a localized area of STF Creek.

3.1.6 WBWR Surface Water

A detection of *total* cyanide in one sample adjacent to the Site exceeded the Kansas surface water quality standard for *free* cyanide. Based on the low HQlow (2.5), absence of other detects, and because the cyanide is likely complexed and not present as free cyanide, potential risks in surface water of the West Branch Walnut River (WBWR) are considered low.

3.1.7 Summary

It was concluded there are no significant risks to relevant ecological receptors in the former MPA, AHA, or WBWR in either sediments or surface water. Implementation of the IRM soil consolidation and covering reduced low risk levels (HQLOAEL = 1.7) associated with invertivorous mammals (represented by the little brown bat) to below levels of concern (i.e., HQLOAEL less than one). Potential risks to the viability and function of the macroinvertebrate community may be present in a localized area of the STF Creek due to concentrations of benzene and xylene in sediments, likely from periodic discharge of impacted groundwater to the creek. No other significant risks to ecological receptors were identified in the STF. This includes birds and mammals in both aquatic and terrestrial areas of the STF, as well as aquatic biota exposed to surface water. Although not included among risk management goals, a screening evaluation of direct exposures in the Screening Level Ecological Risk Assessment

(SLERA) indicated there are no significant risks to plants and invertebrates in the STF. It was also concluded that risks associated with cumulative multi-site exposures over the MPA, AHA, and STF are low.

3.2 HHRA CONCLUSIONS

A Baseline HHRA was performed for COCs found in surface soil, subsurface soil, sediment, groundwater, and surface water. Receptors evaluated in the HHRA included full-time indoor workers, full-time outdoor workers, part-time outdoor workers, excavation workers, trespassers, recreators, and hypothetical future residents. Risks for exposure to surface water and sediment in the WBWR and AHA spring were not quantified since COC concentrations in surface water and sediment were consistent with or lower than background concentrations. The risk and hazard results are briefly summarized in Table 3-1 and below:

3.2.1 Cancer Risks Ranging From 1E-06 to 1E-04

Reasonable maximum exposure (RME) cancer risks were within, or below, the 1E-06 to 1E-04 risk range, and hazard indices (HI) were less than 1.0 for the following populations:

- Full-time outdoor workers in the MPA, AHA, and STF
- Part-time outdoor workers in the MPA, AHA, and STF
- Excavation workers in the AHA and both off-site areas East of North Topeka Street
- Trespassers in the MPA, AHA, and STF
- Recreators in the STF creek
- All populations evaluated as part of the STF school assessment

3.2.2 Cancer Risks Greater Than 1E-04

Cancer risks exceeded the target of 1E-04 for the following populations:

- Indoor workers and residents in the MPA
- Indoor workers at the AHA and STF
- Residents in the AHA, STF, and both off-site areas

3.2.3 Non-Cancer Risks - HI Greater Than 1

Hazard indices exceeded the target of 1 for the following exposure populations:

- Indoor workers, excavation workers, and residents in the MPA
- Indoor workers at the AHA and STF
- Residents in the AHA
- Excavation workers and residents in the STF
- Residents in both off-site areas

3.2.4 General Conclusions

The following general conclusions were reached:

- Exposure to surface soil (0-2 feet below ground surface [bgs]) did not result in cancer risks exceeding 1E-04 or hazard indices exceeding 1 for any non-residential receptors in the MPA, AHA, or STF.
- Exposure to STF Creek sediment did not result in cancer risks exceeding 1E-04 or hazard indices exceeding 1.
- Cancer risks exceeding 1E-04 and hazard indices exceeding 1 were due primarily to chemicals in <u>subsurface soil and groundwater</u>:
    - Cancer risks exceeding 1E-04 for the full-time indoor worker exposure scenario in the MPA and STF were due primarily to inhalation of petroleum-related volatiles released from subsurface soil and groundwater.
    - Cancer risks exceeding 1E-04 for the full-time indoor worker exposure scenario in the AHA were due primarily to inhalation of petroleum-related volatiles released from subsurface soil.
    - Cancer risks exceeding 1E-04 for the residential exposure scenario in the MPA, AHA, STF, and both off-site areas were due primarily to ingestion of groundwater.
    - Hazard indices exceeding 1 for the full-time indoor worker and excavation worker exposure scenarios in the MPA and STF were primarily due to inhalation of petroleum-related volatiles released from subsurface soil and groundwater.
    - Hazard indices exceeding 1 for the full-time indoor worker exposure scenario in the AHA were primarily due to inhalation of petroleum-related volatiles released from subsurface soil.
    - Hazard indices exceeding 1 for the residential exposure scenarios in the MPA, AHA, STF, and both off-site areas were primarily due to ingestion of groundwater.

4.0 INTERIM REMEDIAL MEASURES (IRM)

From 2006 through 2012, EPME-PC performed a series of Interim Remedial Measures (IRMs) to facilitate closure of the Site's wastewater treatment ponds by December 31, 2012. The wastewater treatment pond closure date was required by the KDHE Bureau of Water (BOW) as set forth in the National Pollutant Discharge Elimination System (NPDES) Permit conditions for the Site. The following is a brief summary of these activities so current site conditions can be considered in conjunction with site investigation and risk assessment findings to select the remaining Site remedial measures. A more detailed summary of most of the IRM actions is included in the *IRM Construction Completion Report (CCR).*

4.1 SEEP INTERCEPTOR TRENCH (SEEP IT)

The first IRM was the installation of a 1,650-foot Seep Interceptor Trench (Seep IT) located immediately upgradient of and paralleling the West Branch of the Walnut River (WBWR) as shown in Figure 4-1 and Figure 4-2. This trench was installed to prevent petroleum-impacted groundwater and product from seeping into the WBWR. The Seep Interceptor Trench Final Design was completed in March 2006. Construction began that summer with the continuous trench being excavated with a hydraulic excavator through the weathered bedrock until refusal. An effort was made to remove all weathered rock possible, including use a bucket equipped with rock teeth. Hydraulic hammering was not used because it was feared it could fracture the competent confining rock below. The final bottom of the fractured bedrock surface undulated across the 1,650-foot long trench. Three extraction sumps (ESs) were installed in the low points along this trench with gravel extending up to above the highest known groundwater elevations. Ten-foot deep screened sumps were drilled at each ES location into the weathered bedrock to place the groundwater extraction pump and floats below the bottom of the trench, maximizing dewatering.

The Seep IT began operation in December 2006. Little to no free-phase LNAPL has been recovered to date. Water was initially treated through the stormwater ponds and, as discussed in later sections, it is currently treated through a wetlands-based system. Over 70,000,000 gallons of water have been recovered and treated to date. Dissolved iron concentrations in the extracted water are elevated, requiring periodical rehabilitation of the wells and cleaning of the pumps and conveyances. The more competent fractured rock surface to which the trench extends also forms the streambed of WBWR; therefore, when river levels are low, reverse gradients are difficult to confirm at all locations; however, groundwater contours imply capture of most to all of the groundwater entering the trench system as shown in Figure 4-3. When the river level drops quickly and the stream-banks drain, some iron staining and product sheens are still evident; however, this is expected given that product historically was present in those soils and is likely still trapped in the soil pores. The number and size of sheens in stagnant pools or upon soil disturbance is now minimal and infrequent and no sorbent boom use is required. A surface water sampling program has confirmed no detectable impact on water quality from the Site.

4.2 2010 MPA DEMOLITION, GRADING, AND LANDFARMING

The original refinery demolition, including removal of all above-grade process equipment, piping, and aboveground storage tanks (AST) was completed over the period of 2004 through 2006. The final MPA demolition IRM activities began in July 2010. Primary activities from July 2010 through March 2011 included:

4.2.1 Facility and Structure Demolition and Abandonment

Remaining above-grade and below-grade structures were removed or properly abandoned in place. This included:

- **Abandonment of Non-Essential Monitoring Wells:** Prior to demolition and grading activities, all non-essential wells located within the construction area were plugged and abandoned in accordance with applicable KDHE rules and regulations. As MPA grading and demolition activities progressed, several additional wells were plugged and abandoned because they were determined to be directly in the way of construction activities. Two wells were subsequently replaced at the request of the KDHE.
- **Subsurface Structures (storm and process sewers, fire water pipes)**: Subsurface structures, such as process and stormwater piping, conveyed infiltrating groundwater and stormwater to the stormwater ponds were abandoned by soil or grout plugging of exposed openings, pressure grouting of pipes to the extent possible, or removal.
- **Underground Storage Tanks (USTs) and Other Structures**: Two abandoned underground tanks, two small steel tanks, and one wet well were removed.
- **Demolition of Existing MPA Buildings:** Twelve remaining buildings were demolished. These buildings consisted of metal frame, concrete masonry units (cinder block), and brick structures.
- **Concrete and Building Debris Removal:** Concrete materials within the top two feet of the existing ground surface were demolished and broken apart sufficiently to load and transport to a concrete rubble stockpile located near the center of the MPA.
- **Concrete Crushing:** Concrete rubble was crushed and stockpiled as recycled crushed concrete (RCC). All of the RCC produced from the concrete crushing was utilized on-site, including the RCC fines.
- **Asphaltic Wastes:** Visually impacted concrete material, general construction waste, and soils that were mixed with asphalt or otherwise visually impacted were stockpiled separately from the concrete-only stockpile. The KDHE approved a waste management plan and two roll-off boxes of asphaltic material were disposed of at a KDHE-approved disposal facility as special waste in accordance with the approved plan.
- **Impacted Soil:** Other impacted soil was combined with the AHA Pit material, placed in the west oxidation pond, stabilized, and capped.

4.2.2 MPA Grading

MPA grading activities established final grades for enhanced runoff (versus infiltration) and management of stormwater within the MPA, including installation of terraces, channels, and basin for sediment control and pollution prevention. These measures will enhance long-term soil stability. The grading also provided a suitable base for landfarming of petroleum-impacted soils.

- **Consolidation of lead-impacted soil:** To eliminate the risk of spreading lead-impacted soil across the MPA during demolition and Site grading, approximately 3,000 cubic yards (cy) total of lead-impacted soil from the northern portion of the MPA were excavated from several areas and consolidated with other lead-impacted soil located in the southern portion of the MPA. The original lead-impacted areas are shown in Figure 2-8. Approximately 8 inches of clean soil were placed over this area to prevent stormwater runoff from contacting the lead-impacted soil. Later, additional soil from the MPA Basin excavation was placed and landfarmed across the entire MPA, adding an additional 8 inches of clean cover soil (after landfarming was complete) over the lead-impacted soil for a total of 16 inches of cover. The MPA was then seeded with a Kansas Department of Transportation (KDOT) warm season grass blend to prevent erosion.
- **Grading:** Grading of the MPA created ground surface slopes of approximately 1 to 3 percent from the west side of the MPA to a main drainage channel (MPA Channel) as shown in Figure 4-4. Terraces were also installed to slow stormwater flow and to convey stormwater to the MPA Channel. Two all-weather gravel roads were constructed.
- **Drainage channel construction (MPA Channel):** An approximately 1,900-foot long channel (Figure 4-4) was constructed along the eastern edge of the MPA to convey stormwater to the MPA Basin. Portions were rip-rapped to prevent erosion.
- **Channel Interceptor Trench (IT) construction:** Groundwater seeps (some containing LNAPL) were exposed along the southern half of the MPA channel; therefore, a narrow 1,200-foot long trench was excavated as deep into the weathered bedrock as possible. A perforated pipe was installed in the bottom to gravity drain into the MPA Basin IT and the trench was filled with gravel and covered with an impermeable membrane. This was then covered with concrete fines and riprap to create the stormwater channel. The result protects surface water quality while enhancing recovery of shallow groundwater perched within the abundant concrete sand bedding that remains from the former refinery structures.
- **Landfarming:** The graded MPA surface soils were screened of rock and debris to a depth of at least 8 inches and landfarmed to remove petroleum hydrocarbons. An estimated 28,600 cy of soil from the MPA Basin and MPA Channel construction were then excavated and spread over the MPA in an approximately eight-inch thick lift. Each landfarm cell was disked until soil concentrations were below KDHE RBSLs. The KDHE-Bureau of Waste Management (BWM) approved landfarm closure in a letter dated November 28, 2012 and the MPA was reseeded.

4.3 MPA STORMWATER BASIN AND GROUNDWATER INTERCEPTOR TRENCH

A new basin for Site stormwater management, the MPA Basin, was installed in the former location of the Marley and Spray Ponds, with construction beginning in October 2010. Excavation continued through January 2011 finishing on the northern end of the MPA Basin where bedrock was encountered shallower than anticipated. Excavators equipped with hydraulic hammers were used to finish the excavation in the northern end of the MPA Basin. Underlying the MPA Basin is a groundwater and product interceptor and collection system that is separated from the Basin with a liner.

4.3.1 MPA Basin

The approximately 800-foot long by 150-foot wide MPA Basin can store approximately 4.6 million gallons of stormwater if it has been fully dewatered using the permanent stormwater pump. The MPA Basin is shown in Figure 4-4. During excavation of the Marley and Spray Ponds, which were located in the footprint of the MPA Basin, petroleum-impacted sediments were transported to the West Oxidation Pond for future stabilization with other waste material (the West Pond Capped area shown in Figure 4-2). The MPA Basin was intentionally installed in a LNAPL-impacted area (Figure 2-6) to remove impacted soil mass and provide for free product recovery; therefore, all 23,000 cy of excavated soils were landfarmed. During landfarming of petroleum-impacted soil, the MPA Basin storage provided for improved stormwater suspended solids settling and subsequent stormwater treatment. Past and potential future uses of the water include dust control, supplemental water to fill or to maintain wetlands water levels, and possible irrigation water. The pool level has recently been lowered to increase storage capacity to provide separation of tar from MPA Spring water (see Section 4.7). Once the MPA Spring tar entrainment issue is resolved, the MPA Basin will return to its normal pool level and stormwater gravity discharge.

4.3.2 MPA Basin IT

A groundwater and LNAPL interceptor trench (Basin IT) was excavated at the bottom of the MPA Basin to collect product and impacted groundwater. The Basin IT was extended through upper weathered bedrock until solid bedrock was encountered. Similar to the Channel IT, a perforated pipe was placed in the bottom, the trench was gravel-filled, and the entire MPA Basin was lined with a 60-mil high-density polyethylene (HDPE) textured flexible membrane liner (FML) to separate the groundwater and stormwater systems within the MPA Basin. A separate sump, pump, and conveyance lines are used to pump extracted water and product to the water treatment system.

4.4 2011 GROUNDWATER TREATMENT SYSTEM AND EAST POND CLEAN CLOSURE

The east stormwater ponds were clean-closed and all petroleum-impacted sediment was consolidated to the West Oxidation stormwater pond for later stabilization and capping. The east pond area was then converted into a wetlands-based groundwater treatment system

shown in Figures 4-1 and 4-2. The first two wetlands stages were installed in 2011 and the final stage was installed in 2012. Other components include an underground oil-water separator (UOWS), a cascade aerator (CA), and a precipitation settling basin (PSB) constructed in the former refinery OWS. A temporary water treatment system was used during this conversion process as described in the Water Treatment Design and IRM CCR, but for brevity, it is not described here. The new currently operating water treatment system consists of:

4.4.1 Underground Oil Water Separator (UOWS)

A mix of groundwater and product from the MPA Channel IT, MPA Basin IT, and Seep IT is pumped to a 2,000-gallon UOWS for removal of entrained free product. The UOWS uses parallel plates to enhance free product separation. Free product is stored within the UOWS (up to 400 gallons) and water gravity flows through the UOWS, discharging into the north end of the CA. Approximately 1,500 gallons of product have been recovered to date.

4.4.2 Cascade Aerator (CA)

The Cascade Aerator is located immediately south of the UOWS. Water discharges at the top of the structure then cascades down two parallel 20-foot long, 24-inch diameter corrugated HDPE pipes. The cascading action adds oxygen from the air to oxidize and precipitate iron and it strips carbon dioxide to initiate precipitation of saturated calcium carbonates. Both ends of the pipes are open and accessible to promote air flow through the pipe and facilitate cleaning.

4.4.3 Precipitation/Settling Basin (PSB)

Oxygenated water discharges from the CA into an 80,000-gallon concrete PSB where groundwater minerals precipitate and settle rather than settling in the wetlands soil, gravel, and piping. The PSB is the repurposed former refinery American Petroleum Institute (API) oil-water separator (OWS) which was properly cleaned and from which wastes were disposed and unneeded equipment was removed during construction.

4.4.4 East Pond Clean Closure

Once the former stormwater ponds were dewatered, pond concrete structures were demolished and removed and the debris was placed in the northwest (former Primary Oxidation) pond. Pond sediment was pushed with a bulldozer to a swale and then to the side where an excavator could lift the material over the central berm and place it into the West Oxidation Pond for future stabilization. The upper 6 inches of impacted soil were also removed during this process. Bentonite was tilled into the pond floors and side-slopes as a precaution to reduce water seepage from the wetlands. The soil was then compacted. Current wetlands influent flows minus effluent flows during non-precipitation periods can be mostly to fully explained by evapotranspiration, implying seepage is minimal.

4.4.5 Stage 1 Wetlands Construction (Summer 2011)

The Stage 1 Wetlands (approximately 1.2 acres in size) was constructed as a deep bed vertical flow system. Perforated HDPE pipe was placed in a grid on the floor and then covered with approximately 1.5 feet of RCC from the MPA demolition work. Water enters the pond at the top, flows across, and then flows down through the RCC. A header is used to convey water to the Stage 1 outfall, hydraulic control structure #1 (HCS#1). The high surface area of the RCC installed in Stage 1 provides a beneficial substrate for bacteria (bio-film) and granular media water filtering that enhance sorption and degradation of heavier components with some ability to remove CVOCs. Frequently, between the combined processes of the CA and Stage 1, groundwater is near or below NPDES effluent limits at the effluent of Stage 1, HCS#1.

4.4.6 Stage 2 Wetlands Construction (Summer 2011)

Stage 2 (approximately 2.2 acres in size) was constructed as a shallow surface flow aerobic wetlands. Effluent from Stage 1 is discharged evenly across the north end of Stage 2. Four 25-foot wide aeration zones were installed with a maximum water depth of 3 feet. Aeration is provided by an 8.5-hp motor regenerative blower located at the northeast corner of Stage 2. Three shallow (1.5 foot deep water) planting “benches” measuring approximately 110 feet wide were constructed between the aeration zones. Topsoil previously removed from the pond berms was placed on each of these benches to provide a suitable rooting media for the wetlands plants. Over 14,000 plants were installed in the benches. Water then gravity flows through HCS#2 into Stage 3.

4.4.7 Stage 3 Wetlands Construction (Summer 2012)

Stage 3 was constructed similarly to Stage 2, with the exception that no blower or aeration piping was installed. This final stage provides a factor of safety for possible future increased flow rates and/or concentrations. It also permits reduced operation of the Stage 2 blower, reducing O&M costs. Similar to the other stages, a weir-controlled outfall structure HCS#3 is used to adjust the water level. A limited amount of seeding was completed in Stage 3 during the fall of 2012; however, the area has since filled with wetlands plants with little or no ongoing maintenance.

4.5 2012 AHA EXCAVATIONS

The Asphalt Handling Area (AHA) was formerly used to manage asphalt and other materials (both solids and liquids) generated during the refinery operation. The AHA included a former disposal pit and approximately sixteen piles of stabilized asphalt visible in Figure 2-17. The AHA Pit was formerly used to mix soil with asphalt to stabilize the asphalt. This material was then removed and placed into piles (the AHA Piles). Given the opportunity presented by the West Oxidization Ponds sediment stabilization and closure (see Section 4.6), EPME-PC decided to remove all waste from the AHA and consolidate it

within the West Oxidation Pond. The soil-like material also proved to be a good stabilizing/drying agent when mixed with the more liquid sediments.

4.5.1 AHA Pit

Prior Site investigation revealed the asphalt remaining in the pit upon cessation of operations was only partially stabilized. During the IRM excavation, the berms surrounding the AHA Pit were found to be made up of material similar to the AHA Piles. This material was also placed in the West Oxidation Pond with the other AHA material. During excavation, the pit was found to be deeper than expected based upon bedrock surface in the area and prior soil borings, reaching over 20 feet in the far northern area. Given near-vertical side walls across the northern side, it was apparent the original pit had either been excavated into bedrock or a former rock pit had been repurposed and was abandoned after it had been filled with partially stabilized asphalt. Over the years, this permitted asphaltic materials to seep into the bedrock fractures and is believed to be the source of the tar-like material entrained in the MPA Spring water. In addition, this meant the pit extended laterally much further north than anticipated. All petroleum-impacted excavatable materials were removed from the AHA Pit area. The total volume transported to the West Oxidization Pond was approximately 14,350 bank cubic yards (bcy). Given this increased size compared to the original design and with no AHA Pit berm soil to use as backfill, soil was borrowed from former tank berms in the STF and the area was restored to grade.

4.5.2 AHA Piles

Approximately 16 piles of previously stabilized asphalt material (AHA Piles) were excavated from the AHA in 2012. The material was transported to the West Oxidation Pond, was placed on top of previously-stabilized pond sediments, and was used as fill to shape the slope of the subgrade of the soil cover. The AHA piles were excavated until visual observation confirmed clean soil or bedrock had been encountered and all asphaltic material had been removed. The total volume of AHA pile material transported to the West Oxidization Pond was approximately 15,000 cy. Once the AHA Piles were removed and the AHA Pit was filled and graded, the AHA was seeded with a KDOT seed blend as provided the AHA Design.

4.5.3 MPA Asphalt-Impacted Soil

In addition to the AHA pit material, approximately 700 cy of asphalt-impacted soil discovered during 2010 MPA Grading activities, were incorporated with the AHA pit material in the former West Oxidation Pond for stabilization.

4.6 2012 WEST OXIDATION POND STABILIZING, CAP, AND CLOSURE

As previously discussed, all waste materials were consolidated in the former West Oxidation Pond. A treatability study for the pond sediments and asphaltic material was performed in 2009

and 2010 to evaluate the efficacy of using chemical stabilization to stabilize the sediments. The resulting design mixes and performance standards were approved by the KDHE.

Following successful field trials, full-scale stabilization began in March 2012. Stabilization was performed in grids sized to provide the proper ratio for each 25-ton load of blast furnace slag. Widths of the cells were adjusted based on the measured depth of the sediment present within the grids to keep a 1.5 percent Portland Cement (PC) and 13.5 percent Furnace Slag (FS) ratio proportionate to sediment weight. As the stabilization work progressed from north to south, more-fluid sediment materials were encountered. After performance testing and with KDHE approval, the mix design was changed to a mixture of 25 percent AHA Pit or Pile material, 5 percent PC (increased from 1.5 percent), and 13.5 percent FS (same as original design). Stabilization was completed on June 29, 2012. Approximately 55,000 cy of sediment were stabilized within the West Oxidation Pond.

Upon completion of sediment stabilization, the surface was graded to prevent ponding of water on the stabilized monolith. A 2-foot thick clay cover and 6 inches of organic soil were then placed on the surface to reduce infiltration and to support a healthy vegetation cover. Cow manure was amended to the soil at approximately 15 to 25 percent by volume and disked into the topsoil to enhance soil fertility and vegetative growth. Final capped West Pond grades are shown in Figure 4-2. All ponds were officially closed by October 24, 2012 and the cap was seeded with an approved KDOT seed mix on November 9, 2012.

4.7 2012-2013 MPA SPRING

The MPA Spring is located in the central portion of the MPA and is believed to have been created when a catalytic cracking unit footing was installed through weathered bedrock many years ago. No spring flow was present after the MPA Grading work was completed in early 2011. Given the removal of the footing concrete and backfilling with compacted soil, it was believed the MPA Spring may have been plugged; however, it surfaced again during the spring of 2012 following a period of rainy weather. MPA Spring flow continued until early summer 2012 and then ceased until April 2013 following several days of rainy weather. MPA Spring flow is very responsive to storm events, increasing within hours of a moderate precipitation event due to the shallow soil and near-surface weathered rock believed to be the source of the MPA Spring water to the west. Flow is present throughout much of the year with flow ebbing, and often halting, during dry summer months and winter. The location of the MPA Spring and system components discussed in the follow sections are shown in Figure 4-5.

4.7.1 2012 MPA Spring Mitigation System

Historically, and again in 2012, water discharging from the MPA Spring was observed to be impacted with viscous asphaltic material (tar); therefore, given the closure of the process sewers and stormwater ponds to which the water previously flowed (see Section 4.2.1), an *MPA Spring Mitigation System* was designed and installed with KDHE approval in the fall of 2012. The objective was to capture the flow, separate and contain the tar, and redirect the clean water

to the MPA Stormwater Channel. (Prior sampling indicated non-detectable contaminant concentrations in the MPA Spring water). Although the newly installed MPA Spring sump appeared to remove most of the tar, small droplets were and continue to be observed in the discharge to the MPA Channel. These create sheens on the surface water and have stained the nearby riprap surface. The tar was tested and found to have a pH of 7.2, flashpoint greater than 200 degrees Fahrenheit (°F), and few (well below standards) leachable components. The (SG) was measured at 0.96, which is near the SG of water (1.00), posing challenges to separate it from the water flow.

The MPA Spring Mitigation System Design (Design) included a contingency polishing underground gravity flow oil/water separator with the ability to add media cartridges, such as granular activated carbon (GAC) or organo-clay media (OCM). However, both possible temporal and physical property changes of the tar entrained in the Spring flow led to MWH's recommendation not to install this equipment immediately, but to wait until the MPA Spring flow resumed so the effluent quantity and quality could be evaluated. If tar was still present in the effluent riser at the discharge point (the MPA Channel), the new capture and conveyance system would permit more accurate measurement of flow, evaluation of the residual entrained tar, and pilot testing of alternative technologies to refine UOWS components and sizing.

4.7.2 2013 MPA Spring Tar Removal System Design

As summarized in a September 4, 2013 letter to the KDHE, MPA Spring flows up to 60 gallons per minute (gpm) were observed during the spring and summer of 2013. Tar entrainment continued to be observed. Given this, a series of pilot tests and containment measures were implemented, including drawing down the MPA Basin (to which the MPA Spring water discharges) to ensure tar capture. In addition, the *MPA Spring Tar Removal System Design* was submitted to and approved by the KDHE in November 2013. The system consists of a large parallel plate coalescing UOWS and polishing filter media (e.g., activated carbon). The system was installed in April 2014 and is performing as designed.

4.7.3 MPA Spring Water Treatment

Dissolved-phase COC concentrations in MPA Spring water are nominal. Untreated TPH-GRO, TPH-DRO and specific COCs (e.g., benzene) concentrations have been reported well below NPDES discharge limits when flow rates are low and little tar is present. When flow rates are high (e.g., 60 gpm) TPH-DRO near 900 micrograms/liter (µg/L) and benzene of 18 µg/L were reported. It is believed these detections are not truly dissolved phase, but a result of fine tar emulsion; therefore, it is possible the UOWS by itself will provide sufficient treatment; however, the subsequent gravity flow GAC filters were included in the design to remove any remaining fine globules of the difficult-to-gravity-separate tar. The 4.6 million-gallon MPA Basin has also proven to provide sufficient residence time and treatment to meet NPDES effluent standards even without the pending system.

5.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARAR)

This section summarizes Site applicable or relevant and appropriate requirements (ARARs):

- **Applicable requirements** are those cleanup standards or controls that are promulgated under state or federal law that specifically address a hazardous substance, pollutant or contaminant, action, location or other situation at a site. Specifically, an applicable requirement is a requirement that a potentially responsible party would have to comply with by law if the same action or activity were being undertaken apart from Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) authority. If a requirement is not applicable, it still may be relevant and appropriate.
- **Relevant and appropriate requirements** are those cleanup standards or controls that do not specifically or fully address a hazardous substance, pollutant or contaminant, action, location or other situation at a site, but address similar situations. For example, remedial standards for environmental media established in K.A.R. 28-71-11 are applicable to those sites addressed under the auspices of the Voluntary Cleanup and Property Redevelopment Program yet are designated relevant and appropriate for all other sites addressed by the KDHE-BER Remedial Section. Once a requirement is deemed relevant and appropriate, it must be complied with as if it were applicable.

There are three general categories of ARARs:

- **Chemical-specific** ARARs are those that pertain to handling or control of certain chemicals and are typically health- or risk-based numerical values or methodologies. As a general rule, if more than one chemical-specific ARAR exists for a particular contaminant, the most stringent should be applied.
- **Location-specific** ARARs are those that control activities based on the location such as flood plains, wetlands, historic sites, or sensitive ecosystems.
- **Action-specific** ARARs are those that govern discrete actions that may include the use of certain technologies for remedial actions or use of certain types of equipment. Action-specific ARARs do not determine the remedial alternative; rather, they indicate how a selected alternative must be achieved.

5.1 ARAR SUMMARY

The BER Policy BER-RS-015 - Potentially Applicable, Relevant, and Appropriate Requirements (ARARs) table has been updated with any additional ARARs and is included as Table 5-1.

5.2 TO BE CONSIDERED

The following To-Be-Considered ARARs warrant additional clarification/discussion:

5.2.1 BER-RS-033 Considerations for Remedial Standards

The December 2005 KDHE guidance document, BER-RS-033 Consideration for Remedial Standards states that for drinking water aquifers, federally promulgated Maximum Contaminant Levels (MCLs) or other ARARs are to be used. If MCLs do not exist for specific COCs, KDHE's Risk-Based Standards for Kansas (RSK) are to be considered. (MCLs are included where available in the current version of the RSK manual). For non-drinking water aquifers or potential drinking water aquifers with no documented threatened or impacted targets, a Tier 3 risk analysis can be performed with KDHE approval to determine if Tier 3 risk-based concentrations (RBCs) also known as Alternate Cleanup Levels (ACLs) may be appropriate. Tier 3 risk analysis is based on site-specific risk assessment information and must follow the guidance provided in the RSK Manual. Soil concentrations that would prevent the migration of soil contaminants to groundwater are identified in RSK Tier 2. For high priority sites, or if the owner wishes to maintain consistency with the National Contingency Plan (NCP), a site-specific baseline risk assessment should be performed.

5.2.2 BER-RS-045 Groundwater Use and Applying RSK Standards

KDHE's Policy BER-RS-045: *Consideration for Groundwater Use and Applying RSK Standards to Contaminated Groundwate*r requires groundwater to be cleaned up to concentrations based on its most beneficial use (BER-RS-045 2B). The policy states that the most beneficial use for groundwater is for potable use unless otherwise demonstrated (BER-RS-045 2C); cleanup levels must prevent additional groundwater degradation caused by contaminant migrations and restore contaminated groundwater to its most beneficial use (BER-RS-045 2E); and this means when MCL standards exist for a COC, those will be the clean-up standards. The time frame and acceptable methods to achieve these standards are determined by the KDHE based upon what is reasonable for a given site.

5.2.3 Waste and Free Product

According to KDHE policy and as stated in the RSK Manual, all free product, including hydrocarbon saturated soil and known wastes, must be addressed.

5.2.4 Alternative Clean-Up Levels

As discussed in Section 5.2.1, Tier 3 risk-based concentrations (RBCs), also known as alternative clean-up levels (ACLs) can be used where applicable. The Site-specific risk assessment data provides a basis for completing these calculations; however, given the number of COCs present within most areas of concern, the number of possible combinations of limits for

specific COCs that remain below an HI of 1 and cancer risk of 1E-05 is very large. Combining this with different standards for different receptors of concern becomes costly and unwieldy for CAS purposes. Given this, the exposure pathways identified in the Site-specific risk assessments as exceeding accepted hazard indices (HI) or cancer risks will be used to assess the adequacy of the proposed remedial alternatives; however, for areas with identified risks, the KDHE RSK RBSLs will be used to establish areas and volumes of impacted media for CAS evaluation. In the future as Site restoration progresses, evaluation of the remaining risk within one or more specific areas may be completed to help determine when the remedial action is no longer required and Site restoration is complete.

6.0 CONTAMINANTS OF CONCERN (COCS)

In this section, potential contaminants of concern (PCOCs) are listed for various media and Site contaminants of concern (COCs) are identified:

6.1 SURFACE WATER AND SEDIMENTS

None of the West Branch of Walnut River (WBWR) sediment samples exceeded Screening Levels. Mercury was detected in WBWR surface water during the Phase III investigation above Kansas Surface Water Quality Standards (SWQSs) in 3 transects; however, the highest concentration was upgradient of the Site adjacent to the Pester Burn Pond; therefore, it was not believed to be related to the Site. Cyanide was detected above the Screening Level (0.0052 mg/L) at one location (0.0132 mg/L) during the February 2009 event. Cyanide was not detected in previous surface water sampling events in 2005 or 2006. No other analytes (VOCs, SVOCs, TPH-DRO, and TPH-GRO) were detected above SWQSs during the Phase III investigation. A 2011 surface water monitoring event detected no VOCs or TPHs above laboratory reporting limits.

The STF Creek sediment samples exceeded standards for lead and nickel; however, comparable concentrations were found in the upgradient sample and hence they are not believed to be Site related. Pyrene exceeded standards in one sediment sample. Other than chloride, no STF Creek surface water samples exceeded SWQSs during the Phase III investigation. Annual surface water sampling was conducted in the STF Creek in 2005, 2009, 2010, and 2012 and no parameters exceeded standards.

6.2 SOIL

Based upon a ProUCL evaluation during the Phase III Investigation, the following metals exceeded background levels in on-site soils: arsenic, barium, cadmium, chromium, lead, magnesium, mercury, nickel, potassium, and zinc. However, only lead and arsenic exceeded a Tier 2 Non-Residential RBSL. Additional non-metal soil exceedances included: benzene, ethylbenzene, chloroform, 2-methylnaphthalene, MTBE, naphthalene, anthracene, chrysene, TPH-GRO, and TPH-DRO. Neither anthracene nor chrysene exceed the current RSK Non-Residential RBSLs.

6.3 GROUNDWATER

The Phase III investigation found isolated (four or fewer) groundwater exceedances of Tier 2 Non-Residential RBSLs for: barium, 2,4-dimethylphenol, 2-methylphenol (o-cresol), methylphenol (M & P-cresols), benzo(a)anthracene, bis(2-ethylhexyl)phthalate, phenol, pyridine, 1,1,2-trichloroethane, 1,1 dichloroethene, 1,2-dichloroethane, 1,2-dichloropropane, acetone, carbon disulfide, ethylbenzene, methyl ethyl ketone (2-Butanone), methyl isobutyl ketone (4-Methyl-2-Pentanone), methylene chloride, n-butylbenzene, sec-butylbenzene,

trichloroethylene (TCE). More wide-spread exceedances existed for: arsenic, manganese, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene (mesitylene), benzene, naphthalene, n-propylbenzene, vinyl chloride, methyl tert-butyl ether (MTBE),TPH-GRO, and TPH-DRO.

Given the limited extent of Site semi-volatile organic compounds (SVOCs) and few metal exceedances, KDHE approved the current 46-well monitoring program analyte list that consists of 3 metals (arsenic, barium, and manganese), VOCs, TPH-GRO, and TPH-DRO, with SVOC analysis in two wells. Contaminants that have recently (since 2012) exceeded a March 2014 KDHE RSK Tier 2 Non-Residential RBSLs for on-site groundwater or Residential RBSLs for off-site groundwater are:

- Benzene
- Ethylbenzene
- 1,1-Dichloroethane
- MTBE
- 2,4-Dimethylphenol
- Naphthalene
- TPH-GRO
- TPH-DRO
- Arsenic
- Barium
- Manganese

The above-chemicals are summarized in Table 6-1 along with historical and current maximum concentrations.

7.0 CORRECTIVE ACTION GOALS (CAGS)

This section identifies the Site-wide corrective action goals (CAGs). The CAGs address all risks identified by the Site investigations (Section 2) and risk assessments (Section 3) as required to comply with the identified ARARs (Section 5) for the identified COCs (Section 6). Already-completed IRMs (Section 4) have addressed many of these concerns; therefore, the evaluation of alternatives (Section 10) will discuss how past IRM actions integrate with the proposed future remedial actions.

7.1 AOC SUMMARY

The Site is composed of multiple sub-Site source areas or areas of concern (AOCs); therefore, to ensure the Site-wide CAGs address the concerns of all areas, a bulleted summary of key prior investigation and risk assessment findings and IRM actions is provided.

7.1.1 Main Process Area (MPA)

- **Wastes/LNAPL**: All known wastes have been excavated during the IRMs; however, four isolated and relatively small LNAPL areas remain scattered across the MPA. The largest LNAPL areas identified during the Third Phase Site Investigation are being addressed by the IRM MPA Basin Interceptor Trench (IT).
- **MPA Spring**: A natural spring (MPA Spring) with entrained asphaltic materials originating from the AHA Pit is also being mitigated as part of the IRM Spring collection and treatment system.
- **Soil and Groundwater Impacts**: Lead-impacted soil has been consolidated to the southern end of the MPA. That soil and any MPA petroleum-impacted soil is now located under approximately 16 inches of clean soil. Following IRM landfarming activities, all surface soil is now below benzene, toluene, ethylbenzene, total xylenes (BTEX) and TPH-GRO/TPH-DRO RBSLs; however, widespread subsurface soil and groundwater petroleum impacts above RBSLs remain across the central and southern MPA.
- **Hydraulic Capture**: Most contaminated MPA groundwater is captured in the MPA Basin IT and MPA Channel IT. The remainder is captured in the Seep IT, with the possible exception of the far northern end; however, any water from this area would be captured by the Pester interceptor trench system. Therefore, the MPA is fully hydraulically contained.
- **BERA-Identified Risks**: The only remaining BERA-identified risk is the HQLOAEL for HMW PAHs for invertivorous mammals; however, due to conservative assumptions applied in the evaluation, the likelihood that potential risks are actually present is considered low.

- **HHRA-Identified Risks**: Identified HHRA risks include indoor workers, excavation workers, and residents in the MPA. This is primarily due to inhalation of petroleum-related volatiles released from subsurface soil and groundwater; ingestion of groundwater. Exposure to surface soil (0-2 feet bgs) did not result in cancer risks exceeding 1E-04 or hazard indices exceeding 1 for any non-residential receptors.

7.1.2 Asphalt Handling Area (AHA)

- **Wastes/LNAPL**: All wastes have been removed from the AHA. Asphaltic LNAPL has migrated into saturated, unexcavatable weathered/fractured bedrock around the former AHA Pit.
- **Soil**: No soil exceedances remain in the AHA.
- **Groundwater**: The asphaltic LNAPL in the rock fractures creates a small and low-concentration dissolved-phase plume in the far eastern side of the AHA.
- **Hydraulic Capture**: The dissolved-phase plume is captured and treated by the MPA spring system or as part of the MPA plume.
- **BERA-Identified Risks**: Following IRM actions, all BERA-related risks are less than 1.
- **HHRA-Identified Risks**: The HHRA identified risks to indoor workers and residents due primarily to inhalation of petroleum-related volatiles released from subsurface soil and ingestion of groundwater; however, following the IRMs, the inhalation risks have been greatly reduced.

7.1.3 South Tank Farm (STF)

- **Wastes/LNAPL**: Buried waste remains in the north-central portion of the STF. Four isolated LNAPL areas are present around former ASTs. Given the age of the release, relatively thin LNAPL thicknesses, and years of monitoring data, it is likely the LNAPL plumes are stable.
- **Soil**: Petroleum-related soil impacts are scattered within the STF former ASTs and pipeline releases.
- **Groundwater**: All dissolved-phase contamination is also petroleum-related with the exception of a small MTBE plume along the southern STF, and an MTBE source located on the north side of STF, which includes trace amounts of chlorinated compounds. The northern MTBE plume is mobile/not stable. Although the majority of it is captured by the MPA Basin IT and Seep IT, a portion has migrated onto Union Tank Car property, and two residential properties. Several petroleum-only plumes emanate from the LNAPL areas and appear to be stable. The southeastern plume migrates slightly off-site to the east. The south plume may intermittently discharge to the STF Creek when groundwater elevations are high.

- **BERA-Identified Risks**: The BERA determined the HQupper slightly exceeded one (1.2) for invertivorous mammals exposed to HMW PAHs. HQlow results were greater than one for benzene (7.9) and xylenes (3.3). These were based on a lower-bound TRV derived from a chronic water quality criterion; therefore, potential risks to the viability and function of the macroinvertebrate community *may* be present in a localized area of STF Creek.
- **HHRA-Identified Risks**: The HHRA identified risks to indoor and excavation workers due primarily to ingestion of groundwater and inhalation of petroleum-related volatiles released from subsurface soil and groundwater.

7.1.4 Stormwater Pond Area (SPA)

- **Wastes/LNAPL**: All wastes (pond sediments) have been consolidated into the West Oxidation Pond, stabilized, capped, and closed according to KDHE standards. All former wastewater and stormwater ponds are closed. Given that no free product has been observed in the Seep IT and the upgradient MPA Basin IT, it is likely little to no mobile free product remains below the SPA.
- **Soil**: Soil immediately beneath the former stormwater ponds is below RBSL standards based upon visual screening during IRM closure activities and prior soil boring field screening (photoionization detector [PID]) and analytical results; however, several feet deeper, saturated soil was impacted by historical LNAPL migration through the weathered rock under the ponds.
- **Groundwater**: A portion of the MPA dissolved-phase plume and contaminants from below the SPA ponds create a dissolved-phase plume that is captured by the Seep IT. Flow to this trench has been greatly reduced since installation of the immediately upgradient MPA Basin IT.
- **BERA**: The BERA did not assess the SPA area because given the clean-closure of the wetlands area and 2-foot clean soil cap over the West Ponds, no significant risks remain.
- **HHRA**: Similarly, given the plan for a long-term presence of wetlands and stabilized/capped pond sediments, no HHRA was completed for the SPA. Similar to the MPA, risks to workers and residents would likely exist from vapors and ingestion of groundwater across most of the area; however, as part of the pond closure, any such future activities are prohibited.

7.1.5 West Branch Walnut River (WBWR)

- **Wastes/LNAPL**: No wastes are present within the WBWR, with the possible exception of isolated sheens if/when river-bank soils are physically disturbed.
- **Sediment**: If the bank erodes and exposes soil previously impacted with LNAPL, sheens are possible as noted above; however, no sediment impacts are known to exist.

- **Surface Water**: As long as the Seep IT remains operational, no surface water impacts above RBSLs have been observed that are attributable to the Site (e.g., upstream sample also showed impacts). However, if the IRM Seep IT were to cease operation, the WBWR remains at potential risk.
- **BERA-Identified Risks**: The BERA found one detection of *total* cyanide in one sample adjacent to the Site exceeded the Kansas water quality standard for *free* cyanide. Based on the low HQlow (2.5), absence of other detects, and because the cyanide is likely complexed and not present as free cyanide, potential risks in surface water of the WBWR are considered low.
- **HHRA-Identified Risks**: Based upon initial sampling, the HHRA eliminated the WBWR as an exposure area.

7.1.6 Off-Site Areas (OSA)

- **Wastes/LNAPL**: No wastes or LNAPL are known to be present.
- **Soil**: No soil above RBLSs is known to be present.
- **Groundwater**: The STF northeast (NE) plumes extend onto four off-site properties.
- **BERA**: There are no BERA-identified risks.
- **HHRA**: Groundwater ingestion within the STF NE plumes is the only identified risk. (Soil vapor sampling in the EPME-PC-owned residence confirmed the absence of vapor intrusion into the basement).

EPME-PC will coordinate with both the Pester and Union Tank Car site owners to help ensure remediation activities at the sites compliment rather than compete with each other.

7.2 SITE-WIDE CAGS

Given the above, the proposed corrective action goals (CAGs) are:

1. Address wastes.
2. Address practically recoverable LNAPL.
3. Control migration of contaminants from soils that hinder achieving groundwater ARARs.
4. Prevent off-site migration of dissolved-phase plumes or LNAPL.
5. Prevent further degradation of the aquifer.
6. Protect the WBWR and the intermittent STF Creek.
7. Prevent exposure to all soil, soil vapors, and groundwater exceeding RBSLs.
8. Restore groundwater to its most beneficial use.

Clean-up levels are summarized in Table 7-1. Whenever practical, contaminant mass will be removed or remediated in-situ; however, when this is not technically or economically feasible, receptor exposure will be prevented. As used herein, this means to prevent exposure of the human receptors identified in the HHRA to contaminant concentrations that would cause an exceedance of a cumulative cancer risk of 1E-05 or HI of 1.0 via the media and exposure pathways summarized in Section 3.2. For CAS purposes, the actual COC concentrations above which exposure is to be prevented will be the KDHE RSK RBSLs (Non-Residential for on-site soil and groundwater and Residential for off-site groundwater); however, EPME-PC may in the future request consideration of Alternative Clean-up Levels (ACLs) for one or more AOCs. Preventing exposure also includes preventing exposure to LNAPL and buried wastes (e.g., tank bottoms).

8.0 POTENTIALLY APPLICABLE TECHNOLOGIES

While there are dozens of potentially applicable remedial technologies (aka process options), such as electrical resistance heating (ERH), soil washing, in-situ vitrification, and thermal desorption, those are rarely used for the types of petroleum impacts present at this Site. This is because many other viable and more cost effective technologies exist. To limit the size of the CAS, EPME-PC proposes the initial screening of technologies be limited to the following commonly used for petroleum hydrocarbons (presumptive remedies). The following brief descriptions will be expanded in Section 10 and then developed further when combined with other technologies to form a complete remedial alternative for a given area.

8.1 NO ADDITIONAL ACTION

A no action alternative is required by KDHE as a baseline alternative. Under this alternative, no additional measures would be implemented to reduce exposure risks or soil and groundwater concentrations and all current active controls would cease. Because a large amount of remediation work has already been completed, no action is actually “No Additional Action” for this Site and is retained for further evaluation and comparison.

8.2 EUC AND SWMP

Environmental Use Controls (EUCs) are often paired with a Soil-Waste Management Plan (SWMP) to mitigate exposure risks while site restoration proceeds.

8.2.1 EUC

As described in the KDHE EUC Program fact sheet, an EUC is a legal mechanism administered by the KDHE for applying restrictions, prohibitions, and conditions on land use for a property that has environmental contamination at levels prohibiting unrestricted use (exceeding RBSL residential standards). An EUC can be voluntarily applied to a property by the landowner to ensure adequate protection of public health and the environment from contamination on the subject property. It is not the same as a local commercial zoning ordinance. It runs with the property and is binding on the landowner and any subsequent owners, lessees, and other users of the property. EUCs allow for the development of and productive use of a contaminated property where cleanup to levels allowing unrestricted use is not economically or technically feasible.

EUCs provide protection from exposure to residual contamination that remains in place on a subject property. For example, an EUC may prohibit groundwater from being used as drinking water, or require the maintenance of an engineered barrier, such as a cap, to prevent exposure to contaminants. EUCs provide landowners with a way to achieve site closure by addressing remaining environmental concerns caused by residual contamination. EUCs also protect the

seller of a property by informing future landowners of the use restrictions necessary to mitigate the environmental liability concerns associated with a property.

8.2.2 Soil-Waste Management Plan (SWMP)

Soil-Waste Management Plans (SWMPs) are often part of EUCs, specifying areas and depth where only properly trained personnel can excavate and how the soil will be tested and managed. A SWMP for the Site was submitted to the KDHE in March 2014 for review and comment. The SWMP was prepared in accordance with the KDHE BER guidance Policy *BER-RS-55 – Developing a Soil-Waste Management Plan* (KDHE, July 2013). The SWMP outlines the general procedures that contractors and others engaged in soil-disturbance activities, such as excavation, grading, drilling, boring, trenching and/or construction activities that disturb soil will employ when working within the EUCs boundaries due to the presence of known and suspected soil contamination. The overall objectives of the SWMP are to:

- Establish a policy for documenting the decision-making process prior to performing soil disturbing activities within the Site,
- Establish a policy for the management and disposal of waste soils which may be generated during soil-disturbing activities within the Site,
- Establish proper notification procedures to the KDHE and other recognized entities,
- Protect workers from potential exposure to contaminated soil while performing routine maintenance, excavation, grading, trenching, or other activities that may result in potential exposure to soil contaminants within the Site,
- Protect workers from potential uncontrolled exposures to contaminated soil during routine work activities that may be unrelated to soil excavation and disturbance, and
- Ensure work is conducted and contaminated soil is managed in accordance with the SWMP, EUCs, and applicable federal and state laws and regulations.

EUCs and a SWMP are retained for further evaluation.

8.3 LONG-TERM GROUNDWATER MONITORING (LTM)

Long-term groundwater monitoring (LTM) of Site's COCs is not active remediation, but is essential to monitoring the performance of active systems and to track remedial progress overtime. A monitoring plan is currently in place for the Site. This plan and any proposed LTM changes are discussed in Section 10.2.2. LTM is retained for further evaluation.

8.4 MNA AND NSZD

Monitored natural attenuation (MNA) and natural source zone depletion (NSZD) are similar concepts evaluating the natural process that control contaminant movement and destruction in

the subsurface. The following were referenced while preparing this section: *Monitored Natural Attenuation*, KDHE BER-RS-042 December 2005 revision, and *Evaluating Natural Source Zone Depletion at Sites with LNAPL,* the Interstate Technology & Regulatory Council (ITRC) April 2009.

8.4.1 Monitored Natural Attenuation (MNA)

MNA focuses on groundwater and the dissolved-phase processes that include destruction such as abiotic degradation (e.g., direct chemical reactions) or biotic degradation (e.g., biodegradation via organism respiration). Decreases in the dissolved-phase concentrations can also occur through non-destructive processes such as dispersion, dilution, sorption (to soil) and volatilization (to soil vapor). This is important when evaluating the risk and/or likely extent of a dissolved-phase plume migration. Natural attenuation occurs even when "no action" is taken and also during active remediation, but MNA adds a monitoring component to confirm and to track the progress. It can be used to monitor degradation rates where source mass remains and/or to monitor plume stability at the very end of remediation.

8.4.2 Natural Source Zone Depletion (NSZD)

NSZD evaluates overall contaminant mass removal from the subsurface; hence it includes the biodegradation aspects of MNA for dissolved-phase source destruction. Historical data from numerous petroleum-impacted sites and recent studies of carbon dioxide vapor flux above LNAPL sources have shown mass-destroying biodegradation processes are also present in the vadose zone. Free-phase or residual-phase (trapped in soil pores) LNAPL vaporize, migrate vertically upward (the source of vapor intrusion risks), dissolve into soil pore water, and biodegrade producing carbon dioxide and/or methane. Heavier-end LNAPL with limited volatilization can be degraded by aerobic bacteria and methanogenic anaerobic bacteria. Produced methane gas migrates vertically and is biologically further oxidized and converted to carbon dioxide as the vapors reach shallow oxygenated depths; hence, vadose zone LNAPL mass, whether sorbed to soil or free phase diminishes over time. Saturated LNAPL mass has similar mass removal processes, and it also dissolves into groundwater with subsequent natural attenuation processes discussed in Section 8.4.1. The combination can result in removal of a large amount of contaminant mass over large aerial footprints.

8.4.3 MNA and NSZD Site Applicability

Confirmation of the presence of natural attenuation processes and NSZD has not been completed at the Site; and hence, *the adequacy of these processes to achieve CAGs is not assumed for this CAS evaluation*. The selected remedies will be required to provide adequate protection even if no natural attenuation processes exist. However, experience at petroleum-impacted sites across the generally moist and nutrient-rich Midwest confirms that not only are natural attenuation processes nearly always present, but they typically result in the destruction.

Given already completed and proposed future source treatment/reductions, if natural attenuation is confirmed, it may either already be, or at some point in the future will be providing adequate containment of the dissolved-phase plume, protecting receptors, and providing final polishing treatment of Site contaminants. If natural attenuation is confirmed, this could permit eventual termination of energy-intensive and costly mechanical remediation processes. Given this, it is proposed to include groundwater MNA as a *potential remediation component* in one or more areas of the Site, pending confirmation that natural attenuation processes are present and sufficiently active. To that end, collection and evaluation of MNA data will be proposed as part of the CAS remedy.

Similar to groundwater natural attenuation processes, *NSZD has not been confirmed at this Site, is not assumed for the CAS evaluation*, and other remedies to address LNAPL are proposed; however, collection of data to confirm the rate of natural LNAPL destruction could aid future decision-making as to when the cost of active recovery efforts is no longer justified. Given this, it is proposed to include NSZD as a *potential remediation component* in one or more areas of the Site, pending confirmation that such processes are present. To that end, collection and evaluation of NSZD data (e.g., carbon dioxide flux) will be proposed in accordance with the previously referenced ITRC NSZD document.

MNA and NSZD are retained for further evaluation.

8.5 SOIL VAPOR EXTRACTION (SVE)/AIR SPARGE (AS)

SVE and air sparge (AS) are complimentary remedial technologies that are often paired to address soil and groundwater impacts at petroleum sites. The technologies rely on physical and biological mass removal mechanisms. SVE uses a low pressure to pull air through the soil and out through a vapor extraction well. AS injects air into the groundwater, typically through wells, to strip volatile compounds, which are subsequently recovered using SVE. SVE not only introduces atmospheric air into the unsaturated site soils, which can enhance biodegradation, but also introduces oxygen to the vadose zone. AS enhances aerobic biodegradation, primarily in saturated soil but also in capillary fringe and deep vadose soil as the air migrates upward to an SVE well. SVE/AS can be implemented using vertical wells, horizontal wells, or trenches.

Vertical Well: Given the low permeability clayey overburden and fractured rock transmissive groundwater zone, it is likely closely-spaced vertical wells would be required and SVE operational issues would occur (e.g., water entrainment). Given this and the size of the candidate treatment areas in the MPA, AHA, and STF, vertical well SVE/AS is not practical and it will not be retained.

Horizontal Well: Horizontal well SVE is similarly not viable or practical given the low permeability clays present at this Site. Dewatering of the more permeable weathered bedrock would be required to achieve reasonable air flow and distribution. This would be effectively multi-phase extraction which is evaluated in Section 8.10. Horizontal well SVE will not be

retained for further evaluation. Horizontal well AS is potentially viable through the weathered rock zone and could be used to create a sparge curtain; however, vapor capture would be a concern. It would likely be implemented in a trench-based approach (next paragraph); hence, horizontal well AS also will not be retained for further evaluation.

Trench-Based: As described in the previous paragraph, trench-based SVE/AS could be used to create a sparge wall (AS), stripping VOCs and adding dissolved oxygen (DO) to groundwater to degrade remaining TPH and co-metabolically degrade MTBE, with a lateral SVE well used to collect the sparge vapors. The vacuum would also draw some air flow down through nearby soils, volatilizing and biodegrading COCs in the vadose zone. This system would likely operate as a hybrid SVE/AS and biovent/biosparge system, but for convenience it will be referred to simply as a trench-based SVE/AS system and will be retained for further consideration.

8.6 BIOVENT AND BIOSPARGE

A *biovent* system uses in-situ microbes (typically native/already acclimated) to primarily aerobically biodegrade petroleum compounds into non-biologically harmful compounds (e.g., carbon dioxide and water) in unsaturated zone soils. It does this by introducing oxygen through an air extraction or injection well. A *biosparge* system injects air into the saturated zone to promote similar processes. The equipment/system is very similar to an SVE/AS system, and in fact, many SVE/AS systems for petroleum compounds are effective biovent/biosparge systems. The primary difference is the objective of promoting only biodegradation versus also volatilization (AS/SVE) and, hence, biovent/biosparge systems tend to introduce less air than SVE/AS. This is a difference of intent or stage of remediation and biovent/biosparge are limited to the same implementation restrictions as SVE/AS; therefore, both will be evaluated together throughout the CAS with the best-suited terminology used for the stage and type of remediation being discussed. Trench-based biovent/biosparge will be retained for further consideration.

8.7 PRODUCT SKIMMING

Product skimming requires the installation of trenches or recovery wells screened across the product/water interface. Accumulated product is either periodically removed through hand-bailing or pumping. It may also be continuously removed through the use of passive skimmers with either collection canisters (for low recovery sites) or pneumatic pumps (for higher recovery sites) that recover only the product. The product is then collected and disposed. Product skimming will be retained for further consideration.

8.8 HYDRAULIC CONTAINMENT (PUMP AND TREAT)

Hydraulic recovery adds a groundwater extraction component to passive skimming (if product recovery is involved) to create a groundwater cone of depression, increasing the free-product capture zone and rate of recovery and providing hydraulic containment of both dissolved-phase and free product plumes. Recovery can be completed with a single pump, entraining both

groundwater and product for later separation or with dual pumps, one for product and one for groundwater. The optimal pumping rate depends upon the aquifer permeability. For reasons previously discussed, vertical well hydraulic recovery would be difficult and costly to implement with limited effectiveness at this Site; however, trench-based hydraulic containment has been proven effective at the Site (Seep IT and MPA Basin IT); therefore, trench-based hydraulic containment will be retained for further consideration. A product separation and water treatment system capable of increased flows is already present on-site (wetlands system) and would be used to treat all extracted groundwater and product.

KDHE Guidance BER-RS-028, *Considerations for Hydraulic Containment*, 2005, has been referenced during the design of the existing systems and will continue to be considered. This includes clearly stating the remedy objectives; defining the target capture zone, and providing a monitoring network sufficient to verify performance. EUCs must be implemented for impacted area and compliance monitoring must be complete along the leading edges of the plume.

8.9 SURFACTANT FLUSHING

Surfactant flushing adds injection of a surfactant to hydraulic recovery. The surfactant is injected between recovery wells or trenches to help mobilize product, enhancing recovery; however, it also increases the solubility of product in groundwater, increasing dissolved-phase concentrations. Although long-term surfactant flushing is possible, most applications are relatively short term with temporary/mobile groundwater extraction and treatment and product recovery equipment. Free-product recovery is usually enhanced; however, given the relatively high costs, surfactant flushing is typically used when short-term drivers, such as risk to receptors or pending redevelopment, justify the higher cost. Given neither of those are true for this Site and given the risk of increased dissolved-phase concentrations, surfactant flushing will not be retained for further consideration.

8.10 MULTI-PHASE EXTRACTION (MPE)

Multi-phase extraction (MPE) is also called dual-phase extraction (DPE), high vacuum extraction, slurping, or bioslurping. MPE systems add vapor extraction (e.g., SVE) to hydraulic recovery wells or trenches. This addition enhances product recovery both in the liquid and vapor phase. It also begins remediation of the vadose soil through volatilization and biodegradation (e.g., bioventing) of product trapped in soil pores. MPE can be particularly useful for sites with volatile product and where groundwater elevations fluctuate seasonally or diurnally. When groundwater elevations are low, the induced vapor flow can remove product through volatilization within the smear zone. This frees soil pore space into which product can sorb as groundwater elevations increase. The cycle then repeats. Vacuum influence is typically easier to create and propagate than hydraulic gradients sufficient to mobile liquid product; therefore, theoretically MPE wells or trenches could be spaced at greater distances than hydraulic recovery alone; however, since groundwater extraction rates are often lower for MPE than for hydraulic recovery, the well or trench spacing is often similar for both approaches.

Similar to hydraulic containment and SVE/AS, MPE would be implemented in trenches at this Site. The addition of a vacuum blower, piping, and possible need for vapor treatment effectively add an SVE/biovent component to hydraulic containment, increasing the initial capital and O&M costs. This process option will be retained for further consideration.

8.11 IN-SITU CHEMICAL OXIDATION (ISCO)

Various chemical oxidants are available that would chemically destroy and promote the biodegradation of Site COCs in the saturated zone. (ISCO reactions occur only in the dissolved phase). Oxidants include: Fenton-based (catalyst-activated hydrogen peroxide), activated persulfate (e.g., FMC's Klozur™), permanganate (e.g., Carus' RemOx™, although this is not effective for most petroleum COCs), and proprietary blends such as RegenOx™, Cool-Ox™, PursulfOx™, and Biox™. Each oxidant has advantages and disadvantages depending upon the contaminants (oxidization potential must be sufficiently high) and site hydrogeology (more contaminant mass present in lower permeability material requires long-lived oxidants); however, all require relatively near-term (hours to days) physical contact with the contaminants to be successful. In low-permeability soils, hydraulic fracturing is required to increase the contact area and inject sufficient oxidant volume; however, given Site conditions, it is likely a large amount of contaminant mass would remain within diffusion-controlled areas of the soil matrix and hence would not be treated. Multiple (e.g., six or more) injection events would likely be required to increase the odds of adequate distribution and adequate treatment; however, it is likely only partial treatment would result. Given this, the lateral extent of saturated impact, and the amount of contaminant mass present (amount of oxidant required), ISCO would not be practical to implement at this Site. Thus, ISCO will not be retained for further evaluation, except as possible distant future contingency polishing treatment in isolated areas.

8.12 SOIL EXCAVATION AND LANDFARMING

Petroleum-impacted and MTBE-impacted soil in source areas can be excavated and landfarmed to reduce the residual contaminant mass, expediting natural attenuation processes. The MPA has been used and is well-suited for use as a landfarm. The MPA is a sufficiently large area (approximately 30 useable acres) for moderate-sized excavations. The MPA Basin captures all stormwater from the MPA area; therefore, any turbidity can settle and contaminants treated (water can be pumped to the wetlands system), if required. Contamination remains beneath the previously landfarmed soils and groundwater is hydraulically contained; therefore, no adverse impacts are likely from landfarming. Depending upon the MPA final remedy, removal of landfarm soil may not be require after treatment since those then clean soils increase the separation distance between impacted soils (included lead-impacted soil) and final ground surface. Regardless, landfarming is also viable in other areas of the Site such as the STF and AHA. Excavation and landfarming will be retained for further analysis.

8.13 WASTE EXCAVATION, STABILIZATION, AND OFF-SITE DISPOSAL

Waste materials remain in the STF and, if excavation is selected as a remedy, it is possible some excavated source area materials may be waste rather than soil. Wastes cannot be landfarmed; therefore, depending upon the classification, the waste may be excavated, stabilized (similar to AHA materials), and either disposed at a hazardous waste landfill or nonhazardous waste (Subtitle D municipal) landfill. Excavation and off-site disposal will be retained for further analysis.

8.14 WASTE EXCAVATION, STABILIZATION, AND ON-SITE DISPOSAL

Depending upon the volumes of waste excavations, the off-site liabilities and costs may justify on-site stabilization, reopening a portion of the closed West Pond cap, and adding those wastes to the IRM site wastes. Given the cap area, large volumes could be accommodated with minor final grade adjustments; however, one objective would be to minimize the cap disturbance area and, hence, the area and volume of cap material requiring removal and replacement. Excavation and on-site disposal of waste will be retained for further analysis.

8.15 CAPPING

If reduced infiltration or isolation of surface soils is required, a low permeability clay soil cap of various thicknesses and/or a flexible membrane liner (FML) with thinner soil cover could be emplaced. Evapo-transpiration (ET) caps utilize plants to control infiltration rates. Given the relatively high rainfall climate and use of caps within this CAS as a physical separation barrier, ET caps will not be retained. Soil and FML-based caps will be retained for further analysis.

8.16 PHYTOREMEDIATION

Phytoremediation uses plants to remediate contaminated soil, sludge, sediment, groundwater, surface water, and wastewater. Plant-related biological processes, soil agronomy, site hydrology, installation techniques, and plant physiology can develop a predictable reactor to accomplish contaminant degradation, removal, or immobilization. These processes primarily occur in the rhizosphere, an area in the soil that extends the entire depth of the active root system plus the capillary fringe. The area with the greatest microbial activity is within approximately 2 centimeters (cm) of the root surface. The mechanisms include:

- Phytosequestration: Immobilizing compounds (e.g., metals) in the rhizosphere
- Rhizodegradation: Biodegradation of contaminants in the rhizosphere
- Phytohydraulics: The evaporation/transpiration of water (for hydraulic control)
- Phytoextraction: Contaminants taken up into the plant matter
- Phytodegradation: Degradation that occurs as part of photosynthetic processes
- Phytovolatilization: Contaminants taken up and transpired (e.g., volatilized)

Soil microbial activity (and resulting biodegradation) can be up to 4 orders of magnitude greater in the rhizosphere (rhizodegradation) than in other areas. The microorganisms are capable of degrading a large range of mineral and organic contaminants, including most petroleum hydrocarbons; therefore, contaminant mass can be reduced in-situ. Similarly, many common metals and metalloids including cadmium, chromium, mercury, lead, boron, selenium, and arsenic can be fixed in place or in the plant matter (phytosequestration). Dissolved-phase contaminants are also entrained in root groundwater uptake and removed through any of the latter four processes: phytohydraulics, phytoextraction, phytodegradation, and phytovolatilization.

As part of phytohydraulics, plants influence the movement of groundwater and soil pore water through the uptake and consumption of large volumes of water; therefore, hydraulic plume control may be possible. Moisture uptake can also capture infiltrating stormwater (and associated contaminant leaching if applicable) and induce upward flow of water from the water table (capillary forces) through the vadose zone. This process may be used in place of or to supplement a pump and treat system. Phytoremediation will be retained for further analysis.

8.17 POTENTIALLY APPLICABLE TECHNOLOGY SUMMARY

The following technologies have been retained for potential consideration in one or more areas of the Site:

- No Additional Action
- EUCs and SWMP
- LTM (groundwater monitoring)
- MNA and NSZD
- SVE/AS – Biovent/Biosparge*
- LNAPL/Product Skimming*
- Hydraulic Containment* (product and groundwater)
- MPE*
- Soil Excavation and Landfarming
- Waste Excavation, Stabilization, and Off-Site or On-Site Disposal
- Capping
- Phytoremediation

*trench-based

9.0 PILOT TESTS

Pilot tests are recommended for any novel technologies or where performance is uncertain for proven technologies. The IRM has effectively tested and proven out several technologies, including hydraulic containment, stabilization, excavation and landfarming, and has provided an effective and operational product separation and water treatment system. The primary retained technologies not tested are SVE and AS (including closely related biovent/biosparge and multi-phase extraction [MPE]). These technologies are perhaps the most commonly implemented remedial technologies for hydrocarbon sites; therefore, much knowledge on their application exists. Although Site hydrogeology poses challenges, performance can be anticipated and estimated with reasonable certainty within ranges. Considerations and limitations will be noted in the detailed evaluation. EPME-PC proposes no additional pilot tests prior to completing the CAS.

10.0 DETAILED EVALUATION OF ALTERNATIVES

This section combines the process options from Section 8 to assemble complete remediation alternatives for detailed evaluation. Each alternative is evaluated with respect to the following 8 criteria:

1. **Overall protection of human health and environment**
   i. Overall summary of key other criteria, especially long-term effectiveness, permanence, short-term effectiveness, and compliance with ARARs
2. **Compliance with Federal and State ARARs**
   i. Location-specific ARARs
   ii. Action-specific ARARs
   iii. Other criteria, guidance, to-be-considered
3. **Long-term effectiveness and permanence**
   i. Magnitude of the residual risk remaining after actions are complete
   ii. Adequacy and reliability of controls used to manage residual risk
4. **Reduction of toxicity, mobility, and volume of contamination through treatment**
   i. Favors treatment processes to reduce risk
   ii. Amount of hazardous material destroyed
   iii. Overall degree of reduction in toxicity, mobility, and volume
   iv. Type and quantity of residuals remaining after treatment
5. **Short-Term effectiveness**
   i. Protection of community during remedial actions
   ii. Protection of workers during remedial actions
   iii. Environmental impacts of remedial actions
   iv. Time until Corrective Action Goals (CAGs) are achieved
6. **Implementability**
   i. Ability to construct the technology/system – necessary specialists
   ii. Reliability of the technology
   iii. Ease of undertaking additional remedial action
   iv. Ability to monitor effectiveness of the remedy
   v. Ability to obtain approval from other agencies (e.g., permits)
7. **Community acceptance**
   i. How possible public concerns are addressed
8. **Cost**
   i. Capital costs (up-front design, construction, implementation, etc.)
   ii. Operation and maintenance (O&M) costs
   iii. Present worth cost (considers time-value of money)

The Site is composed of several sub-areas, each with their unique setting and COC make-up; therefore, three alternatives are discussed for each of the five areas of concern (AOCs), the Main Process Area (MPA), Asphalt Handling Area (AHA), South Tank Farm (STF), Stormwater Pond Area (SPA), and Off-Site Areas (OSA). For the purposes of this discussion, the STF includes the property owned by EPME-PC that is located east of North Topeka Street.

This section includes the following components:

- **Section 10.1 – IRM Components**: A large amount of remediation has already been completed as part of the IRM activities discussed in Section 4. This work impacts what remains to be completed and is part of the overall remedial costs.
- **Section 10.2 – Shared Components**: Appropriate combinations of technologies vary among the areas; however, several components will likely be shared across more than one area. Therefore, common remedy components are summarized and costed separately for subsequent reference within the area-specific discussions.
- **Section 10.3 – MPA:** Three complete alternatives that address the issues specific to the MPA are assembled, evaluated, and costed.
- **Section 10.4 – AHA:** Three complete alternatives that address the issues specific to the AHA are assembled, evaluated, and costed.
- **Section 10.5 – STF:** Three complete alternatives that address the issues specific to the STF are assembled, evaluated, and costed.
- **Section 10.6 – SPA:** Three complete alternatives that address the issues specific to the SPA are assembled, evaluated, and costed.
- **Section 10.7 – OSA:** Three complete alternatives that address the issues specific to the off-site areas (OSAs) are assembled, evaluated, and costed.

10.1 IRM COMPONENTS

The following already-complete interim remedial measures (IRMs) are discussed in Section 4.0. Costs are tallied and allocated among the Site areas in Appendix D. The total IRM cost for each area is then included in the area-specific evaluation and costing (Section 10.3 through 10.6) including associated Cost Tables 10-1 through 10-4. The total IRM cost was $20.5 million. The individual IRM tasks (and individual cost) are:

1) Seep Interceptor Trench ($1,600,000)
2) MPA Demolition and Grading ($8,800,000)
3) Landfarming ($180,000)
4) Lead-Impacted Soil Management ($150,000)
5) MPA Stormwater Basin and Groundwater IT ($750,000)
6) MPA Spring Collection and Treatment System ($360,000)

7) AHA Pit and Piles Excavation ($950,000)
8) West Pond Waste Stabilization and Capping ($5,600,000)
9) Wetlands-Based Groundwater Treatment System ($2,200,000)

10.2 SHARED REMEDY COMPONENTS

There are several remedy components shared among most of the alternatives for each of the Site areas of concern (AOCs):

a) EUCs and SWMP,
b) Long-term groundwater monitoring (LTM)
c) Free-Phase LNAPL Recovery (separate from IT operation),
d) MNA and NSZD,
e) Groundwater (and LNAPL) Treatment System (GTS), and
f) Closeout of the Above (eventual removal of wells/equipment)

For these components, activities in one AOC interrelate/overlap with those of another; therefore, an integrated plan is presented for each within this section. This is then referenced when one of these components is included in a specific alternative. Costs are tallied and allocated among the Site AOCs in Appendix D based upon the percent of work required for each area. Appendix D also includes associated support calculations and figures.

Annual Report: Similar to other shared tasks, the reporting cost is included within each of these components. Costs assume a single combined report to KDHE-BER for a Site-wide report for all corrective measures - *Annual O&M, Monitoring, and EUC Inspection Report* (Annual Report). The assumed reporting period is annually throughout the CAS evaluation period of 30 years given the proven effectiveness of the IRM components, years of data confirming the stability of LNAPL and dissolved-phase plumes, and the fact additional remedial components will enhance the overall protectiveness.

10.2.1 EUC and SWMP

All known free-phase LNAPL, soil impacts, and nearly all of the dissolved-phase plumes are located on-site or on property owned by EPME-PC. An objective of Alternatives 2 and 3 for all areas is to contain the plumes within Site property boundaries (if not already so); therefore, Environmental Use Controls (EUCs) can become a readily implemented and important component of the remedial strategy to protect potential receptors from exposure until CAGs are achieved. An important component of the EUCs is a Soil-Waste Management Plan (SWMP) that describes notification, planning, and field procedures for screen, sampling, and handling/disposal of any impacted soil or unknown waste encountered during excavations within the EUC area. A Draft SWMP was prepared and was submitted to the KDHE in March 18, 2013 for review. A copy of this plan is included in the Appendix A CD for reference.

Given the risks identified by the risk assessments and addressed in the SWMP, the proposed EUC area includes the contiguous area identified in Figure 10-1. This area would be surveyed by Kansas-registered surveyors for official recording with the EUC. It is proposed the EUC include:

- Prohibition on installation of any drinking water wells within the EUC areas.
- Required implementation of the SWMP for any excavation greater than 6 inches within the EUC area.
- Prohibition of excavation (exempting earthwork for cover repair) or the construction of any structure above the stabilized waste area (former West stormwater pond area).
- Prohibition on the construction of any building intended for human occupation within the EUC area unless a vapor barrier and mitigation system is designed by a professional engineer and approved by the KDHE.

Inspections and Reporting: Annual inspections, confirmed implementation and compliance with the SWMP, and EUC-required reporting is assumed to be completed by EPME-PC during the CAS evaluation period.

A Long-Term Care Agreement would be negotiated with the KDHE to respond to notifications, manage the EUC database, track any changes if property within the EUC area is sold, and eventually take over EUC inspection and reporting.

10.2.2 Long-Term Groundwater Monitoring (LTM)

Free-phase and groundwater fluid levels are currently measured in all existing 173 monitoring wells, shown in Figure 2-4. This gauging and creation of potentiometric surface maps with groundwater flow direction is proposed to continue to confirm the effectiveness of some likely remedial components (e.g., hydraulic containment).

Using low-flow sampling where possible, and bailers elsewhere, groundwater samples are currently collected semi-annually from the 46 wells and the MPA Spring as listed in the table below and as shown (highlighted) in Figure 2-10.

Main Process Area (8)			
MW-55	MW-67R	MW-115	MW-123
MW-SB17	OW-37	OW-39	MPA Spring*
South Tank Farm (19)			
OW-08	OW-09	MW-03	MW-12
MW-16	MW-19	MW-24D	MW-24S
MW-86	MW-87	MW-89	MW-94
MW-97	MW-98	MW-104D	MW-104S
MW-106D	MW-106S	MW-108	
Adjacent to West Branch Walnut River (8)			
N3-2	OW-29	OW-30	OW-31
OW-32	OW-33	W-01S	W-22
West of the Wetlands (4)			
N3-3	MW-SB36	MW-SB37	W-24
East of North Topeka Street (8)			
MW-75	MW-77	MW-81	MW-111
MW-112	MW-113	MW-114	MW-133

*Untreated influent spring water.
Groundwater samples are analyzed for field parameters:

- pH,
- temperature,
- specific conductivity,
- dissolved oxygen,
- ORP, and
- turbidity.

Groundwater samples are also analyzed for laboratory parameters:

- VOCs by EPA Method 8260B,
- TPH-DRO by Method 8015M,
- TPH-GRO by Method 8015, and
- Metals (arsenic [total], barium, and manganese) by EPA Method 6010B (unfiltered).

Analytical methods may change in the future; therefore, applicable methods would be specified and revised as necessary in the long-term monitoring plan. MW-55 and Well MW-67R are also

analyzed for SVOCs (Skinner List) by EPA Method 8270C. Sampling and analyses are conducted in accordance with the Third Phase Investigation Quality Assurance Project Plan (QAPP) dated September 2006, revised November 2009.

The CAS evaluation assumes continuation of the current monitoring program, with the exception of changing to a sampling frequency of annually for a period of 10 years. EPME-PC believes annual monitoring is more than sufficient given 1) the proven effectiveness of the IRM components; 2) years of data confirming the stability of LNAPL and dissolved-phase plumes; 3) proposed additional remedial components would only enhance the overall environmental protectiveness; and 4) protection of the West Branch Walnut River (WBWR) is best verified through operational data (e.g., pumping rates and drawdown) because of residual soil and hence dissolved-phase impacts in the downgradient monitoring wells.

While typical variability in data will exist, statistically significant changes in plume concentration and shape are unlikely over periods of less than 5 years; therefore, after sufficient data have been collected to confirm plume stability and dissolved-phase trends (for CAS costing purposes, assumed to be the previously stated 10-year period) it is further assumed the LTM program can be decreases to bi-annually (once every 2 years) for the next 10 years and then once every 5 years until ARARs are achieved.

10.2.3 Free-Phase LNAPL Recovery

The existing Interceptor Trenches (ITs) currently provide the primary LNAPL containment and recovery. This is proposed to continue in all alternatives (with the exception of the No Additional Action alternatives). Supplementation of this recovery is proposed from any Site wells with measurable (e.g., greater than 0.01 foot) free product as assessed during each Site-wide gauging round completed as part of Section 10.2.2 – LTM. During the second half of 2013 gauging event, LNAPL was encountered in 14 monitoring wells shown in Figure 2-7. Apparent LNAPL thicknesses in these wells ranged from 0.01 feet in well MW-122 to 3.74 feet in well MW-02. Given this range and the fact that water elevations affect both the number of wells with LNAPL and the recoverability of that LNAPL, the type of recovery equipment used is likely to vary. The cost estimate includes a mix of sorbent socks, passive skimmers with collection canisters, and active collection with above-grade storage for higher production wells. The objective would be to maintain non-detectable thicknesses with periodic rebound testing (removal of equipment) when minimal or no free phase recovery is apparent. Inspection of equipment and change-out of socks is assumed to occur monthly for costing purposes.

10.2.4 MNA and NSZD

Monitored natural attenuation (MNA) and natural source zone depletion (NSZD) are not assumed to be essential components of any alternative because neither have been confirmed nor quantified at the Site; hence, neither is included in alternative criteria rankings. However, experience at other petroleum sites suggests MNA and NSZD contaminant destruction

mechanisms are likely present and active at the Site; therefore, the following is proposed to first confirm that MNA and NSZD biodegradation are occurring, and if they are, to monitor remedial progress. If mechanical treatment systems are eventually deactivated at the Site based upon MNA/NSZD findings, they would be left in place for a then-agreed-upon period of time; therefore, if MNA/NSZD are subsequently determined to be inadequate, the systems can be reactivated.

10.2.4.1 MNA. A detailed MNA evaluation plan would be developed in accordance with the KDHE BER policy BER-RS-042 (June 2012) for KDHE review and approval. However, for the purposes of CAS discussion, costing, and evaluation, a conceptual plan has been developed. Groundwater samples would be collected from the following locations:

Area	Location			
	Upgradient	**Source**	**Mid-Plume**	**Down-Gradient**
MPA – SPA Benzene	N2-1	MW-115	OW-37	OW-31
MPA – SPA TPH-DRO/GRO	OW-39	MW-55	MW-SB37	OW-31
STF NE Plumes	N2-1	MW-115	MW-108	MW-113
STF Mid TPH-DRO	MW-25S	MW-98	OW-10	MW-77
STF South Benzene	MW-09	MW-16	MW-97	MW-98
STF South TPH-DRO/GRO	MW-84	MW-86	MW-12	OW-09

These areas and flow paths are sketched on a representative groundwater potentiometric surface and COC plume maps included in Appendix D1. MNA is not proposed for the AHA because no known dissolved-phase impacts remain following excavation of the asphaltic pit area. In addition to the proposed LTM in Section 10.2.2 which includes Site COCs, MNA-related parameters would also be analyzed for these wells as outlined below:

- Dissolved oxygen*
- ORP*
- pH*
- Temperature*
- Specific Conductance*
- Nitrate
- Nitrite

- Ammonia
- Iron(II)
- Manganese(II)
- Sulfate
- Sulfide
- Alkalinity

*Wells also in the LTM program would already be analyzed for field parameters.

An initial round of MNA monitoring would be completed across all AOCs at the start of the Corrective Action Plan (CAP) implementation period. The data would be evaluated and recommendations presented in a report. A Long-Term MNA Monitoring Plan may then be developed based upon the results and COC concentration trends. For the purpose of the CAS cost evaluation only, the following is assumed:

- **AHA, MPA, and SPA (all plumes):** Natural attenuation processes will be *active but currently insufficient* to prevent adverse impact to the WBWR. After 20 years, concentrations and contaminant flux would have decreased sufficiently to reevaluate possible cessation of Seep IT and Basin IT operation with MNA alone. Therefore, MNA will be part of the remedy, but will not be implemented until year 20, at which time it will be conducted annually until the end of the evaluation period (year 30).
- **STF North Plumes:** Natural attenuation processes will be *active but currently insufficient* to prevent off-site migration of the STF NE benzene, TPH-GRO, TPH-DRO, and MTBE plumes. After 20 years, concentrations and contaminant flux would have decreased sufficiently to reevaluate possible cessation of the selected active treatment remedy, relying on MNA alone. Therefore, MNA will be part of the remedy, but will not be implemented until year 20 at which time it will be conducted annually until the end of the evaluation period (year 30).
- **STF All Other Plumes:** Natural attenuation processes will be *active and sufficient* to prevent off-site plume migration and adverse impact to the STF Creek. MNA will be part of the remedy, and will be implemented immediately. Verification sampling (MNA parameters) will be completed biannually (every 2 years) for a period of 10 years and then every 5 years thereafter to confirm processes remain active.

10.2.4.2 LNAPL: Natural Source Zone Depletion (NSZD). As previously discussed, natural attenuation is one component of NSZD. Studies have shown that by ground surface nearly all hydrocarbon mass destroyed in-situ has been converted to carbon dioxide (CO_2); therefore, the other component to access NSZD is to determine the CO_2 surface flux across the area(s) of impact. There are various methods to accomplish this.

For the purposes of this CAS, it is assumed a work plan will be prepared and select E-Flux® technology. Canisters are installed approximately 2 feet into the ground surface and left open to the atmosphere. CO_2 passing through the trap is converted to solid-phase carbonate salts and water (H_2O) for later extraction and quantification. Each trap contains a top and a bottom element. The bottom element captures CO_2 discharged upward from the soil. The upper element captures CO_2 driven downward from the atmosphere into the trap during periods of increasing barometric pressure, resulting in *all* CO_2 captured in the lower element being from the subsurface. Part of this CO_2 would be from natural organic degradation and part would be from Site petroleum degradation; therefore, canisters would also be placed in non-impacted areas of the Site to subtract out CO_2 generated from natural organics. Vertical CO_2 flux through the soil is estimated by dividing the accumulated mass of CO_2 by the cross-sectional area of the trap and the period the trap was deployed. That CO_2 flux is then converted to hydrocarbon losses using the stoichiometric ratio between CO_2 and LNAPL and that resulting unit rate (pounds of hydrocarbon per square foot per year) can be multiplied by the soil plume area to produce a total natural mass removal rate. This approach avoids many of the uncertainties associated with past tracer studies and, if anything, is likely to underestimated LNAPL losses.

Case Studies: From 2009 to 2012, sixteen CO_2 trap studies were completed, including at five refinery sites (Colorado, Wyoming, Ohio, Illinois, Hawaii) and other impacted industrial sites. At the Illinois and Wyoming facilities, side by side studies were conducted using CO_2 traps and LI-COR® systems (by UBC staff from Dr. Uli Mayer's group). Similar results were obtained with both methods. To date, results from CO_2 traps indicate LNAPL losses on the order of thousands of gallons per acre per year.

To evaluate and semi-quantify the Site rates for this *potentially* significant petroleum removal mechanism, an initial E-Flux® study is proposed for representative impacted areas in the MPA and STF, including background locations to assess natural soil organic CO_2 production. A Work Plan would be prepared, but for the purposes of CAS costing, it is assumed a total of 12 E-Flux® traps would be installed and sampled during each event. Two initial events (e.g. spring and fall) would be completed to assess seasonality. This initial NSZD rate will gradually reduce overtime; therefore, the CAS assumes a follow-up study in the same areas will be completed every five years, which along with MNA mass removal results will be included total Site mass removal estimates to better track the progress of overall Site restoration.

10.2.5 Groundwater Treatment System

As described in Section 4.4, the current and proposed future LNAPL and groundwater treatment system (GTS) is the wetlands-based system consisting of an underground oil-water separator (UOWS), a cascade aerator (CA), a mineral precipitation/settling basin (PSB), a vertical-flow Stage 1 anaerobic wetland, a lateral-flow aerated/aerobic Stage 2 wetlands, and a contingency non aerated Stage 3 wetlands as shown in Figures 4-1 and 4-2.

10.2.5.1 Adequacy. This existing system was designed to treat all Site flow streams (including flow rates) likely to be extracted as part of the CAS-selected remedies. Current monitoring data confirm the resulting current over-performance of the system, often achieving effluent standards by the end of Stage 1 Wetlands, with Stage 2 and Stage 3 providing additional reserve treatment capacity.

10.2.5.2 O&M Costs. Costs are included for 1) free product removal and disposal; 2) cleaning and sediment removal from the PSB every 5 years; 3) maintenance of flow control structures, blower O&M, general wetlands maintenance according to the existing O&M plan; 4) quarterly effluent NPDES sampling and monthly BOW reporting, and 5) reporting of results/system performance in the Annual Report.

10.2.5.3 Years of Operation. It is assumed operation of one or more ITs would be required for 20 additional years following Corrective Action Decision (CAD) finalization; hence the treatment system would also require operation for the same time period. Given the amount of contaminant mass remaining within the MPA and under the SPA, it is possible more than 20 years of operation would be required to remain protective of the WBWR. This can be accommodated with extended system operation. However for the purposes of this CAS costing evaluation, it is assumed the combination of prior remediation efforts, phytoremediation (proposed alternative discussed in Section 10.3.4.4), and MNA/NSZD processes would sufficiently attenuate the dissolved-phase plume, thus data from a year of monthly surface water sampling would indicate no statistically significant Site impacts to the WBWR. (Statistical significance is necessary given the inherent variability of surface water sampling and potential upstream sources of contamination not associated with the Site).

10.2.6 Closeout of Shared Components

The infrastructures for the shared remedy components discussed in the prior sections will eventually require removal and are: 1) the 173-point monitoring well network and 2) the GTS. It is assumed after all Site restoration is complete, the MPA Spring and MPA Basin structures will be left in place to manage ongoing spring and stormwater flow. Costs in Appendix D assume removal and proper abandonment of all monitoring wells and that the wetlands will be allowed to revert to natural wetlands; therefore, it is assumed the hydraulic control structures (HCS) would remain, but all other equipment would be removed, including flow monitoring, the blower, and all structures associated with the UOWS, CA, and PSB.

10.3 MAIN PROCESS AREA (MPA)

The MPA was the location of most refinery processes and releases; therefore, it has been and remains the focus of many Site remediation activities. This section contains the following subsections:

- **IRM Summary (10.3.1)**: A large amount of remediation work has already been completed in the MPA as discussed in Section 4; therefore, to better identify what remains, a brief summary is provided.
- **Applicable Technologies (10.3.2)**: There were 12 technologies retained in Section 8 that may be applied to one or more areas of the Site. Reasons are listed is this section for those included and not included in the assembled MPA alternatives.
- **Alternatives Presentation (10.3.3, 10.3.4, and 10.3.5)**: The majority of this section presents 3 alternatives to address the remaining MPA contaminants discussed in Section 2, risks identified in Section 3, and resulting CAGs discussed in Section 7. Recommendation of an alternative for each area occurs in Section 11.

10.3.1 Already Completed

The already-completed IRMs that address one or more of the original MPA environmental risks are:

- **Seep Interceptor Trench (Section 4.1)**: The primary reason for installation of the Seep IT was because of impacted groundwater and risk of LNAPL migration from the MPA to the river (WBWR).
- **Demolition, Grading, and Landfarming (Section 4.2)**: Most site demolition activities were focused within the MPA to remove wastes from process and sewer pipes and structured that hindered access. Landfarming of both the MPA surface soils and soil from the MPA Basin excavation were also completed across most of the MPA.
- **Lead-Impacted Soil Consolidation and Cover (Section 4.2)**: Lead-impacted soil from across the MPA was excavated and consolidated in the southern portion of the MPA. Clean soil was placed, graded, and seeded over this area.
- **MPA Basin and Interceptor Trench (Section 4.3):** The MPA Basin was installed to remove and treat a large area of impacted soil and also to manage stormwater during construction and landfarming activities. The MPA Basin IT was installed for groundwater and product recovery and containment.
- **Wetlands Groundwater Treatment System (Section 4.4):** The majority of water requiring treatment comes from the MPA Basin IT and the Seep IT. Pond closure necessitated a replacement system, the currently operating wetlands-based system.
- **Waste Stabilization (Section 4.6)**: Some waste material from the MPA, including sediments from the Marley and Spray Ponds, were transferred to and stabilized within the West Oxidation Pond.
- **MPA Spring System (Section 4.7)**: Although the source of the water and tar was the AHA, that source has been removed; most remaining tar impacts are below the MPA;

the MPA Spring and system are located within the MPA; and the spring could capture some impacted MPA groundwater and/or LNAPL. Therefore, MPA Spring construction and future operation and maintenance (O&M) costs are discussed here.

Costs provided in Table 10-1 show actual IRM expenditures to date. When one of the remedies discussed above addressed more than one AOC, the total expenditure was allocated between the appropriate AOCs. A more detailed breakout of IRM costs is included in Appendix D.

10.3.2 Potentially Applicable Technology Selection

The following 12 technologies were retained in Section 8.17 as possibly applicable to one or more environmental risks in one or more Site AOCs:

1. No Additional Action
2. EUCs and SWMP
3. LTM (groundwater monitoring)
4. MNA and NSZD
5. SVE/AS – Biovent/Biosparge
6. LNAPL/Product Skimming
7. Hydraulic Containment (product/groundwater recovery and treatment)
8. MPE
9. Soil Excavation and Landfarming
10. Waste Excavation, Stabilization, and Off-Site or On-Site Disposal
11. Capping
12. Phytoremediation

No Action is retained for the MPA to provide a baseline against which to compare the other alternatives; however, because much work has already been completed, it is referred to as the "No Additional Action" alternative. As previously discussed, EUCs and SWMP are proposed across all AOCs, including the MPA, as are LTM and MNA/NSZD (if confirmed). Soil vapor extraction/air sparge (SVE/AS) and multi-phase extraction (MPE) are not proposed for the MPA because the large amount of remaining contaminant mass, soil types, and saturation make implementation infeasible, likely requiring hundreds of wells and decades of operation costing $10s of millions. Soil excavation and landfarming is a better, albeit still costly, alternative to SVE/AS and MPE, and is retained for costing and discussion.

Excavation was selected over capping because the majority of MPA contamination is not shallow (no known surface exposure risks) and most petroleum impacts are saturated; hence, prevention of stormwater infiltration and resulting leaching would do little to reduce contaminant flux into groundwater. The reduced surface water infiltration resulting from a cap would slow the delivery of dissolved oxygen to groundwater (rapidly used to enhance biodegradation) and it would reduce the flushing of COCs from the soil, reducing mass removal in the both the unsaturated and saturated zones. Also natural source zone depletion (NSZD) is likely a

significant contaminant mass removal mechanism, and a cap would hinder the flow oxygen into and carbon dioxide out of the soil, slowing contaminant mass degradation. Given the proposed robust groundwater containment system, consisting of both the MPA Basin IT and Seep IT, a cap provides little remedial benefit and conversely hinders both MNA and NSZD processes, increasing the total Site restoration time.

Product skimming is retained, along with product and groundwater recovery in the MPA Basin IT and Seep IT. Known wastes have been removed from the MPA; thus, this is not applicable to this AOC. Phytoremediation provides benefit in this setting if combined with other technologies and is retained for discussion. These have been assembled into the following complete alternatives (*Key differences between Alternative 2 and 3 are italicized*):

- **Alternative 1 – No Additional Action**
    - No additional action beyond the already-completed IRM remediation.
- **Alternative 2 – ITs and Phytoremediation**
    - Hydraulic Containment
        - MPA Channel IT, MPA Basin IT, Seep IT Continued Operation
        - Groundwater Treatment System Continued Operation
    - MPA Spring System Continued Operation
    - *LNAPL/Product Skimming*
    - *Phytoremediation*
    - LTM (groundwater monitoring)
    - MNA and NSZD (If confirmed. Not considered in criteria evaluation)
    - EUCs and an SWMP
- **Alternative 3 – Seep IT and Excavation**
    - Hydraulic Containment
        - Seep IT Continued Operation
        - Groundwater Treatment System Continued Operation
    - *Excavate and Landfarm All Impacted Soil/Weathered Rock to Bedrock*
    - Replacement MPA Spring Collection and Treatment System
    - LTM (groundwater monitoring)
    - MNA (If confirmed. Not considered in criteria evaluation)
    - EUCs and an SWMP

10.3.3 MPA Alternative 1 – No Additional Action

As required by CAS guidance, the first alternative is the “No Additional Action” alternative is to establish a baseline for comparison.

10.3.3.1 <u>Alternative Components</u>. No Additional Action means the cessation of any already implemented controls, such as Interceptor Trench (IT) operation, cap maintenance, all Site water management, and no EUCs or SWMP.

10.3.3.2 <u>Alternative Evaluation Criteria.</u> The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities. Given that, No Additional Action ranks higher than typical for some criteria:

10.3.3.2.1 Overall Protection of Human Health and Environment. No air emissions are generated, land can be reused, and no additional natural resources are required; therefore, from a "green remediation" perspective it rates relatively high. Also, the largest Site risks have been addressed during the IRM work; however, no additional action would result in termination of IT operation; therefore, the risk of impacted groundwater and product discharge to WBWR would return. This alternative does not address possible future risk pathways, such as 1) contact with impacted shallow soils if an area is excavated for construction or utilities, 2) migration of VOCs into future buildings (vapor intrusion), 3) or contact/ingestion of groundwater. Therefore, it provides a moderate protection of human health and the environment.

10.3.3.2.2 Compliance with ARARs. Chemical-specific ARARs for groundwater would not be achieved for many decades. This alternative only slightly reduces groundwater or soil contaminant concentrations because no active remediation is conducted. Natural attenuation and NSZD processes may not be occurring and cannot be assumed. No action-specific or location-specific ARARs have been identified for this alternative. Compliance with ARARs is low.

10.3.3.2.3 Long-Term Effectiveness and Permanence. The IRMs have removed many risks and, through capping or covering, implemented some controls; however, this alternative provides no adequate or reliable controls/long-term management measures to protect against exposure from the remaining risks (e.g., vapor intrusion [VI], groundwater ingestion, soil exposure, resumption of discharge to WBWR, etc.). Long-term effectiveness and permanence is moderately low.

10.3.3.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. The IRM work has resulted in a large reduction in the mobility and volume of contamination (e.g., waste removal and stabilization); however, no additional reduction in toxicity, mobility, or volume of contamination through treatment would occur under this alternative. Natural attenuation and NSZD would likely occur but are not considered treatment for the purposes of this criterion. Overall reduction in toxicity, mobility, and volume through treatment would be long term and moderately high.

10.3.3.2.5 Short-Term Effectiveness. No additional action would occur; hence, no risk to on-site workers or the community from that action would exist and the IRM has removed many risks. However, the immediate resumption of impacted groundwater and possible LNAPL discharge to WBWR, permitted installation of drinking water wells, and uncontrolled digging/building construction (including residential) could result in exposures. The time until

Corrective Action Goals (CAGs) are achieved would be many decades. The overall result is moderate short-term effectiveness.

10.3.3.2.6 Implementability. There would be no construction or technology concerns posed by this remedy and it would easily undertaken/implemented since no additional action would be taken. No agency approvals/permits would be required; however, the ability to monitor the effectiveness of the remedy would be limited since no LTM or site inspections would be completed, resulting in overall moderate implementability.

10.3.3.2.7 Community Acceptance. Much Site remediation has been completed, and if left uncontrolled, the Site would likely be used for hunting and recreation with little obvious concern from the public or users. One exception would be if product seeps resumed into the WBWR, which given completed IRM work is now a low risk. Those concerned with repair of environmental damage would be unsatisfied with the incomplete restoration. Therefore, overall public acceptance would be moderate.

10.3.3.2.8 Cost. The prior IRM work costs are summarized in Table 10-1. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The additional cost of this alternative is $0 since no additional action would be taken; however, given all the prior Site work, the overall cost is still ranked as high.

10.3.4 MPA Alternative 2 – ITs and Phytoremediation

Alternative 2 includes operation of the current systems and additional measures as summarized below:

- Continue to operate MPA Channel IT, MPA Basin IT, Seep IT
- Continue to operate Groundwater Treatment System (GTS)
- Continue to operate MPA Spring system
- LNAPL/Product Skimming
- Phytoremediation
- LTM
- MNA and NSZD (If confirmed. Not considered in criteria evaluation)
- EUCs and an SWMP

10.3.4.1 <u>Alternative Components</u>. The following describe each alternative component:

10.3.4.1.1 MPA Channel IT, MPA Basin IT, and Seep IT. This alternative assumes all three existing interceptor trenches (IT) would continue to be operated for 20 additional years to capture groundwater and mobile LNAPL. It is assumed by that time, dissolved-phase concentrations will have sufficiently decreased to permit termination of active containment and that natural attenuation and NSZD will be found to be sufficient to protect the WBWR and complete Site restoration. These existing trenches have been proven effective in containing

and recovering not only MPA groundwater and LNAPL, but also a portion of the MTBE-impacted groundwater from the northern STF plume. Trench operation includes 1) operation of four extraction sumps (ESs) including pumps, flow meters, and pressure gauges; 2) monthly inspection of system parameters and ESs; 3) biannual (every 2 years) pressure-jet cleaning of the wells, collection, and conveyance piping; 4) an escrow for equipment (i.e., pump, controls, meters, etc.) replacement; and 5) an allowance for annual reporting of the data in the Annual Report. All analytical monitoring is included in the GTS tasks and associated costs.

10.3.4.1.2 Groundwater Treatment System. Continued IT operation requires operation of the newly-installed wetlands-based groundwater treatment system for the same 20-year period as described in Section 10.2.5 – Treatment of Extracted LNAPL and Groundwater. The wetland cells could operate indefinitely, and it is assumed the few concrete structures, UOWS, and cascade aerator would last decades, requiring only minor repairs or replacement. Only the single regenerative blower is likely to require periodic replacement.

10.3.4.1.3 MPA Spring System. The MPA Spring will continue to flow indefinitely. Under this alternative, the gravity-flow spring water capture and treatment system would continue to be maintained, including for costing purposes: 1) monthly inspection and NPDES effluent sampling and reporting; 2) quarterly cleaning of and removal of tar from the UOWS coalescing media; 3) quarterly replacement of GAC media filters; and 4) reporting in the Annual Report for a period of 5 years. Thereafter, it is assumed GAC media change-out and NPDES monitoring are no longer required because of then-confirmed system performance with no/low dissolved-phase concentrations (below NPDES limits) when all tar is removed within the UOWS. It is also assumed that UOWS cleaning/tar removal are lessened after 10 years, reducing O&M costs for the remainder of the 20 year MPA Spring treatment period.

10.3.4.1.4 LNAPL/Product Skimming. In addition to LNAPL recovery from the MPA Basin IT and MPA Spring System, LNAPL would also be manually skimmed from any MPA wells containing LNAPL as described in Section 10.2.3.

10.3.4.1.5 Phytoremediation. As briefly discussed in Section 8.16, phytoremediation involves the design and installation of plants (trees) to enhance hydraulic containment and contaminant mass removal and destruction through a variety of root (rhizosphere) and leaf-based processes. The processes are particularly effective with petroleum hydrocarbons, but also include phytosequestration of metals, such as lead, into the plant matter.

Rhizodegradation, the biodegradation of contaminants in the rhizosphere, would lead to the destruction of large organic molecules, including petroleum hydrocarbons, in the soil contacted by roots and root exudates. The smaller molecules may be taken into the plant and subject to further degradation processes. The extent of the root system is the practical extent of the rhizodegradation zone. The width of the root system can be estimated as equivalent to the width of the tree canopy. Thus, a tree with a 30-foot diameter canopy can be expected to have approximately a 30-foot diameter root zone.

Phytohydraulics, the evaporation and transpiration of water mediated by plants, would play a role in reducing groundwater recharge within the MPA and would lead to a reduction in groundwater flux over time during growing seasons. The transpiration rate can be highly variable. For example, mature (30 year) poplar trees have been reported to transpire between 13 and 200 gallons per day (ITRC, 2009). The long-term establishment of a tree stand over the MPA would result in decreased groundwater infiltration and increased uptake and transpiration of groundwater, reducing groundwater flux to the Basin IT and Channel IT.

A planting design would be developed, including testing of the soil to verify conditions for growth and identify amendments which may help support tree growth. The design and field conditions would also modify the tree species selection and spacing from that proposed herein, possibly including small meadow areas where robust tree growth may not be possible for one or more reasons (e.g. subsurface obstructions, soil type, or contaminant toxicity).

This alternative assumes approximately 1,700 trees would be planted across the MPA (Figure 10-2). The parking area, ground immediately around overhead electric line areas, and access points would not be planted. Approximately 50 percent of the planted trees would be hybrid poplar which are fast growing and transpire large volumes of water. Willow trees, which are also fast growing with high transpiration rates, would comprise approximately 20 percent of the tree mix. Hardwood species, such as oak and maple, would comprise the remaining trees. Multiple tree species would be used for to provide diversity in the event of disease which may affect one species. Hybrid poplars and willows are the predominant trees because their rapid growth rate would initiate rapid phytoremediation.

Planting would be conducted on an average 30-foot spacing, which is the typical canopy diameter of a mature hybrid poplar. The other proposed trees have similar or greater mature canopy sizes. Since the extent of the root zone mirrors the canopy, the mature trees would cover the MPA above grade and below the subsurface, thus maximizing phytoremediation. The rapid growth of the hybrid poplars and willows means these trees would likely reach maturity within 10 to 15 years. The hardwood trees would take longer to reach maturity.

After the initial planting, the ground surface would be seeded with grasses for understory development and erosion control. Over time, the understory would naturally change as the canopy develops and less sunlight is available on the ground surface. Irrigation with water from the MPA Basin and/or wetlands can be completed during initial tree establishment, if required. The MPA Basin is equipped with a high-volume pump that could provide water over the MPA area.

The pattern of tree planting would be established to minimize development of obvious lines as feasible so the tree planting appear more natural/random. During demolition of the MPA, structures were removed to approximately 2 feet below grade; therefore, tree placement would be adjusted around structures which may be encountered. Planting would be completed by

trenching or augering a void space to place the tree and soil amendments. The existing soil conditions would be evaluated during the design phase.

After the initial planting, evaluation of the tree health and overall development would be conducted in each of the subsequent three years. The resulting action may include replacing trees that did not grow and identifying areas where soil conditions need further amendment for sufficient tree growth.

A portion of the south area of the MPA contains lead-impacted soil. Lead may be phytosequestered in the trees. Given the relatively low levels of lead, it is not anticipated the lead would be inhibitory to growth or accumulate at a rate that requires special disposal, however, an evaluation of lead concentrations in the tree material would be completed prior to transporting trees from this area off-site.

Typical annual maintenance would include recovery/mulching of storm-damaged limbs/trees, mowing, addition of fertilize, herbicide, and/or pesticide, and inspection of trees. Some replanting of trees would also likely be required annually due to disease, storm damage, or age in a stand of 1,700 trees. For the purposes of CAS costing, O&M is assumed to continue for a period of 10 years at which time a sufficiently mature canopy and a natural forest ecology would have developed to permit a self-sustaining system for the remainder of Site restoration.

10.3.4.1.6 LTM. This alternative includes LTM of groundwater as described in Section 10.2.2. This COC dissolved-phase data would be used to track remedy performance and help determine when and where shifts between active and natural remediation components may be warranted.

10.3.4.1.7 MNA and NSZD. This alternative includes MNA and NSZD as described in Section 10.2.4, including the acknowledgement that these are unproven and not assumed in the criteria evaluation/ranking. They are presented here as a placeholder for possible later remedy incorporation. The initial periodic checks would confirm the processes remain active and will provide a basis to compare natural versus active contaminant mass removal/destruction to help determine when and where changes between active and natural remediation components may be warranted.

10.3.4.1.8 EUCs and SWMP. Throughout the evaluation period, this alternative includes the use of EUCs and a SWMP as described in Section 10.2.1. This would provide protection of potential receptors throughout the Site restoration process.

10.3.4.1.9 Additional Considerations. The following were also considered during alternative assembly:

- **Surface Soil Exposure Risk/Lead-Impacted Soil**: The original MPA surface soils were determined to present relatively low exposure risks to most receptors; however, as part

of the IRM activities, the upper 8 inches were landfarmed to remove residual petroleum impacts, and as discussed in Section 4.2.2, lead soils were consolidated to the southern end of the MPA and covered with 8 inches of clean soil. Soil from the MPA Basin excavation was then spread across all but the far northern portion of the MPA in an 8-inch lift and landfarmed to below RSK-based standards. This provides approximately 16 inches of clean cover material across the MPA. Given: 1) this barrier/cover, 2) proposed activities, including phytoremediation of the soil, and 3) proposed EUCs/SWMP, EPME-PC believes surface soil exposure risks are adequately mitigated.

- **Surface Water Infiltration**: Given remaining MPA vadose soil impacts and surface water infiltration, leaching of contaminants to groundwater could warrant a low-permeability cap to reduce surface water infiltration. However:
    - Most of the MPA contaminant mass is continuously or periodically saturated; therefore, any reduction in infiltration would likely do little to reduce dissolved-phase concentrations.
    - Installation of a cap would hinder natural vadose zone remediation processes such as barometric pumping and resulting oxygenation and NSZD.
    - Cap installation would likely preclude phytoremediation given the difficulty in keeping tree roots from penetrating the cap, decreasing its integrity (increase cap net effective permeability).
    - Most groundwater recharge occurs west of the MPA where weathered bedrock is near ground surface. MPA soils are relatively thick and low permeability; therefore, capping would do little to reduce net groundwater flux.
    - The existing hydraulic containment system would protect receptors/contain MPA groundwater (including any infiltrating stormwater) until the net flux of dissolved-phase contaminants is no longer a threat to receptors; therefore, in EPME-PC's opinion, the worst case scenario is no cap installation extends the period of operation for this system. However, EPME-PC believes NSZD and phytoremediation would provide sufficient treatment, eliminating or sufficiently reduce vadose-soil leaching concerns.

  For these reasons, a low-permeability cap was not included in this alternative.

- **Contingencies**: If after 20 years, data do not support cessation of the hydraulic containment system O&M, one alternative would be to resume extraction from all ITs. A second alternative would be to resume short-term operation of only the Seep IT for protection of the river, and given then reduced contaminant concentrations, periodically dosing a chemical oxidant (in-situ chemical oxidation – ISCO) and/or oxygen releasing compound into the MPA Channel and Basin ITs, flooding weathered rock preferential flow paths under the SPA. The volume, concentration and frequency of the injections would require determination at that time, but all injections could occur over a period of several years. The objective would be to remove additional contaminant mass and to

restore a supply of electron acceptors such as oxygen or sulfate, which would enhance natural attenuation under the SPA and provide for a long-term reduction of the residual contaminant mass/flux that may then allow subsequent termination of Seep IT operation. Given the long time frame until this would occur and resulting uncertain need for and uncertain cost-effectiveness of this approach, it was not included in this alternative, but was noted for future consideration.

10.3.4.2 <u>Alternative Evaluation Criteria.</u> The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities.

10.3.4.2.1 Overall Protection of Human Health and Environment. Long-term hydraulic containment with wetlands treatment provides a low-energy (green) solution compared to most other active remediation alternatives. The technologies of pump and treat, product recovery, wetlands treatment, MPA Spring gravity flow UOWS, phytoremediation, LTM, MNA/NSZD, and EUCs/SWMP are all readily implementable, effective and comply with all ARARs. Prior remedial action, EUCs, and engineered barriers prevent receptor exposure while Site restoration proceeds; therefore, the overall protection of human health and the environment is very high.

10.3.4.2.2 Compliance with ARARs. Chemical-specific ARARs for groundwater would be achieved after several decades given phytoremediation. Compliance with all action-specific and location-specific ARARs is readily achieved because 1) the existing containment and treatment system is already installed; 2) the KDHE has approved the SWMP and indicated concurrence regarding the need for and applicability of EUCs; 3) all property is owned by EPME-PC; 4) and other remedy components require no or little permitting or regulatory approval. Compliance with ARARs is very high.

10.3.4.2.3 Long-Term Effectiveness and Permanence. The magnitude of the residual risk after all remedial actions are complete would be low. Given the time frame until these actions are complete, the remedy incorporates robust institutional controls (e.g., EUC and SWMP) to adequately and reliability protect receptors during the remediation period. Long-term effectiveness and permanence is high.

10.3.4.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. IRM work removed a large amount of contaminant mass and LNAPL in the MPA Basin area and disposed of all known wastes. Groundwater and product extraction eliminated contaminant mass and control mobility through treatment. Overall reduction of source mass toxicity, mobility and volume would be completed through phytoremediation (and if confirmed, enhanced by MNA and NSZD). Given the biodegradability of petroleum contamination and these processes, a large reduction in toxicity, mobility, and volume would be achieved; therefore, the overall rating is very high.

10.3.4.2.5 Short-Term Effectiveness. The community and workers would be protected from COC exposure during implementation of the remedy. On-site exposure to COCs would be prevented by the prior remedial action, EUCs, and SWMP. Off-site exposures would be prevented because all receptors are protected and all proposed remedy components are primarily destructive in nature, biodegrading contaminants (e.g., wetlands, phytoremediation, NSZD, and MNA) rather than transferring them to another media (e.g., air stripping or SVE) or simply transferring them from one location to another (e.g., excavation and landfilling). Given this and the low power consumption required, the environmental impacts of implementing the remedy are very low. The time until CAGs are achieved is long. Overall short-term effectiveness is high.

10.3.4.2.6 Implementability. The reliability of and ability to construct the technologies is very high. Additional remedial action (e.g., contingency ISOC or similar injections) would be easily undertaken. The ability to monitor the remedy is high (e.g., LTM and EUC inspections) and the ability to obtain approval from all agencies is anticipated to be very high based upon past conversations and lack of permitting. Overall implementability for this remedy is very high.

10.3.4.2.7 Community Acceptance. Millions of dollars of remediation have been completed, including transformation of an eyesore industrial brownfield into ponds, wetlands, natural grassland, and proposed forest (phytoremediation). Seeps to the WBWR have been contained and dissolved-phase plumes originating within the MPA do not encroach on any residences of off-site properties. No large amounts of truck traffic, dust, or VOC emissions are proposed for these alternative components. Given this, overall public acceptance is anticipated to be very high.

10.3.4.2.8 Cost. The prior IRM work costs and the additional cost of this alternative, including both initial capital and O&M, are summarized in Table 10-1. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The overall cost is high.

10.3.5 MPA Alternative 3 – Excavation

Alternative 3 includes operation of the current systems and additional measures as summarized below:

- Excavate and Landfarm All Impacted Soil/Weathered Rock to Bedrock
- Hydraulic Containment
    - Seep IT Continued Operation
    - Groundwater Treatment System Continued Operation
- New MPA Spring Collection and Treatment System
- LTM (groundwater monitoring)
- MNA (If confirmed. Not considered in criteria evaluation)
- EUCs and an SWMP

10.3.5.1 <u>Alternative Components</u>. The following describe each alternative component:

10.3.5.1.1 Excavate All Impacted Soil and Weathered Rock. The primary differentiator of this alternative is excavation of most of the MPA soil and weathered/excavatable rock down to fractured/unexcavatable bedrock. Figure 10-3 depicts the proposed excavation area along with the estimated ground surface and depth to fractured rock contours. Removal of the weathered rock is essential to the success of this approach because it is the primary flow pathway for both groundwater and historical LNAPL and hence contains a large amount of the MPA overall contamination mass. A large-scale excavation would require the removal and off-site landfill disposal of buried concrete foundations and currently plugged and abandoned-in-place piping, sewers, and associated structure. All weathered bedrock within the excavation area is assumed to be impacted and either would fail land application standards (e.g., fail toxicity characteristic leaching procedure [TCLP] testing) or could not be landfarmed because of the rocky matrix. Hence, it is assumed all excavated rock would also require off-site landfill disposal, estimated at 290,000 bank cubic yards (bcy). For the purposes of cost estimating, it is assumed one-third of the soil would be clean and could be segregated and stockpile within the MPA for later use as backfill. Estimates also assume 99 percent of all excavated material would be classified as nonhazardous waste with the remainder requiring hazardous waste handling and disposal. All nonhazardous soil would be landfarmed across the STF in a 6-inch deep 260-acre area in 4 stages/lifts over a period of 4 years and then returned to the MPA for backfill of the excavation area. The MPA excavation area would remain fenced during this landfarming period. Given the amount of heavy truck traffic required and poor condition of the existing asphalt road, costing assumes the existing pavement would be removed and converted to a gravel road with dust control measures during Site work and periodic and final grading.

10.3.5.1.2 Continue to Operate Seep IT. Operation of the Seep IT is assumed to continue because of prior MPA LNAPL migration under the SPA area and residual impacts in unexcavatable fractured rock within the MPA. However, the cost estimate assumes only 10 years are required to remediate the residual mass in these areas to concentrations that can permit long-term natural attenuation processes to complete Site restoration; however, the reduced mass flux to groundwater during this period increases the likelihood this would be possible. (The MPA Basin, MPA Basin IT, and MPA Channel IT would be removed during excavation).

10.3.5.1.3 Continue to Operate Groundwater Treatment System. Water from the Seep IT would require continued operation of the groundwater treatment system. Given the wetlands based treatment, the O&M requirements and cost change little with the flow rate; therefore, similar annual O&M costs are assumed for this alternative as for others but for a period of only 10 years.

10.3.5.1.4 Install New MPA Spring Collection and Treatment System. Excavation of the MPA soil and weathered rock would not slow or halt continued flow and migration of tar impacts

from the AHA through the fractured rock. Addressing this flow would require reinstallation of a spring capture and treatment system similar to the existing system. The concrete collection sump, UOWS, and GAC filters are assumed to be reusable. Costs assume equipment can be installed on the excavation floor with no new design required. Years of O&M and reduction in treatment needs are unchanged from the prior assumptions (Section 10.3.4.1.3), since excavation does not address the AHA-related materials in fractured rock.

10.3.5.1.5 LTM. This alternative includes LTM of groundwater as described in Section 10.2.2. This COC dissolved-phase data would be used to track remedy performance and help determine when and where shifts between active and natural remediation components may be warranted. Given residual source mass, the period of LTM is assumed to remain the same.

10.3.5.1.6 MNA. This alternative includes MNA as described in Section 10.2.4, including the acknowledgement that MNA is unproven and not assumed in the criteria evaluation/ranking. MNA is presented here as a placeholder for possible later remedy incorporation. The initial periodic checks would confirm the processes remain active and would provide a basis to compare natural versus active contaminant mass removal/destruction to help determine when and where changes between active and natural remediation components may be warranted. NSZR is not included in this alternative because that data and evaluation are primarily vadose soil focused and this material would be excavated and landfarmed under this alternative.

10.3.5.1.7 EUCs and SWMP. Throughout the evaluation period, this alternative includes the use of EUCs and a SWMP as described in Section 10.2.1. This would provide protection of potential receptors throughout the Site restoration process.

10.3.5.2 <u>Alternative Evaluation Criteria.</u> The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities.

10.3.5.2.1 Overall Protection of Human Health and Environment. The technologies of excavation, landfarming, landfilling, pump and treat (Seep IT operation), product recovery, wetlands treatment, MPA Spring gravity flow UOWS, phytoremediation, LTM, MNA, and EUCs/SWMP are all readily implementable, effective and comply with all ARARs. This alternative requires consumption of petroleum fuel for equipment for the excavation, long-distance waste transport to landfill, and landfilling; therefore it less green than Alternative 2. Prior remedial action, the excavation and EUCs prevent receptor exposure while Site restoration completed; therefore, the overall protection of human health and the environment is still very high.

10.3.5.2.2 Compliance with ARARs. Chemical-specific ARARs for groundwater would be achieved more rapidly than Alternative 2, but still could require several decades. Compliance with all action-specific and location-specific ARARs is readily achieved because the existing containment and treatment system is already installed; the KDHE has approved the SWMP and

indicated concurrence regarding the need for and applicability of EUCs; all property is owned by EPME-PC; and other remedy components require no or little permitting or regulatory approval. Compliance with ARARs is very high.

10.3.5.2.3 Long-Term Effectiveness and Permanence. The magnitude of the residual risk after all remedial actions are complete would be very low. Given the time frame until these action are complete, the remedy incorporates robust institutional controls (e.g., EUC and SWMP) to adequately and reliability protect receptors during the remediation period. Unlike Alternative 2, some COC mass would not be destroyed (biodegraded), but would be transferred to a landfill for long-term containment. Long-term effectiveness and permanence is high.

10.3.5.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. Groundwater and product extraction eliminates contaminant mass and controls mobility through treatment. Overall reduction of source mass toxicity, mobility, and volume would be completed through excavation and landfarming, and if confirmed, natural attenuation of residual fractured rock impacts. Given these processes, a large reduction in toxicity, mobility, and volume would be achieved; however, as previously noted, contaminants in landfilled materials would not be destroyed, just contained; therefore, the overall rating is very high.

10.3.5.2.5 Short-Term Effectiveness. Community and workers exposure risk to Site COCs, including VOCs, and vehicle injury would be elevated during the excavation and transport of 47,000 loads (assuming 12 bcy loads) of soil, rock, and waste transport; however, soil COC exposure risks throughout the remainder of the remedy implementation would be slightly reduced. Given the large amount of fugitive air emissions during excavation and landfarming and the large amount of truck traffic, it is possible overall risk of injury or death for workers and residents is higher than the No Additional Action alternative. Exposure to COCs through water wells or VOC vapor intrusion concern from dissolved-phase off-gassing would be prevented by the prior remedial action, EUCs, and SWMP. Off-site exposures and impacts, including the WBWR, would be prevented because all receptors are protected through remedy components. The environmental impacts of the remedy implementation are moderate, primarily controlled by the extensive use of heavy diesel-powered equipment for soil excavation, transportation, and treatment. The time until CAGs are achieved is long. Overall short-term effectiveness is moderate.

10.3.5.2.6 Implementability. The reliability of and the ability to construct the technologies/systems is high; although the scale of excavation and volume of soil requiring landfarming and rock requiring landfilling poses logistical challenges. Additional remedial action is easily undertaken. The ability to monitor the remedy is high (e.g., LTM and EUC inspections) and the ability to obtain approval from all agencies is anticipated to be very high based upon past conversations and few permitting needs (e.g., landfarming). Overall implementability for this remedy is moderately high.

10.3.5.2.7 Community Acceptance. Millions of dollars of remediation have been completed, including transformation of an eyesore industrial brownfield into ponds and wetlands. Seeps to the WBWR have been contained, and dissolved-phase plumes originating within the MPA do not encroach on any residences of off-site properties. The excavation noise, traffic, and years of landfarming (with related VOC emissions) may cause some complaints/concerns; however, overall public acceptance is anticipated to be moderate.

10.3.5.2.8 Cost. The prior IRM work costs and the additional cost of this alternative, including both initial capital and O&M, are summarized in Table 10-1. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The overall cost is very high.

10.4 ASPHALT HANDLING AREA (AHA)

The AHA was a stabilization and storage area for off-specification asphalt with no known mechanical processes, equipment, tanks, or piping. The structure of this section is:

- **IRM Summary (10.4.1)**: A large amount of remediation work has already been completed in the AHA as discussed in Section 4; therefore, to better identify what remains, a brief summary is provided.
- **Applicable Technologies (10.4.2)**: There were 12 technologies retained in Section 8 that may be applied to one or more areas of the Site. Reasons are listed is this section for those included and not included in the assembled MPA alternatives.
- **Alternatives Presentation (10.4.3, 10.4.4, and 10.4.5)**: The majority of this section presents 3 alternatives to address the remaining AHA contaminants discussed in Section 2, risks identified in Section 3, and resulting CAGs discussed in Section 7. Recommendation of an alternative for each area occurs in Section 11.

10.4.1 Already Completed

The already completed IRMs that address one or more of the original AHA environmental risks are:

- **Removal and stabilization of all AHA Pit wastes to competent rock (Section 4.5.1):** All partially soil stabilized asphaltic wastes buried in the AHA Pit were excavated to the full lateral extent and maximum practical depth (fractured bedrock). Wastes were stabilized and capped with the West Oxidation Pond waste stabilization work.
- **Removal and stabilization of all AHA Pile wastes (Section 4.5.2):** All soil-stabilized asphaltic piles were excavated to the full lateral extent and maximum practical depth

(fractured bedrock). Wastes were stabilized and capped with the West Oxidization Pond waste stabilization work.

Costs provided in Table 10-2 show actual IRM expenditures to date. When one of the remedies discussed above addressed more than one AOC, the total expenditure was allocated between the appropriate AOCs. A more detailed breakout of IRM costs is included in Appendix B.

10.4.2 Potentially Applicable Technology Selection

The following 12 technologies were retained in Section 8.17 as possibly applicable to one or more environmental risks in one or more Site AOCs:

1. No Additional Action
2. EUCs and SWMP
3. LTM
4. MNA and NSZD
5. SVE/AS – Biovent/Biosparge
6. LNAPL/Product Skimming
7. Hydraulic Containment (product/groundwater recovery and treatment)
8. MP
9. Soil Excavation and Landfarming
10. Waste Excavation, Stabilization, and Off-Site or On-Site Disposal
11. Capping
12. Phytoremediation

No additional action is retained for the AHA to provide a baseline against which to compare the other alternatives. EUCs and a SWMP are proposed across all AOCs including the AHA, as are LTM and MNA (if confirmed). SVE/AS and MPE are not proposed for the AHA because all soil remediation has already been completed and the technologies would be of limited effectiveness for tar recovery and difficult to implement in fractured bedrock. Soil and waste excavation, stabilization, and on-site disposal have already been completed and the excavations have been backfilled with clean soil; therefore, capping and phytoremediation are not applicable. LNAPL product skimming could be completed; however, no wells currently exist within the AHA with any measureable product and given the high tar viscosity, the use of trenches and aggressive dewatering would likely be required to force any residual tar from the fractures; therefore a trench-based product/groundwater hydraulic containment system is retained for consideration. These have been assembled into the following complete alternatives (*The single difference between Alternative 2 and 3 is italicized*):

- **Alternative 1 – No Additional Action**
    - No additional action beyond the already-completed IRM activities

- **Alternative 2 – MPA Spring, Basin IT, Plus**
    - Groundwater/Product Recovery and Treatment
        - MPA Spring System - Asphalt in rock fractures is either immobile or, similar to AHA groundwater, would flow to the MPA Spring.
        - MPA Basin IT – AHA impacted groundwater (if any exists) not captured by the MPA Spring is captured by this trench.
        - Groundwater Treatment System (GTS) Operation
    - LTM (groundwater monitoring)
    - MNA (if confirmed)
    - EUCs and SWMP

- **Alternative 3 – Additional Interceptor Trenches**
    - Groundwater/Product Recovery and Treatment
        - MPA Spring Operation – Same as Alternative 2
        - MPA Basin IT Operation – Same as Alternative 2
        - *Additional ITs along east side of AHA and west side of MPA*
        - GTS Operation
    - LTM
    - MNA (if confirmed)
    - EUCs and SWMP

10.4.3 AHA Alternative 1 – No Additional Action

As required by CAS guidance, the first alternative is the "No Additional Action" alternative to establish a baseline for comparison.

10.4.3.1 <u>Alternative Components</u>. No Additional Action means the cessation of any already implemented controls, such as IT operation, cap maintenance, all Site water management and no EUCs or SWMP

10.4.3.2 <u>Alternative Evaluation Criteria.</u> The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities.

10.4.3.2.1 Overall Protection of Human Health and Environment. No air emissions are generated, land can be reused, and no additional natural resources are required; therefore, from a "green remediation" perspective no additional action rates relatively well. Post-IRM, the AHA has few residual risks; however, given that no EUCs are in place, a drinking water well could be installed in the future within the small area of tar-impacted fractured bedrock. Also, the residual tar-free product is not addressed. Therefore, this alternative provides moderately high protection of human health and the environment.

10.4.3.2.2 Compliance with ARARs. It is unclear in the absence of trace tar globules, if groundwater would exceed standards; therefore, it is possible chemical-specific ARARs for groundwater may already be achieved. The requirement to address free product would not be met. No action-specific or location-specific ARARs have been identified for this alternative. Net overall compliance with ARARs is moderately high.

10.4.3.2.3 Long-Term Effectiveness and Permanence. This alternative provides no controls for exposure and no long-term management measures; however, potential future exposure risks are low. Given all the completed IRM work, long-term effectiveness and permanence is moderately high.

10.4.3.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. A large reduction in toxicity, mobility, or volume of contamination through engineered treatment has been completed; however, under this alternative, little additional reduction would occur. Natural attenuation would likely occur but would remain unconfirmed and effectiveness unmonitored. Overall reduction in toxicity, mobility, and volume through treatment would be moderately high.

10.4.3.2.5 Short-Term Effectiveness. No additional action would occur; hence, no risk to on-site workers or the community from that action would exist; however, the possibility of future water well installation in the former AHA Pit area would pose some potential risk to a future owner. The time until CAGs are achieved would be many decades because residual LNAPL (tar) would not be addressed. The overall result is moderately high short-term effectiveness.

10.4.3.2.6 Implementability. There would be no construction or technology concerns posed by this remedy and it would easy undertaken/implemented since no additional action would be taken. However, the ability to monitor the effectiveness of the remedy would be limited since no LTM or site inspections would be completed, resulting in overall moderate implementability.

10.4.3.2.7 Community Acceptance. Much remediation has been completed and if left uncontrolled, the Site would likely be used for hunting and recreation with little obvious concern from the public or users. The residual tar poses little future risk; therefore, overall public acceptance would be moderately high.

10.4.3.2.8 Cost. The prior IRM work costs are summarized in Table 10-2. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The additional cost of this alternative is $0 since no additional action would be taken; however, given all the prior Site work, the overall cost is still ranked as high.

10.4.4 AHA Alternative 2 – MPA Spring System, Basin IT, Plus

Alternative 2 includes operation of the current systems and additional measures as summarized below:

- Groundwater/Product Recovery and Treatment
    - MPA Spring System - Asphalt in rock fractures is either immobile or, similar to AHA groundwater, flows to the MPA Spring.
    - MPA Basin IT – AHA impacted groundwater (if any exists) not captured by the MPA Spring is captured by this trench.
- LTM (groundwater monitoring)
- MNA
- EUCs and SWMP

10.4.4.1 Alternative Components. The following describe each alternative component:

10.4.4.1.1 MPA Spring System. Given 1) weathered bedrock topography directing AHA groundwater flow toward the MPA Spring area; 2) the location of the AHA Pit (the source of the asphaltic tar) immediately upgradient of the MPA Spring; and 3) dewatering and resulting drawdown in the MPA Spring collection sump once the UOWS and GAC filter are installed, it is likely most or perhaps all AHA-impacted groundwater and tar would flow toward the MPA Spring area and hence would be captured and treated by the MPA Spring gravity flow system. As described in Section 10.3.4.1.3, the MPA Spring System would remain in operation to provide tar recovery and, if necessary, dissolved-phase treatment. The MPA Spring would continue to flow indefinitely with anticipated near-term elimination of dissolved-phase contamination (a likely remnant of entrained tar) and eventual elimination of tar entrainment now that the primary source of the tar, the AHA Pit, has been removed. Regardless, the MPA Spring UOWS and GAC filter structures should remain structurally sound for decades; therefore, all structures may be left in place indefinitely to provide added protection. Given the shared role of the MPA Spring System, the costs are shared between the MPA and AHA areas.

10.4.4.1.2 MPA Basin IT. If the preferred MPA alternative is selected, the MPA Basin IT would remain operational. This would provide capture of any AHA-impacted groundwater not captured by the MPA Spring System. The quantity of flow and concentrations are likely to be negligible compared to MPA impacts; therefore, no costs for this system are allocated to the AHA, but this is included and noted as an additional contingency. The Seep IT system would provide a third layer of capture, containment, and protection.

10.4.4.1.3 LTM. This alternative includes LTM of groundwater as described in Section 10.2.2, which includes monitoring of the MPA Spring influent water. This COC dissolved-phase data would be used to track remedy performance and help determine if/when remedy components can be removed (e.g., GAC filters and perhaps coalescing media) to reduce long-term O&M costs.

10.4.4.1.4 MNA. This alternative conditionally includes MNA as described in Section 10.2.4, including the acknowledgement that these are unproven and not assumed in the criteria evaluation/ranking. MNA is included to confirm that if dissolved-phase concentrations in deep fractured rock are present, that they are decreasing as a result of natural processes. If dissolved-phase concentrations in MPA Spring water do not exceed RBSLs following installation of the UOWS (after entrained tar is removed), MNA would not be a necessary component for the AHA. (NSZD is similarly not included because all impacted soil and waste have been removed from the AHA).

10.4.4.1.5 EUCs and SWMP. Throughout the evaluation period, this alternative includes the use of EUCs and an SWMP as described in Section 10.2.1 across a limited portion of the AHA. It is debatable if a SWMP is required given clean soil should be present to unexcavatable bedrock, but it was included as an additional precaution. The EUC and SWMP would provide protection of potential receptors throughout the Site restoration process.

10.4.4.2 <u>Alternative Evaluation Criteria.</u> The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities.

10.4.4.2.1 Overall Protection of Human Health and Environment. The gravity flow MPA Spring system was installed as part of IRM activities and would address both dissolved-phase impacts and free product (tar). Future O&M should require minimal natural resources and no power consumption. Air emissions should be negligible and only during tar management. LTM and MNA (if applicable) would track remedial performance. Post-IRM, the AHA has few residual risks; however EUCs would prevent installation of a future a drinking water well within the area of tar-impacted fractured bedrock. Therefore, this alternative provides a very high protection of human health and the environment.

10.4.4.2.2 Compliance with ARARs. It is unclear if, in the absence of trace tar globules, groundwater would exceed standards; therefore, it is possible chemical-specific ARARs for groundwater may already be achieved, and if not, may soon be as increased flushing rates (increased gradients into the spring collection sump) flush tar and reduce contaminant mass. The requirement to address free product (tar) would be met. The only action-specific ARAR is effluent monitoring of the system for NPDES purposes. Net overall compliance with ARARs is very high.

10.4.4.2.3 Long-Term Effectiveness and Permanence. This alternative provides long-term management and control measures (EUCs); nearly all contaminant mass has been removed; and as a result future exposure risks are very low. Long-term effectiveness and permanence is very high.

10.4.4.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. A large reduction in toxicity, mobility, or volume of contamination through engineered treatment

has been completed. Treatment of the residual contaminant mass in bedrock would occur overtime as a result of continued bedrock flushing and likely biodegradation. Overall reduction in toxicity, mobility, and volume through treatment would be very high.

10.4.4.2.5 Short-Term Effectiveness. The environmental impacts of the MPA Spring System are very low. O&M of this system and LTM pose essentially no risk to the community and very low risk to on-site O&M staff. EUCs would provide long-term exposure prevention until CAGs are achieved. The time until CAGs are achieved is uncertain, but, for the purposes of this CAS, is estimated to be two decades. Overall short-term effectiveness would be very high.

10.4.4.2.6 Implementability. There would be no construction or technology concerns posed by this remedy as the equipment has already been installed. NPDES permitting has been completed. Performance is easily monitored and confirmed. Overall reliability of the system remains to be confirmed but proven technologies were selected; therefore, it is believed to be high. The overall implementability would be very high.

10.4.4.2.7 Community Acceptance. Most AHA remediation has been completed, residuals would be addressed, and risks would be controlled. Reuse of most, possibly all, of the AHA for pastureland is likely; therefore, overall public acceptance is expected to be very high.

10.4.4.2.8 Cost. The prior IRM work costs and the additional cost of this alternative, including both initial capital and O&M, are summarized in Table 10-2. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The overall cost is High.

10.4.5 AHA Alternative 3 – Additional Interceptor Trenches

Alternative 3 is the same as Alternative 2 with the exception that 2 ITs are installed to accelerate free product (tar) recovery:

- Groundwater/Product Recovery and Treatment
    - MPA Spring Operation
    - MPA Basin IT Operation
    - Two AHA ITs
    - Groundwater Treatment System Operation
- LTM
- MNA
- EUCs and SWMP

10.4.5.1 <u>Alternative Components</u>. Given the similarity to Alternative 2, only the differences will be discussed: Two 200-foot long ITs would be installed to fractured bedrock directly east of the AHA Pit as shown in Figure 10-4. Both ITs would run north-south perpendicular to groundwater flow. One would be located immediately west of the Site access road and one

would be located immediately east. The west IT would extend across the floor of the suspected former quarry, which appears to have been quarried into fractured rock to depths of approximately 20 feet. Given the high viscosity of the asphaltic tar, a second east trench would be used to reduce the required migration distance, increasing the total rate of product recovery. Perforated pipe and a single collection sump would be installed in the low point and the trench would be backfilled with 5 feet of gravel, followed by the excavated soil. A 10-foot deep pump sump would be drilled into bedrock to permit full dewatering of the trenches with water and any entrained tar conveyed to the groundwater treatment system through a connection at the MPA Basin IT. A single electric submersible pump in each sump would be used to remove entrained tar globules and groundwater. It is assumed the tar quantity would be minimal and would dissolve into the lighter-end hydrocarbons collected from the other IT; therefore, no additional GTS O&M costs are assumed. Given the very low dissolved-phase concentrations, it is assumed only modest additional wetlands treatment costs would be incurred.

10.4.5.2 Alternative Evaluation Criteria. The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is evaluated prior to implementation of any Site restoration work, including the recently completed IRM activities. Although the full alternative is evaluated in the ranking, only the differences compared to Alternative 2 are discussed:

10.4.5.2.1 Overall Protection of Human Health and Environment. The two additional trenches would enhance tar recovery, but would reduce groundwater flux to and hence the tar recovery from the MPA Spring system. The net overall effect would likely be a modest increase in the rate of tar recovery from the bedrock fractures and hence slightly reduced timeframe until CAGs and ARARs are achieved. Therefore, this alternative provides a very high protection of human health and the environment.

10.4.5.2.2 Compliance with ARARs. Overall compliance with ARARs is increased to very high because of the slightly reduced time frame until ARARs are achieved, which is estimated to be 15 years.

10.4.5.2.3 Long-Term Effectiveness and Permanence. The long-term effectiveness and permanence is similar to Alternative 2, very high.

10.4.5.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. Overall reduction in toxicity, mobility, and volume through treatment would also be similar to Alternative 2, very high.

10.4.5.2.5 Short-Term Effectiveness. Given mechanical and electrical equipment (i.e., groundwater pump) the risks to Site O&M workers is slightly increases compared to Alternative 2. Protection of the community would be similar. Overall environmental impact associated with implementing the remedy would be slightly higher because of the trench

construction, equipment, and electric requirements. The time until CAGs are achieved would be slightly reduced to 15 years. Overall short-term effectiveness would be very high.

10.4.5.2.6 Implementability. Similar trenches have been successfully designed, permitted, installed, and operated at the Site and the excavation depth is relatively shallow in this area (excepting the suspected former quarry part of the AHA Pit excavation); therefore, overall implementability is unchanged, very high.

10.4.5.2.7 Community Acceptance. Overall public acceptance is expected to be very high.

10.4.5.2.8 Cost. The prior IRM work costs and the additional cost of this alternative, including both initial capital and O&M, are summarized in Table 10-2. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The overall cost is very high.

10.5 SOUTH TANK FARM (STF)

The STF contained large product aboveground storage tank (ASTs), piping, and a laboratory facility. This section is organized as follows:

- **IRM Summary (10.5.1)**: Early during Site demolition, the product ASTs and known piping were removed from the STF. No remediation-focused IRM work has been completed.
- **Applicable Technologies (10.5.2)**: There were 12 technologies retained in Section 8 that may be applied to one or more areas of the Site. Reasons are listed is this section for those included and not included in the assembled STF alternatives.
- **Alternatives Presentation (10.5.3, 10.5.4, and 10.5.5)**: The majority of this section presents 3 alternatives to address the remaining STF contaminants discussed in Section 2, risks identified in Section 3, and resulting CAGs discussed in Section 7. Recommendation of an alternative for each area occurs in Section 11.

10.5.1 Already Completed

Early during Site demolition, the product ASTs and known piping were removed from the STF. No remediation-focused IRM work has been completed.

10.5.2 Potentially Applicable Technology Selection

The following 12 technologies were retained in Section 8.16 as possibly applicable to one or more environmental risks in one or more Site AOCs:

1. No Additional Action
2. EUCs and SWMP
3. LTM
4. MNA and NSZD
5. SVE/AS – Biovent/Biosparge
6. LNAPL/Product Skimming
7. Hydraulic Containment (product/groundwater recovery and treatment)
8. MPE
9. Soil Excavation and Landfarming
10. Waste Excavation, Stabilization, and Off-Site or On-Site Disposal
11. Capping
12. Phytoremediation

No additional action is retained for the STF to provide a baseline against which to compare the other alternatives. As previously discussed, EUCs and SWMP are proposed across all AOCs including the STF, as are LTM and MNA/NSZD (if confirmed). SVE/AS are not proposed for the STF because the lateral extent, soil types and saturation make implementation infeasible, likely requiring hundreds of wells and decades of operation costing $10s of millions. Soil excavation and landfarming is a better alternative to SVE/AS and is retained for costing and discussion. Excavation was selected over capping because the majority of STF contamination is not shallow (no known surface exposure risks) and most petroleum impacts are within the saturated smear zone; hence prevention of stormwater infiltration and resulting leaching would do little to reduce contaminant flux into groundwater. MPE could be used to enhance source treatment and residual product recovery after excavation given the dewatering would expose a portion of the deeper more permeable weathered rock zone. Product skimming is retained along with product and groundwater recovery in interceptor trenches. A single known waste area remains in the STF which could be addressed by excavation and either on-site or off-site disposal. Given other viable technologies and the large area, phytoremediation is not proposed for the STF other than what would occur naturally from existing deep-rooted grasses and trees. The retained technologies have been assembled into the following complete alternatives (*Key differences between Alternative 2 and 3 are italicized*):

- **Alternative 1 – No Additional Action**
  - No additional action beyond the already-completed IRM remediation.
- **Alternative 2 – Waste Excavation and Containment**
  - Excavate, Stabilize, and Dispose of Known Waste
  - Hydraulic Containment

        - MPA Basin Interceptor Trench Continued Operation
        - STF Northeast (NE) Plume Interceptor Trenches
        - Groundwater Treatment System (GTS) Operation
    - *STF Creek Surface Water Sampling* with Contingency Interceptor Trench
    - *LNAPL/Product Skimming*
    - LTM
    - MNA and NSZD (if confirmed)
    - EUCs and SWMP

- **Alternative 3 – Source Excavation, Large-Scale Containment, and MPE**
    - Excavate, Stabilize, and Dispose of Waste (will evaluate on-site or off-site)
    - Hydraulic Containment
        - MPA Basin Interceptor Trench Continued Operation
        - STF NE Plume Interceptor Trenches
        - *STF Creek Interceptor Trench (south bank)*
        - *SE North Topeka St Interceptor Trench*
        - GTS Operation
    - *Spot-Excavate Source Area Soil*
    - *MPE (from excavation floor gallery)*
    - LTM
    - MNA and NSZD
    - EUCs and SWMP

10.5.3 STF Alternative 1 – No Additional Action

As required by CAS guidance, the first alternative is the "No Additional Action" alternative to establish a baseline for comparison.

10.5.3.1 <u>Alternative Components</u>. Relative to the MPA, environmental risks are relatively low across most of the STF; however, No Additional Action also means no EUCs or SWMP would be implemented.

10.5.3.2 <u>Alternative Evaluation Criteria.</u> The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities.

10.5.3.2.1 Overall Protection of Human Health and Environment. No air emissions are generated, land can be reused, and no additional natural resources are required; therefore, from a "green remediation" perspective, it rates relatively well. However, no additional action means stability and natural attenuation of the petroleum-related dissolved-phase plumes would not be confirmed; the MTBE, TPH-GRO, and TPH-DRO plumes would continue to migrate off-site, including a residential area; and the lack of EUCs and SWMP would allow for the possibility of future owners excavating impacted soil or waste without adequate protection or planning;

installation of water wells within groundwater plumes; and even construction of residential homes above impacted areas with resulting VI risk. Therefore, this alternative provides moderately low protection of human health and the environment.

10.5.3.2.2 Compliance with ARARs. Chemical-specific ARARs for groundwater would not be achieved for many decades. This alternative only slightly reduces groundwater or soil contaminant concentrations because no active remediation is conducted. Natural attenuation processes would be ongoing; however, these processes require time and it is unlikely ARARs would be achieved for many decades. No action-specific or location-specific ARARs have been identified for this alternative. Compliance with ARARs is low.

10.5.3.2.3 Long-Term Effectiveness and Permanence. This alternative provides no controls for exposure and no long-term management measures. Potential future exposure risks would remain. Long-term effectiveness and permanence is moderately low.

10.5.3.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. No reduction in toxicity, mobility, or volume of contamination through engineered treatment would occur. Natural attenuation and NSZD would likely occur but would remain unconfirmed and effectiveness unmonitored. Overall reduction in toxicity, mobility, and volume through treatment would be long-term and low.

10.5.3.2.5 Short-Term Effectiveness. No additional action would occur; hence, no risk to on-site workers or the community from that action would exist. However, continued MTBE plume migration, installation of drinking water wells, and uncontrolled digging/building construction (including residential) could result in exposures. The time until CAGs are achieved would be many decades. The overall result is low short-term effectiveness.

10.5.3.2.6 Implementability. There would be no construction or technology concerns posed by this remedy and it would be easy to undertake/implement since no additional action would be taken. However, the ability to monitor the effectiveness of the remedy would be limited since no LTM or site inspections would be completed, resulting in overall moderate implementability.

10.5.3.2.7 Community Acceptance. If left uncontrolled the Site would likely be used for hunting and recreation with little obvious concern from the public or users; however, those concerned with repair of environmental damage would be displeased with no remedial action. Therefore, overall public acceptance would be moderate.

10.5.3.2.8 Cost. The prior IRM work costs are summarized in Table 10-3. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The additional cost of this alternative is $0 since no additional action would be taken; however, given all the prior Site work, the overall cost is still ranked as high.

10.5.4 STF Alternative 2 – Waste Excavation and Containment

Alternative 2 includes several remedial measures as summarized below:

- Excavate, Stabilize, and Dispose of Known Waste (on-site or off-site)
- Hydraulic Containment
    - MPA Basin Interceptor Trench Continued Operation
    - STF NE Plume Interceptor Trenches
    - Groundwater Treatment System Operation
- STF Creek Surface Water Sampling and Contingency Interceptor Trenches
- LNAPL/Product Skimming
- LTM
- MNA and NSZD
- EUCs and SWMP

10.5.4.1 <u>Alternative Components</u>. The following describe each alternative component:

10.5.4.1.1 Excavate, Stabilize, and Dispose of Known Waste. A buried waste area was encountered in the northeastern portion of the STF during pipeline removal work. It was investigated during the Third Phase Site Investigation and was found to be approximately 2,000 square feet, 5 feet deep (approximately 400 cy) as shown in Figure 10-5. The waste contains elevated lead (2,020 milligrams per kilogram [mg/kg]), TPH-DRO (27,000 mg/kg), and TPH-GRO (2,900 mg/kg) concentrations. The waste is not believed to have appreciably leached into underlying soils based upon analyses performed on soil samples from the area.

It is assumed a work plan would be developed to better characterize the waste (hazardous or nonhazardous) and determine if stabilization is required. For the purposes of this CAS cost estimate, it is assumed nominal stabilization similar to the AHA pit material would be required and that the material would be nonhazardous (once stabilize it would not fail TCLP). The economics of reopening and recapping a portion of the West Oxidization Pond stabilized waste area are uncertain given this moderate volume. That cost versus off-site landfill disposal would be compared once characterization and classification results are known, but for the purposes of this CAS, it is assumed the waste would be disposed off-site at a KDHE-approved landfill and that the excavation would be backfilled would clean fill from existing STF berms.

10.5.4.1.2 Hydraulically Contain STF NE Plumes. The STF northeast (NE) plumes (benzene, TPH-GRO, TPH-DRO, and MTBE) migrate onto EPME-PC property located east of North Topeka Street, which for the purposes of this CAS is also considered part of the STF area of concern (AOC). Currently the plumes continue to migrate onto Union Tank Car and nearby residential property. The largest of the off-site plumes, the MTBE plume, is shown in Figure 10-6. MTBE does not sorb well to soil; therefore, options to prevent off-site migration and address the source area are limited.

Given existing Site infrastructure and anticipated need for long-term hydraulic containment elsewhere on Site, the same approach (hydraulic containment) was selected for this alternative. Two interceptor trenches (STF NE Plume ITs) would be placed along the east and south sides of the EPME-PC-owned property as shown in Figure 10-6. A total of 3 groundwater recovery sumps would be installed at least 10 feet into bedrock to permit full dewatering of the STF NE Plume ITs and full MTBE (and other COC) capture. An electric pump in each sump would be used to extract groundwater, which would be conveyed north to the nearby MPA Basin IT sump where it would tee into the conveyance line for treatment in the Groundwater Treatment System. A pre-design investigation would be completed to better define depth to bedrock in the proposed construction area and to assess the need for and/or exact size of both trenches. Modeling may also be completed. It is possible the east-west trench would not be required if sufficient hydraulic influence is present from the north-south trench.

This approach should immediately contain the plume to the Site and given the mobility and low soil sorption coefficient of MTBE, it may also pull back a portion of the nearby plume. Once the source is cut-off, the remainder of the plumes should naturally attenuate. Given the high solubility of MTBE, the CAS assumes 20 years of additional flushing would be sufficient to reduce the source and resulting dissolved-phase plume to acceptable concentrations, preventing off-site migration above ARARs. If this proves incorrect, the contingency actions are continued operation of MTBE ITs and/or delineation, excavation, and off-site disposal of the source area.

10.5.4.1.3 Continued MPA Basin IT Operation. The MPA Basin IT would also continue to be operated to capture the northern finger of the STF NE Plumes. A small gap would exist between the two trenches; however, given bedrock slopes directing natural groundwater flow toward the ITs and the lack of contamination in that area, it is likely all impacted groundwater would be captured between the two MPA Basin IT and STF NE Plume ITs; however, if not, the Seep IT would capture all groundwater from that vicinity further downgradient.

10.5.4.1.4 Groundwater Treatment System. MTBE is more recalcitrant to wetlands degradation processes than other Site COCs; however, given the current successful MTBE treatment and the reserve treatment capacity (e.g., Stage 3), it is very likely no system modification would be required. Costing assumes the same 20-year period as described in Section 10.2.5 – Treatment of Extracted LNAPL and Groundwater.

10.5.4.1.5 STF Creek Surface Water Sampling and Contingency ITs. Groundwater and surface water elevations indicate the western portion of the STF Creek is a “gaining” stream during all but the driest periods of the year. (The eastern portion near the N Topeka Street and beyond is likely a losing stream section). This means the upper (shallow groundwater) of the south STF TPH (GRO and DRO) and BTEX groundwater plumes likely discharge to the STF Creek. Historical sediment and surface water sampling have occasionally detected low levels of contaminants, supporting this theory. However, the most recent surface water samples have shown no contaminants above ARARs and sediment impacts were below human health risk-

based standards. This is likely because TPH and BTEX are readily degradable; groundwater plume concentrations at the STF Creek are relatively low; and the groundwater seepage rate is likely low, allowing for natural processes to quickly attenuate the contaminants similar to a natural wetlands treatment process. No contaminants have even been detected migrating off-site in the STF Creek or even approaching the Site boundary at North Topeka Street.

Given the prior discussion, it is debatable if active containment of the plume is necessary to protect human health and the environment. Interceptor trenches are assumed for Alternative 3, but this alternative (Alternative 2) proposes to monitor the STF Creek to gather up to 36 data points for statistical analysis and trending. It assumes three years of quarterly surface water sampling at 3 STF Creek Locations (upstream, groundwater discharge area, and downstream near property boundary) would confirm STF Creek ITs are not necessary; however, if the data indicate Site CAGs are not achieved, the contingency plan would be to install the STF Creek ITs described in Alternative 3 (Section 10.5.5.1.1).

10.5.4.1.6 LNAPL/Product Skimming. LNAPL would be manually skimmed from any STF wells containing free product as described in Section 10.2.3.

10.5.4.1.7 LTM. This alternative includes long-term monitoring (LTM) of groundwater as described in Section 10.2.2. This COC dissolved-phase data would be used to track remedy performance and help determine when and where shifts between active and natural remediation components may be warranted.

10.5.4.1.8 MNA and NSZD. This alternative includes monitored natural attenuation (MNA) and natural source zone reduction (NSZD) as described in Section 10.2.4, including the acknowledgement that these are unproven and not assumed in the criteria evaluation/ranking. However, this alternative assumes MNA will be present and sufficient for most of the STF plumes; therefore, MNA begins immediately with periodic checks to confirm the processes remain active. This data would also provide a basis to compare natural versus active contaminant mass removal/destruction to help determine when and where changes between active and natural remediation processes may be warranted.

10.5.4.1.9 EUCs and SWMP. Throughout the evaluation period, this alternative includes the use of EUCs and a SWMP as described in Section 10.2.1. This would provide protection of potential receptors throughout the Site restoration process.

10.5.4.2 <u>Alternative Evaluation Criteria.</u> The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities.

10.5.4.2.1 Overall Protection of Human Health and Environment. Free-product recovery and waste excavation address free product and wastes. Long-term hydraulic containment with wetlands treatment provides a low energy (green) solution compared to most other active

remediation alternatives. The technologies of pump and treat, product recovery, wetlands treatment, surface water monitoring, LTM, MNA/NSZD, and EUCs/SWMP are all readily implementable, effective and comply with all ARARs. EUCs and the SWMP would prevent receptor exposure while Site restoration proceeds; therefore, the overall protection of human health and the environment is high.

10.5.4.2.2 Compliance with ARARs. Chemical-specific ARARs for groundwater would be achieved after several decades. Compliance with all action-specific and location-specific ARARs is readily achieved because 1) trenches have been successfully installed and the Groundwater Treatment System (GTS) is already operational; 2) the KDHE has approved the SWMP and indicated concurrence regarding the need for and applicability of EUCs; 3) all property is owned by EPME-PC; and 4) other remedy components require no or little permitting or regulatory approval. Compliance with ARARs is high.

10.5.4.2.3 Long-Term Effectiveness and Permanence. The magnitude of the residual risk after all remedial actions are complete would be low. Given the time frame until these action are complete, the remedy incorporates robust institutional controls (e.g., EUC and SWMP) to adequately and reliably protect receptors during the remediation period. Long-term effectiveness and permanence is high.

10.5.4.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. Waste would be removed. Natural attenuation processes are likely and would be confirmed. Hydraulic containment of the MTBE plume (groundwater extraction) removes contaminant mass and controls mobility through treatment. Overall reduction of source mass toxicity, mobility and volume would be completed through NSZD (if confirmed). Given the biodegradability of petroleum contamination and these processes, a large reduction in toxicity, mobility, and volume would be achieved; therefore, the overall rating is moderate.

10.5.4.2.5 Short-Term Effectiveness. The community and workers would be protected from COC exposure during implementation of the remedy. On-site exposure to COCs would be prevented by the previously discussed remedial action, EUCs, and SWMP. Off-site exposures would be prevented because all receptors are protected and all proposed remedy components are primarily destructive in nature, biodegrading contaminants (e.g., wetlands, phytoremediation, NSZD, and MNA) rather than transferring COCs to another media (e.g., air stripping or SVE) or simply transferring them from one location to another (e.g., excavation and landfilling). Given this and the low power consumption required, the environmental impacts of implementing the remedy are very low. The time until CAGs are achieved is long. Overall short-term effectiveness is high.

10.5.4.2.6 Implementability. The reliability of and the ability to construct the systems is very high. Additional remedial action such as additional source/waste removal, installation of trenches, etc. is easily undertaken. The ability to monitor the remedy is high (e.g., LTM and EUC inspections) and the ability to obtain approval from all agencies is anticipated to be very

high based upon past conversations and lack of permitting needs. Overall implementability for this remedy is very high.

10.5.4.2.7 Community Acceptance. This remedy would result in the removal of all off-site risks (e.g., groundwater plume) and allow for future beneficial reuse of the STF. No noisy equipment, VOC emissions, dust, or larger amounts of truck traffic would be required. Given this, overall public acceptance is anticipated to be high.

10.5.4.2.8 Cost. The prior IRM work costs and the additional cost of this alternative, including both initial capital and O&M, are summarized in Table 10-3. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The overall cost is high.

10.5.5 STF Alternative 3 – Excavation, Containment, and MPE

Alternative 3 includes several remedial measures as summarized below:

- Excavate, Stabilize, and Dispose of Waste (will evaluate on-site or off-site)
- Hydraulic Containment
    - MPA Basin Interceptor Trench Continued Operation
    - STF NE Plume Interceptor Trenches
    - *STF Creek Interceptor Trench*
    - *SE North Topeka St Interceptor Trench*
    - Groundwater Treatment System Operation
- *Excavation of Source Areas with Landfarming*
- *MPE (from excavation floor gallery)*
- LTM
- MNA and NSZD
- EUCs and SWMP

Alternative 3 is the same as Alternative 2, except the *above-four italicized components* are additional.

10.5.5.1 <u>Alternative Components</u>. Given the similarity to Alternative 2, only the differences are discussed below for brevity:

10.5.5.1.1 STF Creek Interceptor Trench. This alternative assumes groundwater discharge to the STF Creek poses an unacceptable risk. Given the dissolved-phase contours (Figures 2-9 through 2-16), one 1,200 foot long IT would be installed along the south side of STF Creek as shown in Figure 10-7 to intercept groundwater. Trace entrainment/recovery of free product is also possible. The trench would be installed similar to other ITs, down to fractured bedrock with a lateral perforated pipe across the bottom and 10-feet of gravel backfill. Given the length and bedrock slope, this alternative assumes at least 4 extraction sumps (ES) would be required to

fully dewater the trench, along with associated electric pumps and controls. Costs include a 5,300-foot long conveyance line to a tie-in with the existing system at the MPA Basin IT sump. The existing GTS has sufficient capacity to the treat the water. Treatment costs increase slightly, as does STF's share of the overall costs.

The groundwater extraction would change the STF Creek water balance from a gaining stream to a losing stream in this area, potentially adversely impacting the immediately downgradient natural wetlands and downstream residents. Approvals may be required from the United States Army Corp of Engineers (USACE), Kansas Department of Agriculture (KDA), and nearby residents.

10.5.5.1.2 SE North Topeka Street Interceptor Trench (IT). This alternative also assumes a 300-foot long IT is required to recover trace LNAPL and contain the TPH-DRO plume (the only parameter exceeding) along the east side of the STF immediately west of and paralleling SE North Topeka St as shown in Figure 10-7. The IT construction is the same as the STF Creek with the exception of requiring only one ES. Water would tie into the same conveyance line and the GTS.

10.5.5.1.3 Source Area Excavation and Landfarming. Four source areas would also be excavated to bedrock as shown in Figure 10-5. Impacts continue into weathered and fractured bedrock; therefore, not all contaminant mass within the excavation foot-print would be removed. The average weathered bedrock depth of 8 feet was used to estimate the following for the areas, from north to south:

- Area 1: 0.2 acres, 2,100 bcy excavation
- Area 2: 1.3 acres, 16,800 bcy excavation
- Area 3: 0.1 acres, 1,300 bcy excavation
- Area 4: 0.5 acres, 6,100 bcy excavation

This would result in a total of 26,000 bcy excavation. The soil would be landfarmed across the MPA, requiring 33 acres at a depth of 6 inches. (This is slightly larger than the original MPA landfarm area of 28 acres, but additional space is now available and/or thicknesses could be slightly increased). The MPA was selected because of previous landfarming activities within the MPA; stormwater control (MPA Basin) allowing for retention and treatment if required; and the beneficial use of the soil to provide additional MPA cover material. Costing assumes landfarming would be complete within one year. Prior to backfilling the excavation, perforated corrugated polyethylene pipe (CPEP) would be placed across the excavation floor in several areas, following bedrock slope the low-point of the excavation floor. The pipe would then tee into an 18-inch solid HDPE conductor casing. The CPEP would be covered with approximately 2 feet of gravel, and the excavation would then be backfilled with soil from STF berms. The purpose for this piping is discussed in the following section.

10.5.5.1.4 Multi-Phase Extraction (MPE). The excavations would remove most free product and the highest concentrations soils; however, source mass would remain. Therefore, an MPE system would be installed in each of the four areas to accelerate collapse of the dissolved-phase plume and recover any remaining trace product (groundwater extraction). Also, an MPE system would extract air through the partially dewatered weathered bedrock to enhance COC volatilization and biodegradation. A 10-inch diameter well would be advanced through the 18-inch diameter conductor casing (installed prior to excavation backfill) 10 feet into the fractured bedrock. The well would be completed with a 15-foot screen.

An electric groundwater pump would be used to fully dewater the excavation, and a vacuum blower would be used to extract air from the excavation and nearby fractured rock. The vacuum blower for Area 3 (near the STF Creek) would also be used to extract vapors from the STF Creek IT to enhance its performance. Extracted vapors would be directly discharged to the atmosphere. Extracted water/product would flow through new conveyance lines that tee into the previously discussed STF conveyance line. The existing wetlands-based GTS should be capable of treating all flow streams depending upon the actual production rates; however, costs have been included to add active aeration (a blower and aeration piping) to the Stage 3 wetlands to enhance treatment.

10.5.5.2 <u>Alternative Evaluation Criteria.</u> The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities.

10.5.5.2.1 Overall Protection of Human Health and Environment. The proposed excavations address free product, wastes, and contaminant source areas, accelerating the remedial process. Long-term hydraulic containment with wetlands treatment provides a low energy (green) solution compared to most other active remediation alternatives. The technologies of excavation with landfarming, hydraulic containment, product recovery, wetlands treatment, surface water monitoring, LTM, MNA/NSZD, and EUCs/SWMP are all readily implementable, effective, and comply with all ARARs. EUCs and the SWMP would prevent receptor exposure while Site restoration proceeds; therefore, the overall protection of human health and the environment is very high.

10.5.5.2.2 Compliance with ARARs. Chemical-specific ARARs for groundwater would be achieved after several decades. Compliance with all action-specific and location-specific ARARs is readily achieved because 1) trenches have been successfully installed and the Groundwater Treatment System is already operational; 2) the KDHE has approved the SWMP and indicated concurrence regarding the need for and applicability of EUCs; 3) all property is owned by EPME-PC; and 4) other remedy components require no or little permitting or regulatory approval. Compliance with ARARs is very high.

10.5.5.2.3 Long-Term Effectiveness and Permanence. Given the aerial footprint of impacted soil, even these large excavations and MPE would address only part of the contaminant mass,

relying on the same processes as Alternative 2 to complete Site restoration. The magnitude of the residual risk after all remedial actions are complete would be low. Given the time frame until these action are complete, the remedy incorporates robust institutional controls (e.g., EUC and SWMP) to adequately and reliability protect receptors during the remediation period. Long-term effectiveness and permanence is very high.

10.5.5.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. Waste, free product, and impacted soil would be removed. Natural attenuation is likely and would be confirmed. Hydraulic containment of the source area, STF NE Plumes, STF Creek, and STF TPH-DRO plumes removes contaminant mass and controls mobility through treatment. Additional reduction of source mass toxicity, mobility and volume would be completed through NSZD (if confirmed). Given the biodegradability of petroleum contamination and these processes, a large reduction in toxicity, mobility, and volume would be achieved; therefore, the overall rating is very high.

10.5.5.2.5 Short-Term Effectiveness. The community and workers would be adequately protected from COC exposure during implementation of the remedy, although VOC vapors from the MPE systems and landfarming would create some exposure and could result in odor complaints. On-site exposure to COCs would be prevented by the previously discussed remedial action, EUCs, and SWMP. Off-site exposures would be prevented because all receptors are protected and most proposed remedy components are mostly destructive in nature, biodegrading contaminants (e.g., wetlands, phytoremediation, NSZD, and MNA). Only excavation/landfarming and MPE transfer COCs to another media (e.g., air). Given this and the low power consumption required, the environmental impacts of implementing the remedy are low. The time until CAGs are achieved is long. Overall short-term effectiveness is high.

10.5.5.2.6 Implementability. The reliability of and the ability to construct the technologies/systems is very high. Additional remedial action such as additional source/waste removal is easily undertaken or flooding of the excavation gravel layer (and nearby bedrock) with oxidant or oxygen-releasing compounds is possible. The ability to monitor the remedy is high (e.g., LTM and EUC inspections) and the ability to obtain approval from all agencies is anticipated to be very high based upon past conversations and lack of permitting needs. Overall implementability for this remedy is high.

10.5.5.2.7 Community Acceptance. This remedy would result in the removal of all off-site risks (e.g., groundwater plume) and allow for future beneficial reuse of the STF. The perception of benefit from increased contaminant mass removal may be off-set by the months of dust, noise, truck-traffic, and VOC emissions from the excavation, landfarming, and MPE system (years of operation). Still, overall public acceptance is anticipated to be high.

10.5.5.2.8 Cost. The prior IRM work costs and the additional cost of this alternative, including both initial capital and O&M, are summarized in Table 10-3. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs,

2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The overall cost is very high.

10.6 STORMWATER POND AREA (SPA)

All SPA wastes have been stabilized and the ponds have been properly closed. The structure of this section is:

- **IRM Summary (10.6.1)**: A large amount of remediation work has already been completed in the SPA as discussed in Section 4; therefore, to better identify what remains, a brief summary is provided.
- **Applicable Technologies (10.6.2)**: There were 12 technologies retained in Section 8 that may be applied to one or more areas of the Site. Reasons are listed is this section for those included and not included in the assembled SPA alternatives.
- **Alternatives Presentation (10.6.3, 10.6.4, and 10.6.5)**: The majority of this section presents 3 alternatives to address the remaining SPA contaminants discussed in Section 2, risks identified in Section 3, and resulting CAGs discussed in Section 7. Recommendation of an alternative for each area occurs in Section 11.

10.6.1 Already Completed

The already-completed IRMs that address one or more of the original SPA environmental risks are:

- **Seep Interceptor Trench (Section 4.1)**: All impacted soil and waste were stabilized in the West Oxidation Pond, and there is no indication the former wastewater/stormwater ponds contributed LNAPL to the WBWR seeps. This is supported by soil borings and evidence of clean soil underlying the clean-closed east ponds. However, MPA LNAPL impacted deeper weathered bedrock under the SPA. The already-installed Seep IT prevents discharge of this LNAPL and impacted groundwater to the WBWR.
- **Groundwater Treatment System and East Ponds Closure (Section 4.4)**: The east ponds were clean-closed and wetlands-based Groundwater Treatment System was installed across the area for use in Site-wide remediation as previously discussed.
- **West Ponds Stabilization, Cap, and Closure (Section 4.6)**: Waste from across the Site was consolidated with waste in the West Oxidation Pond, stabilized, graded, and capped providing closure of all former wastewater ponds.

Costs provided in Table 10-4 show actual IRM expenditures to date. When one of the remedies discussed above addressed more than one AOC, the total expenditure was allocated between the appropriate AOCs. A more detailed breakout of IRM costs is included in Appendix B.

10.6.2 Potentially Applicable Technology Selection

The following 12 technologies were retained in Section 8.16 as possibly applicable to one or more environmental risks in one or more Site AOCs:

1. No Additional Action
2. EUCs and SWMP
3. LTM
4. MNA and NSZD
5. SVE/AS – Biovent/Biosparge
6. LNAPL/Product Skimming
7. Hydraulic Containment (product/groundwater recovery and treatment)
8. MPE
9. Soil Excavation and Landfarming
10. Waste Excavation, Stabilization, and Disposal
11. Capping
12. Phytoremediation

No additional action is retained for the SPA to provide a baseline against which to compare the other alternatives. EUCs and a SWMP are proposed across all AOCs including the SPA, as are LTM and MNA (if confirmed). NSZD processes would be limited in the SPA by the West Pond cap and wetlands, both of which inhibit vapor flux; therefore, NSZD is not proposed for this area. SVE/AS is not proposed because the clean shallow soils and deeper and narrow saturated treatment zone mean SVE is not applicable and AS would require cost-prohibitively close spacing. Soil and waste excavation, stabilization, and capping have already been completed. Given the West Pond cap, phytoremediation is not recommended since the roots would enhance stormwater infiltration through the low permeability cap. LNAPL recovery is ongoing with the Seep IT, although only trace sheens are occasionally evident within the trench. LNAPL skimming is retained for any monitoring wells (e.g., west side near the MPA) containing free product. The Seep IT already implements hydraulic containment, with the wetlands providing treatment. The retained technologies have been assembled into the following complete alternatives (*Key differences between Alternative 2 and 3 are italicized*):

- **Alternative 1 – No Additional Action**
  - No additional action beyond the already-complete IRM activities
- **Alternative 2 – Seep IT, Cap Maintenance, and EUCs**
  - Hydraulic Containment
    - Seep Interceptor Trench

        - Groundwater Treatment System Operation
    - Inspect and Maintain Cap
    - LNAPL/Product Skimming
    - LTM
    - MNA
    - EUCs and SWMP

- **Alternative 3 – Alternative 2 Plus MPE**
    - Hydraulic Containment
        - Seep Interceptor Trench
        - Groundwater Treatment System Operation
    - Inspect and Maintain Cap
    - *MPE in Seep IT and Additional ITs*
    - LNAPL/Product Skimming
    - LTM
    - MNA
    - EUCs and SWMP

10.6.3 SPA Alternative 1 – No Additional Action

As required by CAS guidance, the first alternative is the "No Additional Action" alternative to establish a baseline for comparison.

10.6.3.1 <u>Alternative Components</u>. No Additional Action means the cessation of any already implemented controls such as Seep Interceptor Trench (IT) operation, cap maintenance, Groundwater Treatment System, and no EUCs or SWMP

10.6.3.2 <u>Alternative Evaluation Criteria.</u> The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities.

10.6.3.2.1 Overall Protection of Human Health and Environment. No air emissions are generated, land can be reused, and no additional natural resources are required; therefore, from a "green remediation" perspective no additional action rates relatively well. However, no additional action would result in termination of IT operation; therefore, the risk of impacted groundwater and product discharge to WBWR would return. This alternative also does not address future risk pathways, such as 1) contact with impacted soil if an area is excavated for construction or utilities, 2) migration of VOCs into a future building which could (without EUCs) be built on the cap, 3) or contact/ingestion of groundwater; therefore, overall it provides moderate protection of human health and the environment.

10.6.3.2.2 Compliance with ARARs. Chemical-specific ARARs for groundwater would not be achieved for many decades. This alternative does not significantly reduce groundwater or soil

contaminant concentrations because no active remediation is conducted. Natural attenuation processes may be ongoing (not confirmed and would not be confirmed); however, these processes require time and it is unlikely ARARs would be achieved for many decades. No action-specific or location-specific ARARs have been identified for this alternative. Compliance with ARARs is low.

10.6.3.2.3 Long-Term Effectiveness and Permanence. This alternative provides no controls for exposure and no long-term management measures. Potential future exposure risks would remain. Long-term effectiveness and permanence is moderately low.

10.6.3.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. A large amount of waste and impacted soil treatment occurred as part of the IRM pond closure waste consolidation and stabilization work. No additional reduction in toxicity, mobility, or volume of contamination through engineered treatment would occur. Natural attenuation would likely occur but would remain unconfirmed and effectiveness unmonitored. Overall reduction in toxicity, mobility, and volume through treatment would be long term and moderately high.

10.6.3.2.5 Short-Term Effectiveness. No additional action would occur; hence, no risk to on-site workers or the community from that action would exist. However, the immediate resumption of impacted groundwater and possible LNAPL discharge to WBWR, possible installation of drinking water wells by future owners, and uncontrolled digging/building construction (including residential) could result in exposures. The time until CAGs are achieved would be many decades. The overall result is moderate short-term effectiveness.

10.6.3.2.6 Implementability. There would be no construction or technology concerns posed by this remedy and it would be readily undertaken/implemented since no additional action would be taken. However, the ability to monitor the effectiveness of the remedy would be limited since no LTM or site inspections would be completed, resulting in overall moderate implementability.

10.6.3.2.7 Community Acceptance. Much remediation has been completed and if left uncontrolled, the Site would likely be used for recreation with little obvious concern from the public or users. One exception would be if product seeps resumed into the WBWR, which given completed IRM work is unlikely. Those concerned with repair of environmental damage would be unsatisfied with the incomplete restoration. Therefore, overall public acceptance would be moderate.

10.6.3.2.8 Cost. The prior IRM work costs are summarized in Table 10-4. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. Given all the prior Site work, the overall cost is ranked as high.

10.6.4 SPA Alternative 2 – Seep IT, Cap, and EUCs

Alternative 2 includes operation of the current systems and additional measures as summarized below:

- Hydraulic Containment
    - Seep Interceptor Trench
    - Groundwater Treatment System Operation
- Inspect and Maintain Cap
- LNAPL/Product Skimming
- LTM
- MNA
- EUCs and SWMP

10.6.4.1 <u>Alternative Components</u>. The following describe each alternative component:

10.6.4.1.1 Seep Interceptor Trench. This alternative assumes the Seep IT would continue to be operated for 20 additional years to capture groundwater and any trace LNAPL. The Seep IT has been proven effective in containing and recovering not only MPA and SPA area groundwater and LNAPL, but also a portion of the MTBE-impacted groundwater from the northern STF plume. Trench operation includes 1) operation of three ESs including pumps, flow meters, and pressure gauges; 2) monthly inspection of system parameters and ESs; 3) biannual (every 2 years) pressure-jet cleaning of the wells, collection, and conveyance piping; 4) an escrow for equipment (pump, controls, meters, etc.) replacement; 5) and an allowance for annual reporting of the data in the Annual Report. All analytical monitoring is included in the GTS tasks and associated costs.

10.6.4.1.2 Groundwater Treatment System. Continued IT operation requires operation of the newly-installed wetlands-based groundwater treatment system for the same 20-year period as described in Section 10.2.5 – Treatment of Extracted LNAPL and Groundwater.

10.6.4.1.3 Inspect and Maintain Cap. A Post-Closure O&M Plan was presented in the May 2011 *Final (100%) Wastewater/Stormwater Pond Interim Measures Closure Work Plan/Design* and was subsequently approved by the KDHE. Under this Alternative, this plan would continue to be implemented as summarized in Section 5.0 and Table 20 of the Design and as presented below:

West Pond Cap Post-Closure Monitoring Summary					
Monitoring Activity	**Purpose**	**Monitoring Frequency**	**Monitoring Locations**	**Monitoring Method**	**Comments**
Visual Cover Inspection	Visually inspect soil cover surface for ponds, sags, drainage interruptions, surface erosion, and vertical cracking	Annually	North-South and East-West transects at 500 foot spacing	Visual with global positioning system (GPS) location marking	The locations of ponds, sags, drainage interruptions, surface erosion, and vertical cracking shall be located with GPS
Vegetation Inspection	Inspect soil cover for vegetation establishment	Annually	North-South and East-West transects at 500 foot spacing	Visual with GPS location marking	Any areas showing vegetation distress will be clearly defined and identified on a map using GPS
Groundwater Monitoring	Monitor groundwater concentrations downgradient of interceptor collection trench	In accordance with the Semi-Annual Monitoring Plan presented in the *Third Phase Environmental Investigation Report* (MWH, 2009)	Semi-Annual Monitoring Plan presented in the *Third Phase Environmental Investigation Report* (MWH, 2009)	In accordance with the Semi-Annual Monitoring Plan presented in the *Third Phase Environmental Investigation Report* (MWH, 2009)	None

10.6.4.1.4 Product Skimming. The Seep IT would recover any mobile LNAPL, although recently no LNAPL has been detected in the SPA. Historically one or more monitoring wells on the west side of the SPA (nearest the MPA) have contained some product. If this occurs in the future, LNAPL would be manually skimmed from any SPA wells containing LNAPL as described in Section 10.2.3.

10.6.4.1.5 LTM. This alternative includes long-term monitoring (LTM) of groundwater as described in Section 10.2.2. This COC dissolved-phase data would be used to track remedy performance and help determine if/when remedy components can be removed to reduce long-term O&M costs.

10.6.4.1.6 MNA. This alternative conditionally includes monitored natural attenuation (MNA) as described in Section 10.2.4, including the acknowledgement that these are unproven and not assumed in the criteria evaluation/ranking. If confirmed, MNA would ensure dissolved-phase concentrations are decreasing as a result of natural processes.

10.6.4.1.7 EUCs and SWMP. Throughout the evaluation period, this alternative includes the use of EUCs and an SWMP as described in Section 10.2.1. This would provide protection of potential receptors throughout the Site restoration process.

10.6.4.2 <u>Alternative Evaluation Criteria.</u> The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities.

10.6.4.2.1 Overall Protection of Human Health and Environment. The Seep IT has been proven effective at protecting the WBWR. The wetlands-based GTS is low energy and environmentally green remediation. Cap inspections would ensure all stabilized waste remains covered and isolated from the environment. LTM and MNA (if applicable/proven) would track remedial performance. Post-IRM, the SPA has few residual risks; however EUCs would prevent installation of a future drinking water well or disturbance of the cap. Therefore, this alternative provides a very high protection of human health and the environment.

10.6.4.2.2 Compliance with ARARs. Given the deep residual source and continued groundwater flux from the MPA, chemical-specific ARARs for groundwater are not likely to be achieved for several decades. The WBWR is protected and associated surface water ARARs met. Free product is addressed. The only action-specific ARAR is effluent monitoring of the system for NPDES purposes and maintenance of the cap in accordance with the post-closure plan as required by KDHE guidance. Net overall compliance with ARARs is very high.

10.6.4.2.3 Long-Term Effectiveness and Permanence. The magnitude of the residual risk after all remedial actions are complete would be low. Given the time frame until these actions are complete, the remedy incorporates robust institutional controls (e.g., EUC and SWMP) to adequately and reliably protect receptors during the remediation period. Long-term effectiveness and permanence is high.

10.6.4.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. Groundwater and product extraction eliminate contaminant mass and control mobility through treatment. Overall reduction of source mass toxicity, mobility and volume would be completed through MNA (if confirmed). Given the biodegradability of petroleum contamination and these processes, significant reduction in toxicity, mobility, and volume would be achieved; therefore, the overall rating is moderately high.

10.6.4.2.5 Short-Term Effectiveness. The community and workers would be protected from COC exposure during implementation of the remedy. On-site exposure to COCs would be prevented by the prior remedial action, EUCs, and SWMP. Off-site exposures would be prevented because all receptors are protected and all proposed remedy components are primarily destructive in nature, biodegrading contaminants (e.g., wetlands water treatment and MNA) rather than transferring them to another media (e.g., air stripping, SVE, or MPE) or

transferring them from one location to another (e.g., excavation and landfilling). Given this and the low power consumption required, the environmental impacts of implementing the remedy are very low. The time until CAGs are achieved is long. Overall short-term effectiveness is high.

10.6.4.2.6 Implementability. The reliability of and the ability to construct the technologies/systems is very high because engineered components are already in place and an EUC is anticipated. Additional remedial action (e.g., contingency ISOC or similar injections) is easily undertaken. The ability to monitor the remedy is high (e.g., LTM and EUC inspections) and the ability to obtain approval from all agencies is anticipated to be very high based upon past conversations and lack of permitting needs. Overall implementability for this remedy is very high.

10.6.4.2.7 Community Acceptance. Millions of dollars of remediation have been completed, including transformation of oily wastewater ponds into wetlands. Seeps to the WBWR have been contained. No large amounts of truck traffic, dust, or VOC emissions are proposed for any of these alternative components. Given this, overall public acceptance is anticipated to be high.

10.6.4.2.8 Cost. The prior IRM work costs and the additional cost of this alternative, including both initial capital and O&M, are summarized in Table 10-4. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The overall cost is high.

10.6.5 AHA Alternative 3 – MPE/Biovent and Cap

Alternative 3 is the same as Alternative 2 with the exception that the Seep IT is converted to MPE and 2 additional MPE trenches are installed in accelerate contaminant mass removal:

- Hydraulic Containment
    - Seep Interceptor Trench
    - Groundwater Treatment System Operation
- Inspect and Maintain Cap
- LNAPL/Product Skimming
- MPE
    - Seep Interceptor Trench (converted to MPE)
    - Two New MPE/Biovent Trenches
    - Groundwater Treatment System Operation
- LTM
- MNA
- EUCs and SWMP

10.6.5.1 <u>Alternative Components</u>. Given the similarity to Alternative 2, only the differences are discussed: Two 1,400-foot long trenches would be installed to fractured bedrock as shown

in Figure 10-8. Both ITs would run northwest to southeast perpendicular to groundwater flow. One would be located in the clean soil (former central pond berm) area between the wetlands and the capped West Ponds and the other would be located immediately west of the capped West Ponds, paralleling the railroad. Perforated pipe would be installed across the bottom, and an ES would be installed in the low points and the trench (assumed 3 per trench for a total of 6). The trench would then be backfilled with 5 feet of gravel and well-compacted excavated soil. Within each ES, a 10-foot deep pump sump would be drilled into bedrock to permit full dewatering of the trenches with water and any entrained tar conveyed to the groundwater treatment system through a connection at the MPA Basin IT. A single electric submersible pump in each ES would be used to remove entrained product (if any) and groundwater. Any recovered water would have been recovered by the Seep IT; therefore, no additional GTS O&M costs are assumed.

The six new multi-phase extraction (MPE) ESs and three existing Seep IT ESs would be connected with 2-inch piping to a rotary lobe vacuum blower. This alternative assumes the trenches could be sufficiently dewatered to expose the permeable weathered rock zone, and that the vacuums would induce air flow through this deep layer, expediting remediation through COC volatilization and biodegradation associated with MPE. However, it is possible that either routinely or during wet seasons, dewatering of the weathered rock beyond the immediate vicinity of the trench would not be possible. Vapor flow would then become very limited in quantity and extent, and the trenches would primarily serve to reduce the groundwater flux to the Seep IT. Alternatively, the system would also be configured to permit reversal of blower to inject air into one or both new trenches (the Seep IT would always remain an extraction trench) to initiate either biovent if the trench is sufficiently unsaturated, or low pressure biosparge through the weathered rock zone.

10.6.5.2 Alternative Evaluation Criteria. The alternative is evaluated against the following eight criteria. The baseline for comparison of all alternatives is prior to implementation of any Site restoration work, including the recently completed IRM activities. Only the differences compared to Alternative 2 are noted for brevity:

10.6.5.2.1 Overall Protection of Human Health and Environment. The two additional MPE trenches and conversion of the Seep IT to MPE would enhance treatment of the primary zone of residual contamination remaining in the SPA, the deep several-foot thick weathered rock interval. However, effectiveness is uncertain given the reliance on near-complete dewatering of the normally saturated zone to induce vapor flow and resulting aeration/biodegradation. The Seep IT already provides adequate WBWR protection; therefore, the overall *increase* in environmental protection is modest, remaining very high.

10.6.5.2.2 Compliance with ARARs. MPE would accelerate obtainment of all ARARs, including chemical-specific ARARs; however, given weathered and fractured rock, final COC reductions to ARAR standards are still likely to rely on long-term natural processes after costly MPE operation is terminated. Also, some recontamination from the MPA groundwater is likely

once MPE is terminated; therefore, overall ARAR compliance would not be appreciably changed and remains very high.

10.6.5.2.3 Long-Term Effectiveness and Permanence. The magnitude of the residual risk after all remedial actions are complete would be very low. Given the time frame until these actions are complete, the remedy incorporates robust institutional controls (e.g., EUC and SWMP) to adequately and reliability protect receptors during the remediation period. Long-term effectiveness and permanence is very high.

10.6.5.2.4 Reduction in Toxicity, Mobility, & Volume of Contamination through Treatment. A large reduction in toxicity, mobility, and volume would be achieved and accelerated through MPE operation (if implementable); therefore, the overall rating is very high.

10.6.5.2.5 Short-Term Effectiveness. The community and workers would be protected from COC exposure during remedy implementation, although MPE vapor emissions and worker exposure to mechanical treatment pose a slightly increased risk. Protection of the WBWR would be slightly enhanced, although most would be protection redundant with the Seep IT. The time until CAGs are achieved is still long. Overall short-term effectiveness is high.

10.6.5.2.6 Implementability. One or both new trenches would likely require bioslurry installation to prevent collapse during excavation as a result of silty seams and wetlands water saturation; however, this is readily done. Full MPE implementation (adequate vapor flow) is uncertain given the uncertain degree of dewatering that could be achieved at various times of the year. However, overall implementability for this remedy remains high.

10.6.5.2.7 Community Acceptance. This would be very protective of human health and the environment (including WBWR); therefore, overall public acceptance is anticipated to be very high.

10.6.5.2.8 Cost. The prior IRM work costs and the additional cost of this alternative, including both initial capital and O&M, are summarized in Table 10-4. Detailed costs for each remedy component are included in Appendix D and are arranged in three groups: 1) IRM costs, 2) remedy costs shared among the AOCs, and 3) AOC-specific costs. The overall cost is very high.

10.7 OFF-SITE AREAS (OSA)

In each AOC section above (MPA, AHA, STF, and SPA), abatement of off-site plume migration was discussed. These concerns were incorporated into the components, costs, and evaluation of each of the proposed remedies; therefore, a detailed evaluation is not repeated in this section. However, given the importance of protecting these off-site areas (OSA), the potential

concerns and proposed protective measures are briefly summarized and supplemental protections and contingency measures are discussed. For brevity, the following assumes Alternative 2 or 3 are selected for each AOC, all of which are protective of off-site receptors identified below:

10.7.1 STF DRO-Plume East of North Topeka St

A small lobe from the south STF TPH-DRO dissolved-phase plume extends across North Topeka Street near the creek onto 1220 North Topeka Street and 1210 North Topeka Street. Alternative 3 proposes an additional trench be placed to intercept the TPH-DRO plume. Alternative 2 does not propose this because 1) TPH-DRO is heavier-end petroleum that is relatively immobile and this portion of the plume is low concentration; 2) no drinking water wells are currently located near this area and a well is not likely to be installed given access to City water; and 3) given the age of the plume, additional migration is unlikely. Regardless of the selected Alternative, the following would be included in the overall Site remedy:

- **Additional Protective Measures – Well Survey:** A well survey within the off-site area that, based on isoconcentration contours, is estimated to exceed half of the TPH-DRO RBSL standard would be completed annually until all off-site monitoring wells remain below RBSL Standards for 3 years. LTM of these wells would continue unless/until the KDHE approves changes to the LTM plan.
- **Contingency Action**: If a water well is found within this well survey area, the contingency action for Alternative 2 would be to abandon the well or install the Alternative 3 trench along the eastern STF property line. Also, granular activated carbon (GAC) treatment of the water, EUCs, and/or ISCO of the area may be implemented in cooperation with the KDHE, based upon the actual risks.

10.7.2 Northern Residential Area

The majority of the benzene, MTBE, benzene, TPH-GRO, and TPH-DRO dissolved-phase plumes that migrate from the southeast corner of the MPA and northeast corner of the STF across North Topeka Street reside on property owned by EPME-PC; however, a portion of each of those plumes currently extends onto two neighboring properties: 1728 and 1730 North Topeka Street (one parcel with two houses, and 1620 North Topeka Street. Both Alternatives 2 and 3 include installation of an interceptor trench just north (upgradient) of the boundary with the EPME-PC-owned property to halt off-site migration and pull back the existing plume. Data suggest that, in this area, no soil impacts above standards are present and that all contamination is from a dissolved-phase plume (no LNAPL or LNAPL trapped in soil); therefore, it is believed the plumes would rapidly collapse (within a few years) once the trench is operational. However, until that time, the following would be included in the remedy:

- **Additional Protective Measures – Vapor Survey**: A sub-slab vapor survey for two houses located at 1728 and 1730 North Topeka Street is planned in the near-future. It is

assumed no impacts will be discovered; however, if any risks are identified, contingency actions would be implemented including possible sub-slab vapor sampling at 1620 North Topeka which is located further down gradient from the Site.

- **Contingency Action for Vapor Intrusion**: Various remedies exist based upon the type of vapor intrusion risk(s) identified, but may include a sub-slab vacuum depression system such as those used for radon abatement. EPME-PC would work with the KDHE and the property owners to identify prudent and acceptable protective measures and future monitoring requirements if such a risk is identified.
- **Additional Protective Measures – Well Survey**: An annual well survey would be completed within the off-site area that, based on isoconcentration contours, is estimated to exceed half of the MTBE, benzene, TPH-GRO, or TPH-DRO RSK RBSL standard. The annual survey would continue until all off-site monitoring wells (e.g., MW-133) and the on-site boundary wells (MW-132, MW-111, and MW-112) remain below RSK Standards for 3 years. LTM of these wells would continue unless/until the KDHE approves changes to the LTM plan.
- **Contingency Action for Water Wells**: If a water well is found within this area, groundwater extraction rates would be increased, if possible, in the boundary interceptor trench. In addition, GAC treatment of the well water, EUCs, and/or ISCO of the area may be implemented in cooperation with the KDHE, based upon the actual risks.

10.7.3 Union Tank Car

The dissolved-phase plumes discussed in the prior section (10.7.2) also migrate onto the Union Tank Car property. They merge with a chlorinated plume originating on the Union Tank Car property, consisting of mostly of trichloroethene (TCE), dichloroethene (DCE), trichloroethane (TCA), dichloroethane (DCA), and vinyl chloride (VC). The proposed interceptor trenches would stop the off-site migration of the EPME-PC plumes. Given the Union Tank Car chlorinated contamination and that KDHE-BER is overseeing the project, no drinking water wells would be installed in this area until all contaminants are removed from this site; therefore, no additional protective action is required. EPME-PC would coordinate operation of the trench with the KDHE and Union Tank Car to facilitate implementation of their site remedy. For example, the readily degraded and low-dissolved-oxygen-petroleum plumes may be found to benefit anaerobic biodegradation of the chlorinated plumes. It is also possible increased or decreased groundwater flux (trench pumping rate decrease/increase) may benefit implementation of a remedy such as ISCO or SVE.

10.7.4 West Branch of the Walnut River

The MPA Basin IT and proposed STF NE Plume IT would assist the Seep IT to provide adequate protection of the WBWR. These are proposed to continue operation in both Alternatives 2 and 3. Semi-annual seep inspections along the river bank would be completed

and results reported in the Annual Report as long as requested by the KDHE. If the remedy fails in the future, installation of a new or additional trench or extraction sumps may be required.

10.7.5 Pester Burn Pond Site

Given the groundwater flow contours induced by the MPA Channel IT, MPA Basin IT, and Seep IT, it can be argued that all MPA-impacted groundwater is captured by the existing system; however, it is possible a portion of northern MPA plume crosses the Pester Burn Pond site. This site has EUCs and a hydraulic containment system that is likely to operate as long as the MPA systems; therefore, no additional measures are required at this time. If conditions change, the MPA Channel IT could be extended.

11.0 RECOMMENDED CORRECTIVE ACTIONS

The recommended corrective actions for each AOC are discussed in this section.

11.1 ALTERNATIVE SUMMARIES

The remedial components of each alternative are restated for review and ease of reference:

11.1.1 Main Process Area (MPA)

- **Alternative 1 – No Additional Action**
  - No additional action beyond the already-completed IRM remediation.
- **Alternative 2 – ITs and Phytoremediation**
  - Hydraulic Containment
    - MPA Channel IT, MPA Basin IT, Seep IT Continued Operation
    - Groundwater Treatment System Continued Operation
  - MPA Spring System Continued Operation
  - LNAPL/Product Skimming
  - Phytoremediation
  - LTM
  - MNA and NSZD (if confirmed)
  - EUCs and an SWMP
- **Alternative 3 – Seep IT and Excavation**
  - Hydraulic Containment
    - Seep IT Continued Operation
    - Groundwater Treatment System Continued Operation
  - Excavate and Landfarm All Impacted Soil/Weathered Rock to Bedrock
  - Replacement MPA Spring Collection and Treatment System
  - LTM
  - MNA (if confirmed)
  - EUCs and an SWMP

11.1.2 Asphalt Handling Area (AHA)

- **Alternative 1 – No Additional Action**
  - No additional action beyond the already-completed IRM activities
- **Alternative 2 – MPA Spring, Basin IT, Plus**
  - Groundwater/Product Recovery and Treatment
    - <u>MPA Spring System</u> - Asphalt in rock fractures is either immobile or, similar to AHA groundwater, flows to the MPA Spring.

        - MPA Basin IT – AHA impacted groundwater (if any exists) not captured by the MPA Spring is captured by this trench.
        - Groundwater Treatment System (GTS) Operation
    - LTM
    - MNA (if confirmed)
    - EUCs and SWMP

- **Alternative 3 – Additional Interceptor Trenches**
    - Groundwater/Product Recovery and Treatment
        - MPA Spring Operation – Same as Alternative 2
        - MPA Basin IT Operation – Same as Alternative 2
        - Additional ITs along east side of AHA and west side of MPA
        - GTS Operation
    - LTM
    - MNA (if confirmed)
    - EUCs and SWMP

11.1.3 South Tank Farm (STF)

- **Alternative 1 – No Additional Action**
    - No additional action beyond the already-completed IRM remediation.
- **Alternative 2 – Waste Excavation and Containment**
    - Excavate, Stabilize, and Dispose of Known Waste (on-site or off-site)
    - Hydraulic Containment
        - MPA Basin Interceptor Trench Continued Operation
        - STF NE Plumes Interceptor Trenches
        - GTS Operation
    - STF Creek Surface Water Sampling and Contingency Interceptor Trenches
    - LNAPL/Product Skimming
    - LTM
    - MNA and NSZD (if confirmed)
    - EUCs and SWMP
- **Alternative 3 – Source Excavation, Large-Scale Containment, and MPE**
    - Excavate, Stabilize, and Dispose of Waste (will evaluate on-site or off-site)
    - Hydraulic Containment
        - MPA Basin Interceptor Trench Continued Operation
        - STF NE Plumes Interceptor Trenches
        - STF Creek Interceptor Trench (south bank)
        - SE North Topeka St Interceptor Trench
        - GTS Operation
    - Spot-Excavate Source Area Soil
    - MPE (from excavation floor gallery)

    - LTM
    - MNA and NSZD (if confirmed)
    - EUCs and SWMP

11.1.4 Stormwater Pond Area (SPA)

- **Alternative 1 – No Additional Action**
    - No additional action beyond the already-complete IRM activities
- **Alternative 2 – Seep IT, Cap, and EUCs**
    - Hydraulic Containment
        - Seep Interceptor Trench
        - Groundwater Treatment System Operation
    - Inspect and Maintain Cap
    - LNAPL/Product Skimming
    - LTM
    - MNA
    - EUCs and SWMP
- **Alternative 3 – MPE and Cap Maintenance**
    - Hydraulic Containment
        - Seep Interceptor Trench
        - Groundwater Treatment System Operation
    - Inspect and Maintain Cap
    - *MPE in Seep IT and Additional Trenches*
    - LNAPL/Product Skimming
    - LTM
    - MNA
    - EUCs and SWMP

11.2 CORRECTIVE ACTION GOALS

The site-wide CAGs are also re-stated for ease of review and reference:

1. Address wastes, including maintenance of the capped West Ponds.
2. Address practically recoverable LNAPL.
3. Control migration of contaminants from soils that hinder achieving groundwater ARARs.
4. Prevent off-site migration of dissolved-phase plumes or LNAPL.
5. Prevent further degradation of the aquifer.
6. Protect the WBWR and the intermittent STF Creek.
7. Prevent exposure to all soil, soil vapors, and groundwater exceeding RBSLs.
8. Restore groundwater to its most beneficial use.

11.3 ALTERNATIVES COMPARISON

The criteria, ranking, and brief synopsis of the rationale discussed in detail in Section 10 are briefly summarized in Tables 11-1 through 11-4 for the MPA, AHA, STF, and SPA, respectively. In italics below each main criterion are subcomponents United States Environmental Protection Agency (USEPA) recommends for consideration in *Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA*, October 1988. The qualitative rankings range from "very low" to "very high".

The alternatives were arranged to present the baseline comparison No Additional Action alternative as Alternative 1, which is followed by a protective Alternative 2 that builds on the IRM work, continuing installed-system operation, and adding additional protective and remedial components. Each Alternative 2 included aggressive protections to the public, Site workers, and the environment during implementation; therefore, the components of each Alternative 3 were selected to include those protective measures but also to include additional components to remove more contaminant mass more rapidly than Alternative 2. Typically the "No Action" alternative ranks lowest, and that is the case here too; however, because much work was completed as part of the IRM, Alternative 1 "No Additional Action" ratings are higher than they would have been had no IRM work been completed.

For brevity, the following presents generalizations that are shared among the alternatives across the four AOCs. More detail is provided in Tables 11-1 through 11-4 and in Section 10:

- **Overall Protection of Health and the Environment**: As implied by the name, this criterion is a summary of the overall protectiveness of the remedy and hence incorporates considerations from many of the other criteria, including Compliance with ARARs; Long-Term Protectiveness and Permanence; Reduction in Toxicity, Mobility, and Volume through Treatment; and Short-Term Effectiveness. Given the already-complete IRM work, even Alternative 1 ranks in the Moderate range for each AOC. Each Alternative 2 and Alternative 3 ranks similarly as High to Very High for protectiveness, because even if a remedy takes more time to complete, high protectiveness can still be maintained throughout.
- **Compliance with ARARS**: There are few Action-Specific or Location-Specific ARARs for consideration and, when present, no large obstacles to compliance would be anticipated; therefore, most of the ranking is controlled by compliance with Chemical-Specific ARARs. The rate at which ARARs (and other considerations) are achieved is assessed under Short-Term Effectiveness; therefore, this assessment includes if, and the level of certainty that, the standards can be met by the alternative components. With the exception of AHA (where very little containment mass remains and it contains few COCs), each Alternative 1 ranks Low because of the lack of data to confirm compliance and lack of additional measures to further reduce COC

concentrations in soil and groundwater. Conversely, there is High to Very High certainty the ARARs can eventually be met for all Alternative 2s and 3s.

- **Long-Term Effectiveness**: This criterion addresses the results of a remedial action in terms of the risk remaining at the Site after the RAOs have been met. The primary focus of this evaluation is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals (e.g., stabilized sediment/waste) and/or untreated wastes. Each Alternative 1 (with the exception of the AHA) ranks Moderately Low, primarily because of the lack of institutional controls such as EUCs and SWMP and lack of monitoring ability to assess those residual risks. All Alternatives 2s and 3s rank either High or Very High because the treatment residuals are low, there is no untreated waste, and measures are implemented to provide protections from those residuals.
- **Reduction in Toxicity, Mobility and Volume Through Treatment**: This evaluation criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce toxicity, mobility, or volume of the hazardous substances as their principal element. Even if MNA and NSZD depletion are confirmed, that are not considered treatment (e.g., engineered) for this criterion. The most variance occurs within each Alternative 1 with a Low rating being provided the STF because no treatment would occur to Moderately High rankings being given to the MPA, AHA, and SPA areas given the large reductions in waste and soil/groundwater treatment that has occurred in those areas during the IRM.
- **Short-Term Effectiveness**: This evaluation criterion addresses the effects of the alternative during the construction and implementation phase until remedial action objectives (RAOs) are met. Each Alternative 1 provides only Low to Moderate protection of the public and Site workers because of the lack of EUCs and SWMP and similar for environmental protection because of the lack of Seep IT and MPA Basin IT operation.

  The ranking for Alternative 2s and 3s become more complex: More contaminant mass is removed more rapidly under each Alternative 3, hence the exposure-risk time period is reduced. However, each Alternative 3 involves action that increases health and environmental risks, such as excavation and landfarming with VOC vapor off-gassing, risk of stormwater impacts, and possible dust migration. Landfilling of impacted weathered rock and wastes would involve a large amount of heavy truck traffic with associated pedestrian and vehicular death risks. Also, landfilling transfers the contaminant mass to a different location rather than biologically destroying it in-situ. Even MPE requires electricity with associated power plant emissions for many years, and the system discharges VOCs to the atmosphere, increasing short-term exposure risks. Given the low risks associated with each Alternative 2, the net effect was a similar ranking of High or Very High for all Alternative 2s and 3s.
- **Implementability**: The implementability criterion addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required during its implementation. No Additional Action is readily implemented since nothing is required; however, the criterion also includes the

"ability to monitor effectiveness", which with no monitoring program, means each Alternative 1 ranks as Moderate. None of the technologies evaluated in each of the Alternative 2s and 3s included anything unproven, difficult to construct, permit, or for which to obtain materials; therefore, rankings were similar, ranging from High to Very High.

- **Community Acceptance**: This assessment evaluates the issues and concerns the public may have regarding each of the alternatives. This is difficult to assess in that some people could be very focused on removal of the maximum amount of contaminant mass from the Site, regardless of the resulting environmental impacts. Others may be concerned about noise, dust, truck traffic, and VOC emissions in their neighborhood and future possible exposures to their children. Others may be happy simply eliminating an eyesore and restoring the land to productive use. Given the IRM work/current condition of the Site but still-remaining risks if left unprotected, each Alternative 1 was ranked as Moderate. Similarly, given the trade-offs in various types of health-risks, each Alternative 2 and 3 ranked High to Very High.
- **Cost**: Cost is always an important consideration. Site restoration activities completed to date have costed more than $20.4 million. The *additional* cost for all Alternative 2s is $7.6 million and for all Alternative 3s it is $70 million.

11.4 ALTERNATIVE RECOMMENDATION

Even although much work has already been completed, EPME-PC believes No Additional Action (Alternative 1s) does not provide sufficient future protection to the public, Site workers, and environmental receptors; therefore, no Alternative 1s are recommended for selection. The choice between each Alternative 2 and Alternative 3 is more complex:

- **MPA**: The primary difference between Alternative 2 and 3 for the MPA is, respectively, a phytoremediation-based approach versus excavation. Similar to other technologies such as SVE/AS and chemical oxidation, the logistics of implementing an excavation become impractical at the scale, contaminant mix, and subsurface geology/structures of the MPA. For excavation, some of those considerations involve risks to both on-site workers and residents from vapor emissions/exposures and the large volumes of truck traffic with related risk of vehicular accidents. When compared against the additional time required for phytoremediation to treat the same contaminant mass, EPME-PC believes phytoremediation is the better approach.
- **AHA**: The primary difference in alternatives for the AHA is the addition of interceptor trenches to accelerate the removal of asphaltic tar from the fractured bedrock. All mobile tar would otherwise be eventually recovered and treated by the MPA Spring system. Given the slow migration and limited risks posed by of the viscous tar, EPME-PC believes the additional trenches would provide nominal benefit and are not recommended.

- **STF**: The STF has several sub-areas but the primary difference of approach is Alternative 3 adds 1) excavations to rapidly remove source mass, 2) MPE to enhance product recovery and accelerate soil treatment, and 3) additional interceptor trenches to reduce the risk of plume migration, either to the STF Creek or off-site. However, these components only slightly reduce exposure risks (already very low under Alternative 2) and given the size of the STF, only modestly accelerate achievement of ARARs. EPME-PC believes the protections and contingencies of Alternative 2 are sufficient.
- **SPA**: Most environmental issues within the SPA area have been addressed; therefore, the primary difference between Alternative 2 and 3 is how quickly the residual smear zone from past MPA LNAPL migration is addressed. The MPE trenches of Alternative 3 would further reduce risk of groundwater reaching the WBWR; however, given both Seep IT and MPA Basin IT operation, this risk from and quantity of any residual groundwater flux is already extremely low. Multi-phase extraction (MPE) should both vaporize and accelerate biodegradation of additional source mass during periods of low groundwater, as would biovent during periods when the weathered rock zone was saturated; however, risks to human health and the environment remain nearly the same, especially given the residual upgradient MPA source mass.

Given the comparable criteria ranking, substantial work completed to date, and that each Alternative 2 meets all Site Corrective Action Goals (CAGs), EPME-PC does not believe the much higher costs of the Alternative 3 technologies are warranted; and therefore, recommends selection of Alternative 2 for each AOC. Table 11-5 summarizes the combined recommended actions. Table 11-6 summarizes the cost of these actions.

12.0 REFERENCES

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TABLES

TABLE 3-1
SUMMARY OF RISK ASSESSMENT FINDINGS
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Receptor	Exposure Scenarios	Exposure Area 1: MPA		Exposure Area 2: AHA		Exposure Area 3: STF		Exposure Area 4: Off-Site (Former Residential Property Owned by EPME-PC)		Exposure Area 5: Off-Site (Residential Area)	
		Cumulative Cancer Risk (RME)	Cumulative Hazard Index (RME)	Cumulative Cancer Risk (RME)	Cumulative Hazard Index (RME)	Cumulative Cancer Risk (RME)	Cumulative Hazard Index (RME)	Cumulative Cancer Risk (RME)	Cumulative Hazard Index (RME)	Cumulative Cancer Risk (RME)	Cumulative Hazard Index (RME)
Full-time Indoor Workers	Exposure to surface soil (0-2 feet bgs) via incidental ingestion, direct dermal contact, and inhalation of dust and vapors in outdoor air; exposure to combined surface and subsurface soil (0-10 feet bgs) and groundwater via inhalation of vapors released from soil and groundwater to indoor air.	3×10^{-3}	33	2×10^{-4}	4	3×10^{-3}	81	N/A	N/A	N/A	N/A
Full-time Outdoor workers	Exposure to surface soil (0-2 feet bgs) via incidental ingestion, direct dermal contact, and inhalation of dust and vapors in outdoor air.	7×10^{-6}	0.7	5×10^{-5}	0.007	7×10^{-6}	0.1	N/A	N/A	N/A	N/A
Part-time Outdoor Workers	Exposure to surface soil (0-2 feet bgs) via incidental ingestion, direct dermal contact, and inhalation of dust and vapors in outdoor air.	2×10^{-6}	0.2	1×10^{-5}	0.002	2×10^{-6}	0.03	N/A	N/A	N/A	N/A
Full-time Excavation Workers	Exposure to combined surface and subsurface soil (0-10 feet bgs) via incidental ingestion, direct dermal contact, & inhalation of dust/vapors.	4×10^{-5}	15	6×10^{-6}	0.1	6×10^{-6}	6	N/A	N/A	N/A	N/A
	Exposure to vapors from groundwater.							6×10^{-7}	0.3	9×10^{-8}	0.1
Trespassers	Exposure to surface soil (0-2 feet bgs) via incidental ingestion, direct dermal contact, and inhalation of dust/vapors in outdoor air.	1×10^{-5}	0.7	8×10^{-5}	0.004	1×10^{-5}	0.04	N/A	N/A	N/A	N/A
Residents	Exposure to surface soil (0-2 feet bgs) via incidental ingestion, direct dermal contact, and inhalation of dust/vapors in outdoor air; exposure to groundwater via ingestion; exposure to combined surface and subsurface soil (0-10 feet bgs) and groundwater via inhalation of vapors released from soil to indoor air.	1×10^{-1}	2,200	2×10^{-3}	7	2×10^{-2}	434	N/A	N/A	N/A	N/A
	Exposure groundwater via ingestion (drinking water scenario), incidental ingestion (kiddie pool scenario) and dermal contact (kiddie pool scenario).	N/A	N/A	N/A	N/A	N/A	N/A	2×10^{-3}	26	N/A	N/A

TABLE 3-1
SUMMARY OF RISK ASSESSMENT FINDINGS
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Receptor	Exposure Scenarios	Exposure Area 1: MPA		Exposure Area 2: AHA		Exposure Area 3: STF		Exposure Area 4: Off-Site (Former Residential Property Owned by EPME-PC)		Exposure Area 5: Off-Site (Residential Area)	
		Cumulative Cancer Risk (RME)	Cumulative Hazard Index (RME)	Cumulative Cancer Risk (RME)	Cumulative Hazard Index (RME)	Cumulative Cancer Risk (RME)	Cumulative Hazard Index (RME)	Cumulative Cancer Risk (RME)	Cumulative Hazard Index (RME)	Cumulative Cancer Risk (RME)	Cumulative Hazard Index (RME)
Residents (cont'd)	Exposure to groundwater via ingestion (drinking water scenario), assuming that a hypothetical domestic well was placed immediately adjacent to Topeka Street in the area of groundwater contamination.	N/A	N/A	N/A	N/A	N/A	N/A	4×10^{-4}	7	4×10^{-4}	7
Recreators	Exposure to creek sediments via incidental ingestion and direct dermal contact.	N/A	N/A	N/A	N/A	2×10^{-6}	0.2	N/A	N/A	N/A	N/A
School Assessment (Based on most sensitive age group 0-6 year old child)	Exposure to surface soil (0-1 feet bgs) via direct dermal contact and incidental ingestion, and inhalation of dust and airborne VOCs released from those soils.	N/A	N/A	N/A	N/A	7×10^{-6}	0.9	N/A	N/A	N/A	N/A

Notes:
RME = Reasonable Maximum Exposure.
MPA = Main Process Area.
AHA = Asphalt Handling Area.
STF = South Tank Farm.
N/A = Not applicable.
bgs = Below ground surface.

TABLE 5-1
SUMMARY OF ARARs AND TBCs
FORMER COASTAL REFINERY, EL DORADO, KANSAS

FEDERAL POTENTIAL ARARs			
Citation	**Description**	**Category**	**Comment**
Archaeological and Historic Preservation Act of 1974 (16 U.S.C. § 469 et seq.)	Provides for the preservation of historical or archaeological data which might be destroyed or lost as the result of 1) flooding, building of access roads, relocation of railroads and highways, and other alterations of terrain caused by the construction of a dam by government or persons, or 2) alteration of terrain caused by Federal construction projects or federally licensed activity or program.	Not Applicable, Relevant, or Appropriate	Will be applicable if construction projects or alteration of terrain at a site have the potential to destroy historical or archaeological materials.
Clean Air Act (CAA) 42 U.S.C. § 7401 et seq. as amended in 1977 and 1990 Standards of Performance for New Stationary Sources (40 CFR 60) National Emission Standards for Hazardous Air Pollutants (40 CFR 61) National Emission Standards for Hazardous Air Pollutants for Source Categories including Site Remediation (40 CFR 63)	Regulates air emissions from area, stationary, and mobile sources. Authorizes EPA to establish National Ambient Air Quality Standards. Identifies standards of performance for new stationary sources of air emissions. Provides emission guidelines and compliance times. Identifies emission standards for specific hazardous air pollutants. Identifies emission standards for hazardous air pollutants that originate from specific categories of sources including site remediation.	**Applicable** For some remedial alternatives considered	May be applicable if remedial actions result in emissions of contaminants to the air. Will be applicable for new stationary sources of air emissions. Will be applicable if the identified hazardous air pollutants are emitted from a site. Will be applicable if the identified hazardous air pollutants are emitted from a specific source category that has been identified.
Clean Water Act (CWA) of 1977 33 U.S.C. § 1251et seq. as amended in 1987 National Pollutant Discharge Elimination System (NPDES) (40 CFR 122) Storm Water Discharge Requirements NPDES (40 CFR 122.26) Federal Water Quality Standards (40 CFR 131) General Pre-treatment Regulations for Existing and New Sources of Pollution for Publicly Owned Treatment Works (40 CFR 403)	Implements a system to impose effluent limitations on, or otherwise prevent, discharges of pollutants into any waters of the United States from any point source. Regulates discharges of pollutants from any point source into waters of the United States Provide requirements to obtain a permit to discharge to the storm water sewer system under the NPDES program Establishes methods and requirements for states in the development of ambient water quality criteria for the protection of aquatic organisms and/or the protection of human health. Provides effluent limitations and guidelines for existing sources, standards of performance for new sources, and pre-treatment standards for new and existing sources.	**Applicable** For all remedial alternatives considered	Will be applicable if discharges to streams, rivers, or lakes occur from a site. Will be applicable if water from the site will be discharged onto land or into streams, rivers or lakes. Will be applicable if the site has storm water that comes in contact with construction or industrial activity or if the selected remedy involves discharge of treated water to surface waters. May be indirectly applicable to surface water remediation and is directly applicable to surface water discharges. Will be applicable if wastewater from a site is discharged to a Publicly Owned Treatment Works (POTW).
Clean Water Act (CWA) of 1977 Wetlands Protection (40 CFR 22, 40 CFR 230 to 233, and 33 CFR 320 to 330)	Allows for permitting of discharge of dredged or fill material to the waters of the United States if no practicable alternatives exists that are less damaging to the aquatic environment. Applicants must demonstrate that the impact to wetlands is minimized.	Not Applicable, Relevant, or Appropriate	Will be applicable if designated wetlands are impacted by a remedy.
Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980 42 U.S.C. § 9601 et seq. as amended by the Superfund Amendments and Reauthorization Act (SARA) of 1986 National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (40 CFR 300) 40 CFR 300.440	Enacted to provide Federal authority to respond directly to releases or threatened releases of hazardous substances that may endanger public health and the environment. Established a trust fund (i.e., Superfund) to provide for cleanup when no responsible party is identified. Provides for liability of persons responsible for releases of hazardous substances. Established prohibitions and requirements concerning closed and abandoned hazardous waste sites. Federal government's blueprint for responding to spills or releases of oil and hazardous substances. Establishes procedures for planning and implementing off-site response actions.	Not Applicable, Relevant, or Appropriate	Will be applicable if the site is on the EPA National Priorities List (NPL). May be applicable for any site where a release of hazardous substances has occurred. Formally referred to as the "off-site rule" wherein required to determine compliance status of the disposal facility.
Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 (42 U.S.C. § 11001 et seq.)	Designated to help local communities protect public health, safety and the environment from chemical hazards. Enables states and communities to prepare to respond to unplanned releases of hazardous substances. Requires facilities at which hazardous substances are present to report the presence of these materials to emergency responders. Requires companies to report the release of hazardous substances.	Not Applicable, Relevant, or Appropriate	Will be applicable if hazardous chemicals are stored or used at a facility.
Endangered Species Act of 1973 (7 U.S.C. § 136; 16 U.S.C. § 460 et seq.)	Provides a program for conservation of threatened and endangered plants and animals and the habitats in which they are found.	Not Applicable, Relevant, or Appropriate	Will be applicable if threatened or endangered species, or their habitats are present at or near a site.
Explosives (18 U.S.C. § 847)	Regulates commerce in explosives. Requires licensing and permitting, record keeping and reporting for purchase and use of explosives. Provides standards for storage of explosive materials.	Not Applicable, Relevant, or Appropriate	Will be applicable if explosives are purchased, stored or used at a site. Will be applicable if hazardous materials are transported to or from a site.
Federal Hazardous Materials Transportation Law (49 U.S.C. § 5101 et seq.)	Regulates the transportation of hazardous wastes and hazardous substances by aircraft, railcars, vessels, and motor vehicles. Requires employers to train, test and maintain training records for all hazmat employees.	**Applicable** for free product disposal and some alternatives	Will be applicable if hazardous materials are transported to or from a site.

TABLE 5-1
SUMMARY OF ARARs AND TBCs
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Citation	Description	Category	Comment
Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1972 (7 U.S.C. § 136 et seq.)	Provides Federal control of pesticide distribution, sale and use. Allows EPA to study the consequences of pesticide use. Requires users of pesticides to take exams for certification as applicators of pesticides. Pesticide users must register purchases of these materials.	Not Applicable, Relevant, or Appropriate	May be applicable if pesticides were distributed, sold or used at a site.
Fish and Wildlife Conservation Act (16 U.S.C. § 2901 to 2911)	Action to conserve fish and wildlife, particularly those species that are indigenous to the state.	Not Applicable, Relevant, or Appropriate	Will be applicable if significant populations are present at a site or they are affected by site activities.
Fish and Wildlife Coordination Act (16 U.S.C. § 661-667e)	The Act allows the Departments of Agriculture and Commerce to assist Federal and State agencies to study the effects of domestic sewage, trade wastes, and other polluting substances on wildlife.	Not Applicable, Relevant, or Appropriate	Will be applicable if significant populations are present at a site or they are affected by site activities.
Flood Control Act of 1944 (16 U.S.C. § 460)	Provides the public with knowledge of flood hazards and promotes prudent use and management of flood plains.	**Applicable**	Will be applicable if a site is located on a designated flood plain. Existing Seep IT located within flood plain. No proposed work located within flood plain
National Historic Preservation Act of 1966 (16 U.S.C. § 470 et seq.)	Establishes a national registry of historic sites. Provides for preservation of historic or prehistoric resources.	Not Applicable, Relevant, or Appropriate	Will be applicable if a site is listed on historic registry and if activities requiring permitting are initiated at a site.
Occupational Safety and Health Act (OSHA) of 1970 (29 U.S.C. § 651 et seq.)	Enacted to ensure worker and workplace safety. Employers are required to provide workers a place of employment that is free from recognized hazards to safety and health.	Not Applicable, Relevant, or Appropriate	Applies to workers and workplaces.
Occupational Safety and Health Standards (29 CFR 1910)	Provides standards for workers and the workplace including: working surfaces; means of egress; ventilation; noise; hazardous materials; personal protective equipment; sanitation; medical services and first aid; fire protection, detection, and suppression; materials handling and storage; machinery and machinery guards; power tools; and welding and electrical equipment. Also requires training for workers.	**Applicable** to all alternatives	Will be applicable to workers and workplaces including hazardous waste sites.
Safety and Health Regulations for Construction (29 CFR 1926)	Provides standards for construction activities including: work practices; safety equipment; scaffolding and ladders; fall protection; heavy equipment; excavations; concrete and masonry construction; steel erection; tunnels and shafts; demolition; use of explosives; power transmission and distribution; and overhead protection.	**Potentially Applicable** to some remedial alternatives	Will be applicable to workers and workplaces where construction activities take place.
Resource Conservation and Recovery Act (RCRA) of 1976 42 U.S.C. § 6901 et seq. as amended by the Hazardous and Solid Waste Amendments of 1984 (HSWA) and 1986, the Federal Facilities Compliance Act of 1992, and the Land Disposal Program Flexibility Act of 1996.	Enacted to provide control of hazardous waste by imposing management requirements on generators and transporters of hazardous waste and upon owners and operators of treatment, storage and disposal (TSD) facilities. Also set forth a framework for management of nonhazardous waste. Focuses only on active or future facilities. HSWA requires phasing out land disposal of hazardous waste.	Not Applicable, Relevant, or Appropriate	Applies to active hazardous and solid wastes including facilities that treat, store and dispose of these materials as well as generators and transporters of hazardous wastes.
Solid Waste Disposal Facility Criteria (40 CFR 257 - 258)	Regulations apply to owners and operators of facilities that treat, store or dispose of solid wastes	**Applicable** to some remedial alternatives	Will be applicable if site activities are analogous to solid waste facility activities.
Standards for Identification and Listing of Hazardous Waste (40 CFR 261)	Provides criteria for identification of hazardous and solid wastes.	**Applicable** to some remedial alternatives	Will be applicable for identifying hazardous wastes.
Standards Applicable to Generators of Hazardous Waste (40 CFR 262)	Regulates the manifesting, pre-transport requirements, and record keeping and reporting for hazardous waste generators.	**Applicable** to some remedial alternatives	Will be applicable if hazardous waste is generated at a site.
Standards Applicable to Transporters of Hazardous Waste (40 CFR 263)	Establishes standards that apply to persons transporting hazardous waste within the United States if the transportation requires a manifest under RCRA.	**Potentially Applicable** to some remedial alternatives	Will be applicable if hazardous waste is disposed off-site.

TABLE 5-1
SUMMARY OF ARARs AND TBCs
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Citation	Description	Category	Comment
Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (40 CFR 264)	Regulations apply to owners and operators of facilities that treat, store, or dispose of hazardous waste through the use of surface impoundments, waste piles, incinerators, land treatment units, and landfills.	**Potentially Applicable** to some remedial alternatives	Will be applicable if site activities are analogous to hazardous waste facility activities.
Manifesting, Record Keeping, and Reporting Requirements (40 CFR 264.70 to 264.77)	These standards apply to owners and operators of all facilities which treat, store or dispose of hazardous wastes	**Potentially Applicable** to some remedial alternatives	Will be applicable if site activities are analogous to hazardous waste facility activities.
Releases from Solid Waste Management Units (40 CFR 264.90 to 264.101)	Regulations apply to owners or operators of hazardous waste treatment, storage or disposal facilities.	**Potentially Applicable** to some remedial alternatives	Will be applicable if solid waste is stored at a site.
Closure and Post Closure Requirements (40 CFR 264.110 to 264.120)	Facility owner or operator must close a hazardous waste facility in a way that minimizes the need for further maintenance and maximizes the protection of human health and the environment.	Not Applicable, Relevant, or Appropriate	Will be applicable upon the closure and post closure of a hazardous waste facility.
Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities (40 CFR 265)	Regulations apply to owners and operators of facilities that treat, store, or dispose of hazardous waste.	Not Applicable, Relevant, or Appropriate	Will be applicable if site activities are analogous to hazardous waste facility activities.
Land Disposal Restrictions (40 CFR 268)	Identifies hazardous wastes that are restricted from land disposal and defines those limited circumstances under which an otherwise prohibited waste may continue to be land disposed.	**Applicable** to some remedial alternatives	Will be applicable depending on the type of waste generated at the site.
Resource Conservation and Recovery Act (RCRA) of 1976 Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (40 CFR 280)	Establishes regulations relating to underground storage tanks (UST) including: performance standards; spill control; corrosion protection; record keeping and reporting; release detection; environmental investigations of releases; corrective actions; and closure of UST systems.	Not Applicable, Relevant, or Appropriate	Will be applicable if underground storage tanks are or were present at a site and if a petroleum release is present. Also provides for environmental assessment at closure of UST systems.
Safe Drinking Water Act (SDWA) of 1974 42 U.S.C. § 300f et seq. as amended in 1986 National Primary Drinking Water Regulations and Implementation (40 CFR 141 and 142) National Secondary Drinking Water Standards (40 CFR 143) Underground Injection Control Program (40 CFR 144 to 148)	Established to protect the quality of drinking water in the Unites States. Focuses on all waters actually or potentially designed for drinking use, whether from above ground or underground sources. The Act authorized EPA to establish safe standards of purity and required all owners or operators of public water supply systems to comply with primary (health-related) standards. Establishes maximum contaminant levels (MCLs) which are health risk based standards for public water systems. Establishes welfare-based secondary standards for public water systems. Assures that Underground Injection will not endanger drinking water sources. Provides regulations governing the use of underground injection wells including: identification of the classifications of injection wells; and the permitting, construction, operation, monitoring, testing, and reporting requirements. Also provides requirements for plugging of injection wells.	**Applicable**	May be applicable, relevant or appropriate at sites where waters that are used or may potentially be used as drinking water supplies are impacted or threatened. Will be applicable at the distribution point (i.e., at the tap). Will be relevant and appropriate for groundwater cleanup at sites where potential drinking water sources (aquifers) are impacted. Will be applicable at the distribution point (i.e., at the tap). Will be applicable if underground injection of liquids or air is conducted as part of a site remedy.
Toxic Substances Control Act (TSCA) of 1976 (15 U.S.C. § 2601 et seq.)	Enacted to give EPA the ability to track industrial chemicals currently produced or imported into the United States. EPA screens these chemicals and may require reporting or testing of those that pose an environmental or human-health hazard. EPA may ban the manufacture and import of those chemicals that pose an unreasonable risk.	Not Applicable, Relevant, or Appropriate	Will be applicable if site activities involve handling of toxic substances such as polychlorinated biphenyls (PCBs) or remediation of these substances.
KANSAS POTENTIAL ARARS			
Ambient Air Quality Standards and Air Pollution Control (K.A.R. 28-19-1 to 28-19-801)	Regulates air emissions from processing operations, indirect heating equipment, and incinerators. Establishes requirements for Attainment and Non-Attainment Areas. Establishes requirements for Stack Heights. Restricts open burning.	**Applicable** to some remedial alternatives	Will be applicable if a remedy results in the release of contaminants to the air.

TABLE 5-1
SUMMARY OF ARARs AND TBCs
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Citation	Description	Category	Comment
Asbestos Control (K.A.R. 28-50-1 to 28-50-14)	Established the requirements for licensing of businesses and examination and certification of asbestos workers. Established requirement for notification of asbestos projects. Establishes work practices for asbestos projects. Establishes rules for disposal of asbestos containing materials.	Not Applicable, Relevant, or Appropriate	Will be applicable if asbestos is handled or removed from a site or encapsulated.
Agricultural Chemicals, Commercial Fertilizers, Anhydrous Ammonia, and Chemigation **(**K.A.R. 4-1-1 to 4-1-17, K.A.R. 4-4-1 to 4-4-984, K.A.R. 4-10-1 to 4-10-17, and K.A.R. 4-20-1 to 4-20-15)	Requires labeling and registration of agricultural chemicals. Provides regulations for storage and secondary containment, transportation and record keeping for commercial fertilizers and anhydrous ammonia. Requires permitting and certification of operators of chemigation equipment.	Not Applicable, Relevant, or Appropriate	Will be applicable if agricultural chemicals, commercial fertilizers or anhydrous ammonia are used at site. Will be applicable if chemicals or animal wastes are applied by chemigation.
Construction, Operation, Monitoring and Abandonment of Salt Solution Mining Wells **(**K.A.R. 28-43-1 to 28-43-11)	Regulates the construction, operation, monitoring, testing and abandonment of salt solution mining wells.	Not Applicable, Relevant, or Appropriate	Will be applicable if salt solution mining wells are present.
Emergency Planning and Right-to-Know **(**K.A.R. 28-65-1 to 28-65-4)	Designated to help local communities protect public health, safety and the environment from chemical hazards. Enables communities to prepare to respond to unplanned releases of hazardous substances. Requires facilities at which hazardous substances are present to report the presence of these materials to emergency responders. Requires companies to report the release of hazardous substances.	**Applicable** to some remedial alternatives	Will be applicable if hazardous chemicals are stored or used at a site.
Environmental Use Controls **(**K.S.A. 65-1,221 to 65-1,235)	An environmental use control "means an institutional control or administrative control, a restriction, prohibition or control of one or more uses of, or activities on, a specific property, as requested by the property owner at the time of issuance, to ensure future protection of public health and the environment when environmental contamination which exceeds department standards for unrestricted use remains on the property following the appropriate assessment and/or remedial activities as directed by the department pursuant to the secretary's authority".	**Applicable**	These restrictions are strictly voluntary as the landowner applies for the restriction to their property to mitigate the risk posed to human health and the environment from contamination at their property (in lieu of active remediation).
Explosive Materials **(**K.A.R. 22-4-1 to 22-4-4)	Requires all contractors to obtain explosive storage site permits before moving, storing or using any explosives or blasting agents at any job site within the state.	Not Applicable, Relevant, or Appropriate	Will be applicable if explosives or blasting agents are used or stored at a site.
Hazardous Waste Management Standards and Regulations (K.A.R. 28-31-1 to 28-31-16)	Identifies the characteristics and listing of hazardous waste. Prohibits underground burial of hazardous waste except as granted by EPA or KDHE. Establishes restrictions on land disposal. Establishes standards for generators or transporters of hazardous waste. Establishes standards for hazardous waste storage, treatment and disposal facilities.	**Applicable**	Will be applicable if hazardous wastes are present at a site.
Hydrocarbon Storage Wells and Well Systems **(**K.A.R. 28-45-1 to 28-45-11)	Establishes a system for permitting of hydrocarbon storage wells. Establishes requirements for construction, operation and monitoring, and plugging of hydrocarbon storage wells.	Not Applicable, Relevant, or Appropriate	Will be applicable if hydrocarbon storage wells are present at a site.
Kansas Board of Technical Professions **(**K.A.R. 66-6-1 through 66-14-12)	Establishes the requirements for licensing of engineers, land surveyors, geologists and architects.	**Applicable**	Will be applicable if the services of a geologist, engineer or land surveyor are required for site investigations or remediation.
Kansas Drycleaner Environmental Response Act **(**K.A.R. 28-68-1 to 28-68-9)	Enacted to provide funds to assist with assessment and corrective action of former and existing drycleaner facilities. Requires registration of drycleaning facilities and compliance with waste management measures.	Not Applicable, Relevant, or Appropriate	May be applicable if a drycleaner operated onsite.
Kansas Historic Preservation Act **(**K.A.R. 118-3-1 to 118-3-160	Provides for the protection and preservation of sites and buildings listed on state or federal historic registries.	Not Applicable, Relevant, or Appropriate	Will be applicable if a site or building is listed on the state or federal historic registry and if activities requiring permitting are initiated at a site.
Kansas Water Appropriations Act **(**K.A.R. 5-1-1 through 5-10-6 and K.A.R. 5-50-1 to 5-50-8)	Establishes the requirements for obtaining, maintaining and transferring water appropriations.	**Applicable**	Will be applicable if water appropriations are required for groundwater remediation.

TABLE 5-1
SUMMARY OF ARARs AND TBCs
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Citation	Description	Category	Comment
Mined Land Reclamation (K.A.R. 47-16-1 to 47-16-11)	Allows for the reclamation of mined land and associated waters.	Not Applicable, Relevant, or Appropriate	Will be applicable if mined land or associated waters are to be reclaimed.
Non-Game, Threatened or Endangered Species (K.A.R. 115-15-1 to 115-15-4)	Identifies Threatened and Endangered Species	Not Applicable, Relevant, or Appropriate	Will be applicable if any of the identified species are present at a site.
PCB Facility Construction Permit Standards and Regulations (K.A.R. 28-55-1;28-55-5 55-1;28-55-5)	Establishes the requirement for permitting of facilities constructed for the treatment, storage or disposal of materials containing polychlorinated biphenyls (PCBs). Establishes standards for PCB facilities.	Not Applicable, Relevant, or Appropriate	Will be applicable if treatment, storage or disposal of materials containing PCBs occurs.
Pesticides (K.A.R. 4-13-1 to 4-13-65)	Requires licensing of pesticide businesses and certification of persons that apply pesticides.	Not Applicable, Relevant, or Appropriate	Will be applicable if pesticides are present at a site or application of pesticides occurs.
Petroleum Products Storage Tanks (K.A.R. 28-44-1 to 28-44-29)	Provides requirements for permitting of the installation and operation of underground storage tanks (USTs). Provides requirements for design and construction of storage tanks. Provides a system for licensing contractors who install and test USTs. Requires implementation of methods for detecting releases and reporting releases from USTs.	Not Applicable, Relevant, or Appropriate	Will be applicable if petroleum storage tanks are or were present at a site. Current UOWS units contain exempt volumes and hence are also exempt.
Radiation (K.A.R 28-35-1 to 28-35-36)	Regulations require registration of radiation producing devices and licensing of sources of radiation. Provides standards for protection against radiation. Provides requirements for industrial radiographic operations and wireline and subsurface tracer studies.	Not Applicable, Relevant, or Appropriate	Will be applicable if radiation producing devices or sources of radiation are present at or are used at a site.
Solid Waste Management (K.A.R. 28-29-1 to 28-29-121 and K.A.R. 28-29-2101 to 28-29-2113)	Provides standards for management of solid wastes. Establishes administrative procedures. Establishes the requirement for development and submittal of Solid Waste Management Plans.	**Applicable** to some remedial alternatives	Will be applicable if solid waste is generated, stored or disposed at a site.
Spill Reporting (K.A.R. 28-48-1 to 28-48-2)	Requires reporting of unpermitted discharges or accidental spills. Requires that containment and immediate environmental response measures be implemented. Also provides for technical assistance for mercury-related spills.	**Potentially Applicable**	Will be applicable if unpermitted discharges or accidental spills occur at a site.
Underground Injection Control Regulations (K.A.R. 28-46-1 to 28-46-44)	Provides regulations governing the use of underground injection wells including: identification of the classifications of injection wells; and the permitting, construction, operation, monitoring, testing, and reporting requirements. Also provides requirements for plugging of injection wells.	**Applicable** to some remedial alternatives	Will be applicable if the remedy involves the injection of fluids or air into the subsurface.
Underground Storage, Disposal Wells, and Surface Ponds (K.A.R. 28-13-1 to 28-13-9)	Regulates the construction and use of underground storage reservoirs, disposal wells and surface ponds for the confinement, storage and disposal of industrial fluids including but not limited to brine. Also pertains to removal of material from surface ponds upon abandonment. Does not include regulations pertaining to oil field activities.	Not Applicable, Relevant, or Appropriate	Will be applicable if underground reservoirs, disposal wells or surface ponds are used for storage or disposal of industrial fluids at a site. Will be applicable if use of a surface pond is discontinued.
Voluntary Cleanup and Property Redevelopment Program (K.A.R. 28-71-1 to 28-71-12)	Provides a mechanism for property owners, facility operators, prospective purchasers, and local governments to voluntarily address contaminated properties with technical and regulatory guidance from KDHE. Identifies remedial standards for cleanup of environmental media. Establishes that groundwater cleanup levels shall be based on the most beneficial use of the groundwater (i.e., current and future use).	**Remedial Standards are Relevant or Appropriate**	May be applicable if a site meets the criteria for acceptance into the Voluntary Cleanup Program. Remedial standards established under KAR 28-71-11 are relevant and appropriate for all other sites being managed under KDHE oversight.
Water Pollution Control (K.A.R. 28-16-1 to 28-16-154)	Provides regulation of sewage discharge. Establishes pre-treatment standards for industry. Designates uses of rivers and streams. Establishes River Basin Quality Criteria and Surface Water Quality Criteria. Provides for the establishment of Critical Water Quality Management Areas.	**Applicable**	Will be applicable if water is to be discharged to state waterways.
Water Well Contractor's License; Water Well Construction and Abandonment (K.A.R. 28-30-1 to 28-30-10)	Establishes the requirements for licensing of drillers. Regulates drilling activities including the construction of wells.	**Applicable**	Will be applicable if drilling and/or well construction or abandonment is conducted at a site.

TABLE 5-1
SUMMARY OF ARARs AND TBCs
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Citation	Description	Category	Comment
TO BE CONSIDERED			
Kansas Department of Health and Environment (KDHE), Bureau of Environmental Remediation (BER), Risk Based Standards for Kansas (RSK Manual, March 1, 2003, as amended.)	Compiles risk-based cleanup screening goals for contaminants in soil and groundwater	**Will Be Considered**	
Evaluating Future Land Use, (KDHE BER Policy #BER-RS005)	Future land use influences the types and frequencies of exposures that may occur to any residual contamination remaining on the site and therefore must be considered in making corrective action decisions.	**Will Be Considered**	
Recommended Remedial Levels for Nitrate in Soil (KDHE BER Policy #BER-RS-012)	Addresses nitrate and ammonia contamination in the soil from point sources of contamination.	Not Applicable	
Investigation and Remediation of Salt (Chloride)-Impacted Soil and Groundwater (KDHE BER Policy #BER-RS-013A)	Provides information on methods for investigating, evaluating and remediating soil and ground water contaminated with brine or salt.	Not Applicable	
Consideration for Remedial Standards (KDHE BER Policy #BER-RS-033)	Identifies remedial standards and situations where they should be used.	**Will Be Considered**	
Soil Clean-up Levels for Total Petroleum Hydrocarbons (KDHE BER Policy #BER-RS-041)	Establishes Total Petroleum Hydrocarbon (TPH) human health and environmental risk-based actions levels consistent with the procedures adopted within the Risk-Based Standards for Kansas (RSK) manual.	**Will Be Considered**	
Monitored Natural Attenuation (KDHE BER Policy #BER-RS042)	Provides further clarification of additional KDHE-BER requirements to the guidance on monitored natural attenuation provided by EPA Directive 9200.4-17P.	**Will Be Considered**	
Considerations for Groundwater Use and Applying RSK Standards to Contaminated Groundwater (KDHE BER Policy #BER-RS-045)	Establishes a mechanism for consistency across BER programs in protecting public health and the environment, in addition to protection of ground water resources of the State.	**Will Be Considered**	
Sediment Policy (KDHE BER Policy #BER-ARS-045)	Provides a consistent definition and assessment approach for contaminated sediment sites in Kansas.	**Will Be Considered**	
Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, (EPA540-G-89-004, October 1988)	Provides the methodology that the Superfund program uses to characterize the nature and extent of risk posed by uncontrolled hazardous wastes sites and for evaluating potential remedial alternatives.	**Will Be Considered**	
Guidance for Quality Assurance Project Plans (EPA240-R-02009 December 2002)	Describes the Quality Assurance Project Plan as four basic element groups covering project management, data generation & acquisition, assessment and oversight, and data validation and useability.	**Will Be Considered**	
Guidance for the Data Quality Objectives Process (EPA600-R96-055, August 2000)	Provides a systematic planning process to develop acceptance or performance criteria for collection, evaluation, or use of environmental data.	**Will Be Considered**	
Risk Assessment Guidance for Superfund (Volume I Part A EPA540-1-89-002, December 1989 Part B EPA540-R-92-003, December 1991 Part C EPA540-R-92-004, December 1991 Part D EPA540-R-97-033, December. 2001 Part E EPA540-R-99-005, July 2004)	Provide guidelines for conducting a baseline risk assessment.	**Was Considered**	

TABLE 5-1
SUMMARY OF ARARs AND TBCs
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Citation	Description	Category	Comment
Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems (2000, MacDonald, D.D , C.G. Ingersoll, and T.A. Berger. , Archives of Environmental Contamination and Toxicology 39:20-31)	Identifies Threshold Effect Concentration (TEC) to be used to assess impacts to sediment.	**Will Be Considered**	
Ground-Water Sampling Guidelines for Superfund and RCRA Project Managers (EPA542-S-02-001, May 2002)	Identifies methods for sampling groundwater.	**Will Be Considered**	
Remedial Design/Remedial Action Handbook (EPA540-R-95059, June 1995)	Provides an overview of the remedial design and remedial action processes.	**Will Be Considered**	
Management of Remediation Waste under RCRA (EPA530-F98-026, October 1998)	Describes management of contaminated environmental media, etc.	**Will Be Considered**	
Best Management Practices (BMPs) for Soils Treatment Technologies EPA530-R-97-007, May 1997)	Describes various BMPs to be implemented during remedy implementation.	**Will Be Considered**	
Storm Water Management for Construction Activities (EPA832-R-92-005, October 1992)	Describes storm water pollution prevention measures.	**Will Be Considered**	
Guide to Discharging CERCLA Aqueous Wastes to Publicly Owned Treatment Works, (EPA OSWER Directive 9330.213FS, March 1991)	Describes applicability and acceptable means of conveyance to a POTW.	Not Applicable	
Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, (EPA OSWER Directive 9200.4-17P, April 21, 1999)	Describes EPA's policy regarding the use of monitored natural attenuation for the remediation of contaminated soil and groundwater at sites administered by EPA's Office of Solid Waste and Emergency Response.	**Will Be Considered**	

TABLE 6-1
MAXIMUM ANALYTICAL RESULTS SUMMARY
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Groundwater				
Compound	**Historical Maximum Concentration (µg/L)**	**Current Maximum Concentration[1] (µg/L)**	**KDHE Tier 2 Level[2] (µg/L)**	
			Residential (Off-site)	**Non-residential (On-site)**
Benzene	129,000	122,000	5	5
Ethylbenzene	1,110	1,050	700	700
1,1-Dichloroethane	801	52	25	46.1
MTBE	38,000	19,000	133	262
2,4-Dimethylphenol	14,000	4,280	292	1,860
Naphthalene	630	575	1.11	2.11
TPH-GRO	270,000	244,000	500	500
TPH-DRO	1,200,000	920,000	500	720
Arsenic	218	218	10	10
Barium	4,570	3,160	2,000	2,000
Manganese	12,900	12,900	50	50

Soil				
Compound	**Historical Maximum Concentration (mg/kg)**	**Current Maximum Concentration[3] (mg/kg)**	**KDHE Tier 2 Level Soil Pathway[4] (mg/kg)**	**KDHE Tier 2 Level Soil-to-GW Pathway[4] (mg/kg)**
Benzene	500	500	28.2	0.168
Ethylbenzene	84	84	145	65.6
Chloroform	1	1	7.14	0.85
MTBE	41	41	1,050	1.66
Naphthalene	290	290	64.7	0.659
2-Methylnaphthalene	69	69	1,280	17.3
TPH-GRO	9,400	9,400	450	79.3
TPH-DRO	34,000	34,000	20,000	7,830
Lead	28,000	28,000	1,000	NE
Arsenic	243	243	63.2	NE

Notes:
[1]Current Maximum Groundwater Concentration from Four Semi-Annual Events - April 2012 through October 2013
[2]KDHE Tier 2 RBSL for Groundwater Pathway. KDHE Tier 2 Levels default to MCLs where available.
[3]Current Soil Maximum Concentrations: Phase III Investigation (2007 - 2009)
[4]KDHE Tier 2 RBSL for Non-Residential Scenario Soil Pathway and Soil-to-Groundwater Pathway.
Tier 2 Level for provided from KDHE's Risk-Based Standards for Kansas (RSK) Manual, March 2014.

TABLE 7-1
CLEANUP LEVELS FOR GROUNDWATER
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Compound	Off-Site KDHE Tier 2 Level* (µg/l)	On-Site KDHE Tier 2 Level** (µg/l)	Alternative Treatment Goal (µg/l)
Benzene	5	5	See Note***
Ethylbenzene	700	700	See Note***
1,1-Dichloroethane	25	46.1	See Note***
MTBE	133	262	See Note***
2,4-Dimethylphenol	292	1,860	See Note***
Naphthalene	1.11	2.11	See Note***
TPH-GRO	500	500	See Note***
TPH-DRO	500	720	See Note***
Arsenic	10	10	See Note***
Barium	2,000	2,000	See Note***
Manganese	50	50	See Note***

Notes:
*KDHE Tier 2 Risk-based Screening Level Residential Scenario Groundwater Pathway, March 2014
**KDHE Tier 2 Risk-based Screening Level Non-Residential Scenario Groundwater Pathway, March 2014
***Alternative Treatment Goals (ATGs) may be evaluated at a later time.
µg/L = micrograms of contaminant per liter of water
TPH = Total Petroleum Hydrocarbons
GRO = Gasoline-range Organics
DRO = Diesel-range Organics
MTBE = Methyl tert-Butyl Ether

TABLE 10-1
MAIN PROCESS AREA (MPA)
REMEDIAL ALTERNATIVE COST SUMMARY
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Remedial Alternative Component and Task	Capital Cost	Annual O&M	Year First	Year Last	Total $	PV* 4.5%	Notes
Completed IRM Actions	*Costs to Date for MPA Portion of the Work including O&M - Future O&M Costs Included in Alternatives Below*						
1 - Seep Interceptor Trench	$ 1,240,000				$ 1,240,000	$ 1,240,000	
2 - MPA Demolition and Grading	$ 7,000,000				$ 7,000,000	$ 7,000,000	
3 - MPA Landfarming	$ 184,000				$ 184,000	$ 184,000	
4 - Lead Impacted Soil	$ 150,000				$ 150,000	$ 150,000	
5 - MPA Channel IT and Basin IT	$ 640,000				$ 640,000	$ 640,000	
6 - MPA Spring System	$ 360,000				$ 360,000	$ 360,000	
7 - AHA Pit and Piles	$ 0				$ 0	$ 0	Not MPA-related
8 - Waste Stabilization & Capping	$ 560,000				$ 560,000	$ 560,000	
9 - Groundwater Treatment System (GTS)	$ 1,400,000				$ 1,400,000	$ 1,400,000	
TOTAL	**$ 11,534,000**	**$ 0**			**$ 11,534,000**	**$ 11,534,000**	
Alternative 1 - No Additional Action							
Initial and Ongoing O&M Costs	$ 0	$ 0	1	30	$ 0	$ 0	
TOTAL	**$ 0**	**$ 0**			**$ 0**	**$ 0**	
Alternative 2 - ITs and Phytoremediation							
A) Existing IT Continued Operation							
Design and Construction	$ -	$ -	1	1	$ 0	$ 0	
O&M	$ -	$ 52,000	1	20	$ 1,040,000	$ 706,851	20 years operation
B) Groundwater Treatment System O&M							
Plan Modifications	$ 9,750	$ -	1	1	$ 9,750	$ 9,750	
O&M	$ -	$ 48,750	1	20	$ 975,000	$ 662,673	20 years operation
C) LNAPL/Product Skimming							
Initial Capital Costs	$ 2,056	$ -	1	1	$ 2,056	$ 2,056	
Ongoing/O&M Costs	$ -	$ 3,384	1	10	$ 33,840	$ 27,982	10 years active recovery
D) LTM							
Initial Capital Costs	$ 1,163	$ -	1	1	$ 1,163	$ 1,163	
Annual Sampling (Equivalent of Annual O&M)	$ -	$ 8,140	1	30	$ 138,372	$ 99,579	Yrs:1-10,12,14,16,18,20,25,30
E) MNA and NSZD							
Work Plans, QAPP, Set-up	$ 19,200	$ -	1	1	$ 19,200	$ 19,200	
MNA Each Event	$ -	$ 6,950	20	30	$ 69,500	$ 25,437	Annually years 20 to 30
NSZD Each Event	$ -	$ 22,640	1	30	$ 181,120	$ 106,904	2 events 1st year, then 1/5 yrs
F) EUCs and SWMP							
Up-Front Documents and Fees	$ 14,000	$ -	1	1	$ 14,000	$ 14,000	
Annual Costs	$ -	$ 5,888	1	30	$ 176,640	$ 100,225	Inspections, reporting, activity
G) Close-Out of Shared Components							
Confirmation Soil and GW Sampling	$ 61,582	$ -	20	20	$ 61,582	$ 26,684	AOC-specific close-out costs are
Well Abandonment & System Removal	$ 139,876	$ -	20	20	$ 139,876	$ 60,609	included within that component
MPA Spring System Continued Operation							
Design and Construction	$ -	$ -	1	1	$ 0	$ 0	
O&M	$ -	$ 7,220	1	20	$ 144,400	$ 98,144	20 years operation
Phytoremediation							
Design and Construction	$ 181,200	$ -	1	1	$ 181,200	$ 181,200	
O&M	$ -	$ 28,750	1	10	$ 287,500	$ 237,728	
TOTAL	**$ 428,827**	**$ 183,722**			**$ 3,475,199**	**$ 2,380,184**	

TABLE 10-1
MAIN PROCESS AREA (MPA)
REMEDIAL ALTERNATIVE COST SUMMARY
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Remedial Alternative Component and Task	Capital Cost	Annual O&M	Year First	Year Last	Total $	PV* 4.5%	Notes
Alternative 3 - Excavation							
A) Existing IT Continued Operation							
Design and Construction	$ -	$ -	1	1	$ 0	$ 0	
O&M	$ -	$ 52,000	1	10	$ 520,000	$ 429,977	10 years operation
B) Groundwater Treatment System O&M							
Plan Modifications	$ 9,750	$ -	1	1	$ 9,750	$ 9,750	
O&M	$ -	$ 48,750	1	10	$ 487,500	$ 403,104	10 years operation
D) LTM							
Initial Capital Costs	$ 1,163	$ -	1	1	$ 1,163	$ 1,163	
Annual Sampling (Equivalent of Annual O&M)	$ -	$ 8,140	10	20	$ 81,395	$ 46,265	Annually years 10 to 20
E) MNA and NSZD							
Work Plans, QAPP, Set-up	$ 19,200	$ -	1	1	$ 19,200	$ 19,200	
MNA Each Event	$ -	$ 6,950	10	20	$ 69,500	$ 39,503	Annually years 10 to 20
NSZD Each Event	$ -	$ 22,640	0	0	$ 0	$ 0	Not required
F) EUCs and SWMP							
Up-Front Documents and Fees	$ 14,000	$ -	1	1	$ 14,000	$ 14,000	
Annual Costs	$ -	$ 5,888	1	20	$ 117,760	$ 80,037	Inspections, reporting, activity
G) Close-Out of Shared Components							
Confirmation Soil and GW Sampling	$ -	$ -	0	0	$ 0	$ 0	Remove during Excavation
Well Abandonment & System Removal	$ -	$ -	0	0	$ 0	$ 0	Remove during Excavation
Excavate and Landfarm All Impacted Soil and Landfill Impacted Rock							
Design and Construction	$ 53,645,307	$ -	1	1	$ 53,645,307	$ 53,645,307	Completed by year 10
O&M	$ -	$ -	0	0	$ 0	$ 0	Landfarm O&M included above
Replacement MPA Spring Collection/Treatment System							
Design and Construction	$ 185,000	$ -	10	10	$ 185,000	$ 124,487	Replaced for tar in fractures
O&M	$ -	$ 7,220	10	30	$ 151,620	$ 101,137	after excavation.
TOTAL	**$ 53,874,420**	**$ 151,588**			**$ 55,302,195**	**$ 54,913,930**	

Notes

*PV = Present value of current and future expenditures, using the listed net rate of return (value of money minus inflation).

A number prior to a description indicates an IRM activities. A letter prior to a description indicates an activity shared among the areas (AOCs).

TABLE 10-2
ASPHALT HANDLING AREA (AHA)
REMEDIAL ALTERNATIVE COST SUMMARY
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Remedial Alternative Component and Task	Capital Cost	Annual O&M	Year First	Year Last	Total $	PV* 4.5%	Notes
Completed IRM Actions	*Costs to Date for AHA Portion of the Work*						
1 - Seep Interceptor Trench	$ 80,000				$ 80,000	$ 80,000	
2 - MPA Demolition and Grading	$ 0				$ 0	$ 0	Not AHA-related
3 - MPA Landfarming	$ 0				$ 0	$ 0	Not AHA-related
4 - Lead Impacted Soil	$ 0				$ 0	$ 0	Not AHA-related
5 - MPA Channel IT and Basin IT	$ 80,000				$ 80,000	$ 80,000	
6 - MPA Spring System	$ 0				$ 0	$ 0	Not AHA-related
7 - AHA Pit and Piles	$ 950,000				$ 950,000	$ 950,000	
8 - Waste Stabilization & Capping	$ 1,400,000				$ 1,400,000	$ 1,400,000	
9 - Groundwater Treatment System (GTS)	$ 110,000				$ 110,000	$ 110,000	
TOTAL	**$ 2,620,000**	**$ 0**			**$ 2,620,000**	**$ 2,620,000**	
Alternative 1 - No Additional Action							
Initial Capital Costs	$ 0	$ 0	1	30	$ 0	$ 0	
Ongoing/O&M Costs	$ 0	$ 0	1	30	$ 0	$ 0	
TOTAL	**$ 0**	**$ 0**			**$ 0**	**$ 0**	
Alternative 2 - MPA Spring, Basin IT, Plus							
A) Existing IT Continued Operation							
Design and Construction	$ -	$ -	1	1	$ 0	$ 0	
O&M	$ -	$ 4,000	1	20	$ 80,000	$ 54,373	20 years operation
B) Groundwater Treatment System O&M							
Plan Modifications	$ 750	$ -	1	1	$ 750	$ 750	
O&M	$ -	$ 3,750	1	20	$ 75,000	$ 50,975	20 years operation
D) LTM							
Initial Capital Costs	$ -	$ -	0	0	$ 0	$ 0	
Annual Sampling (Equivalent of Annual O&M)	$ -	$ -	0	0	$ 0	$ 0	No AHA LTM is required
E) MNA and NSZD							
Work Plans, QAPP, Set-up	$ -	$ -	0	0	$ 0	$ 0	
MNA Each Event	$ -	$ 1,738	0	0	$ 0	$ 0	Contingency only
NSZD Each Event	$ -	$ -	1	30	$ 0	$ 0	Not required
F) EUCs and SWMP							
Up-Front Documents and Fees	$ 3,500	$ -	1	1	$ 3,500	$ 3,500	
Annual Costs	$ -	$ 1,472	1	30	$ 44,160	$ 25,056	Annual inspections/fees
G) Close-Out of Shared Components							
Confirmation Soil and GW Sampling	$ -	$ -	20	20	$ 0	$ 0	AOC-specific close-out costs are
Well Abandonment & System Removal	$ -	$ -	20	20	$ 0	$ 0	included within that component
MPA Spring System Continued Operation							
Design and Construction	$ -	$ -	0	0	$ 0	$ 0	Already installed
O&M	$ -	$ -	1	20	$ 0	$ 0	All costs included within MPA
TOTAL	**$ 4,250**	**$ 10,960**			**$ 203,410**	**$ 134,654**	

TABLE 10-2
ASPHALT HANDLING AREA (AHA)
REMEDIAL ALTERNATIVE COST SUMMARY
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Remedial Alternative Component and Task	Capital Cost	Annual O&M	Year First	Year Last	Total $	PV* 4.5%	Notes
Alternative 3 - Additional Interceptor Trenches							
A) Existing IT Continued Operation							
Design and Construction	$ -	$ -	1	1	$ 0	$ 0	
O&M	$ -	$ 4,000	1	15	$ 80,000	$ 54,373	15 years operation
B) Groundwater Treatment System O&M							
Plan Modifications	$ 750	$ -	1	1	$ 750	$ 750	
O&M	$ -	$ 3,750	1	15	$ 75,000	$ 50,975	15 years operation
D) LTM							
Initial Capital Costs	$ -	$ -	0	0	$ 0	$ 0	
Annual Sampling (Equivalent of Annual O&M)	$ -	$ -	0	0	$ 0	$ 0	No wells required within AHA
E) MNA and NSZD							
Work Plans, QAPP, Set-up	$ -	$ -	0	0	$ 0	$ 0	Not required if
MNA Each Event	$ -	$ 1,738	0	0	$ 0	$ 0	two additional tar ITs
NSZD Each Event	$ -	$ -	0	0	$ 0	$ 0	are installed
F) EUCs and SWMP							
Up-Front Documents and Fees	$ 3,500	$ -	1	1	$ 3,500	$ 3,500	
Annual Costs	$ -	$ 1,472	1	20	$ 44,160	$ 25,056	Required only until year 20
G) Close-Out of Shared Components							
Confirmation Soil and GW Sampling	$ -	$ -	20	20	$ 0	$ 0	AOC-specific close-out costs are
Well Abandonment & System Removal	$ -	$ -	20	20	$ 0	$ 0	included within that component
MPA Spring System Continued Operation							
Design and Construction	$ -	$ -	0	0	$ 0	$ 0	
O&M	$ -	$ -	1	15	$ 0	$ 0	All costs included within MPA
IT Along East Side of AHA and West Side of MPA							
Design and Construction	$ 437,800	$ -	0	0	$ 437,800	$ 457,501	
O&M	$ -	$ 21,600	1	15	$ 324,000	$ 242,413	15 years until ARARs achieved
TOTAL	**$ 442,050**	**$ 32,560**			**$ 965,210**	**$ 834,568**	

Notes

*PV = Present value of current and future expenditures, using the listed net rate of return (value of money minus inflation).

A number prior to a description indicates an IRM activities. A letter prior to a description indicates an activity shared among the areas (AOCs).

TABLE 10-3
SOUTH TANK FARM (STF)
REMEDIAL ALTERNATIVE COST SUMMARY
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Remedial Alternative Component and Task	Capital Cost	Annual O&M	Year First	Year Last	Total $	PV* 4.5%	Notes
Completed IRM Actions	*Costs to Date for STF Portion of the Work*						
1 - Seep Interceptor Trench	$ 80,000				$ 80,000	$ 80,000	
2 - MPA Demolition and Grading	$ 880,000				$ 880,000	$ 880,000	
3 - MPA Landfarming	$ 0				$ 0	$ 0	Not STF-related
4 - Lead Impacted Soil	$ 0				$ 0	$ 0	Not STF-related
5 - MPA Channel IT and Basin IT	$ 40,000				$ 40,000	$ 40,000	
6 - MPA Spring System	$ 0				$ 0	$ 0	Not STF-related
7 - AHA Pit and Piles	$ 0				$ 0	$ 0	Not STF-related
8 - Waste Stabilization & Capping	$ 0				$ 0	$ 0	Not STF-related
9 - Groundwater Treatment System (GTS)	$ 440,000				$ 440,000	$ 440,000	
TOTAL	**$ 1,440,000**	**$ 0**			**$ 1,440,000**	**$ 1,440,000**	
Alternative 1 - No Additional Action							
Initial Capital Costs	$ 0	$ 0	1	30	$ 0	$ 0	
Ongoing/O&M Costs	$ 0	$ 0	1	30	$ 0	$ 0	
TOTAL	**$ 0**	**$ 0**			**$ 0**	**$ 0**	
Alternative 2 - Waste Excavation and Containment							
A) Existing IT Continued Operation							
Design and Construction	$ -	$ -	1	1	$ 0	$ 0	
O&M	$ -	$ 16,000	1	20	$ 320,000	$ 217,493	20 years operation
B) Groundwater Treatment System O&M							
Plan Modifications	$ 3,000	$ -	1	1	$ 3,000	$ 3,000	
O&M	$ -	$ 15,000	1	20	$ 300,000	$ 203,899	20 years operation
C) LNAPL/Product Skimming							
Initial Capital Costs	$ 8,224	$ -	1	1	$ 8,224	$ 8,224	
Ongoing/O&M Costs	$ -	$ 13,536	1	10	$ 135,360	$ 111,926	10 years active recovery
D) LTM							
Initial Capital Costs	$ 2,907	$ -	1	1	$ 2,907	$ 2,907	
Annual Sampling (Equivalent of Annual O&M)	$ -	$ 20,349	1	30	$ 345,930	$ 248,948	Yrs:1-10,12,14,16,18,20,25,30
E) MNA and NSZD							
Work Plans, QAPP, Set-up	$ 19,200	$ -	1	1	$ 19,200	$ 19,200	
MNA Each Event	$ -	$ 5,213	1	30	$ 52,125	$ 26,348	Yrs: 0,2,4,6,8,10,15,20,25,30
NSZD Each Event	$ -	$ 22,640	1	30	$ 181,120	$ 181,120	2 events 1st year, then 1/5 yrs
F) EUCs and SWMP							
Up-Front Documents and Fees	$ 7,000	$ -	1	1	$ 7,000	$ 7,000	
Annual Costs	$ -	$ 2,944	1	30	$ 88,320	$ 50,112	Annually throughout
G) Close-Out of Shared Components							
Confirmation Soil and GW Sampling	$ 61,582	$ -	20	20	$ 61,582	$ 26,684	AOC-specific close-out costs are
Well Abandonment & System Removal	$ 139,876	$ -	20	20	$ 139,876	$ 60,609	included within that component
Excavate, Stabilize, and Dispose of Waste							
Design and Construction	$ 139,220	$ -	1	1	$ 139,220	$ 139,220	North waste area removal
O&M	$ -	$ -	1	1	$ 0	$ 0	
NE Plumes Interceptor Trench							
Design and Construction	$ 683,373	$ -	1	1	$ 683,373	$ 683,373	
O&M	$ -	$ 28,800	1	20	$ 576,000	$ 391,487	
STF Creek Surface Water Sampling							
Design and Construction	$ 5,000	$ -	1	1	$ 5,000	$ 5,000	
O&M	$ -	$ 14,760	1	3	$ 44,280	$ 42,401	
TOTAL	**$ 1,069,382**	**$ 139,241**			**$ 3,112,518**	**$ 2,428,950**	

TABLE 10-3
SOUTH TANK FARM (STF)
REMEDIAL ALTERNATIVE COST SUMMARY
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Remedial Alternative Component and Task	Capital Cost	Annual O&M	Year First	Year Last	Total $	PV* 4.5%	Notes
Alternative 3 - Source Excavation, Large-Scale Containment, and MPE							
A) Existing IT Continued Operation							
Design and Construction	$ -	$ -	1	1	$ 0	$ 0	
O&M	$ -	$ 16,000	1	20	$ 320,000	$ 217,493	20 years operation
B) Groundwater Treatment System O&M							
Plan Modifications	$ 3,000	$ -	1	1	$ 3,000	$ 3,000	
O&M	$ -	$ 15,000	1	20	$ 300,000	$ 203,899	20 years operation
D) LTM							
Initial Capital Costs	$ 2,907	$ -	1	1	$ 2,907	$ 2,907	
Annual Sampling (Equivalent of Annual O&M)	$ -	$ 20,349	1	30	$ 345,930	$ 248,948	Yrs:1-10,12,14,16,18,20,25,30
E) MNA and NSZD							
Work Plans, QAPP, Set-up	$ 19,200	$ -	1	1	$ 19,200	$ 19,200	
MNA Each Event	$ -	$ 5,213	1	30	$ 52,125	$ 26,348	Yrs: 0,2,4,6,8,10,15,20,25,30
NSZD Each Event	$ -	$ 22,640	1	30	$ 181,120	$ 181,120	2 events 1st year, then 1/5 yrs
F) EUCs and SWMP							
Up-Front Documents and Fees	$ 7,000	$ -	1	1	$ 7,000	$ 7,000	
Annual Costs	$ -	$ 2,944	1	30	$ 88,320	$ 50,112	Inspections, reporting, activity
G) Close-Out of Shared Components							
Confirmation Soil and GW Sampling	$ 61,582	$ -	20	20	$ 61,582	$ 26,684	AOC-specific close-out costs are
Well Abandonment & System Removal	$ 139,876	$ -	20	20	$ 139,876	$ 60,609	included within that component
Excavate, Stabilize, and Dispose of Waste							
Design and Construction	$ 139,220	$ -	1	1	$ 139,220	$ 139,220	
O&M	$ -	$ -	1	20	$ 0	$ 0	
NE Plumes Interceptor Trench							
Design and Construction	$ 683,373	$ -	1	1	$ 683,373	$ 683,373	
O&M	$ -	$ 28,800	1	20	$ 576,000	$ 391,487	
STF Creek Interceptor Trench							
Design and Construction	$ 1,052,811	$ -	1	1	$ 1,052,811	$ 1,052,811	
O&M	$ -	$ 36,000	1	20	$ 720,000	$ 489,359	
SE Topeka St Interceptor Trench							
Design and Construction	$ 216,125	$ -	1	1	$ 216,125	$ 216,125	
O&M	$ -	$ 16,800	1	20	$ 336,000	$ 228,367	
Spot Excavate Source Area Soil							
Design and Construction	$ 846,922	$ -	1	1	$ 846,922	$ 846,922	
O&M	$ -	$ -	1	20	$ 0	$ 0	
MPE From Excavation Galleries							
Design and Construction	$ 978,223	$ -	1	1	$ 978,223	$ 978,223	
O&M	$ -	$ 91,200	1	20	$ 1,824,000	$ 1,239,708	
TOTAL	**$ 4,150,240**	**$ 254,945**			**$ 8,893,735**	**$ 7,312,915**	

Notes

*PV = Present value of current and future expenditures, using the listed net rate of return (value of money minus inflation).

A number prior to a description indicates an IRM activities. A letter prior to a description indicates an activity shared among the areas (AOCs).

TABLE 10-4
STORMWATER POND AREA (SPA)
REMEDIAL ALTERNATIVE COST SUMMARY
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Remedial Alternative Component and Task	Capital Cost	Annual O&M	Year First	Year Last	Total $	PV* 4.5%	Notes
Completed IRM Actions	*Costs to Date for SPA Portion of the Work including O&M - Future O&M Costs Included in Alternatives Below*						
1 - Seep Interceptor Trench	$ 160,000				$ 160,000	$ 160,000	
2 - MPA Demolition and Grading	$ 880,000				$ 880,000	$ 880,000	
3 - MPA Landfarming	$ 0				$ 0	$ 0	Not SPA-related
4 - Lead Impacted Soil	$ 0				$ 0	$ 0	Not SPA-related
5 - MPA Channel IT and Basin IT	$ 0				$ 0	$ 0	Not SPA-related
6 - MPA Spring System	$ 0				$ 0	$ 0	Not SPA-related
7 - AHA Pit and Piles	$ 0				$ 0	$ 0	Not SPA-related
8 - Waste Stabilization & Capping	$ 3,600,000				$ 3,600,000	$ 3,600,000	
9 - Groundwater Treatment System (GTS)	$ 220,000				$ 220,000	$ 220,000	
TOTAL	**$ 4,860,000**	**$ 0**			**$ 4,860,000**	**$ 4,860,000**	
Alternative 1 - No Additional Action							
Initial Capital Costs	$ 0	$ 0	1	30	$ 0	$ 0	
Ongoing/O&M Costs	$ 0	$ 0	1	30	$ 0	$ 0	
TOTAL	**$ 0**	**$ 0**			**$ 0**	**$ 0**	
Alternative 2 - Seep IT and Cap Maintenance							
A) Existing IT Continued Operation							
Design and Construction	$ -	$ -	1	1	$ 0	$ 0	
O&M	$ -	$ 8,000	1	20	$ 160,000	$ 108,746	20 years operation
B) Groundwater Treatment System O&M							
Plan Modifications	$ 1,500	$ -	1	1	$ 1,500	$ 1,500	
O&M	$ -	$ 7,500	1	20	$ 150,000	$ 101,950	20 years operation
C) LNAPL/Product Skimming							
Initial Capital Costs	$ -	$ -	0	0	$ 0	$ 0	Included as contingency
Ongoing/O&M Costs	$ -	$ -	0	0	$ 0	$ 0	No free product present
D) LTM							
Initial Capital Costs	$ 930	$ -	1	1	$ 930	$ 930	
Annual Sampling (Equivalent of Annual O&M)	$ -	$ 6,512	1	30	$ 110,698	$ 79,663	Yrs:1-10,12,14,16,18,20,25,30
E) MNA and NSZD							
Work Plans, QAPP, Set-up	$ 9,600	$ -	1	1	$ 9,600	$ 9,600	
MNA Each Event	$ -	$ 3,475	20	30	$ 34,750	$ 12,719	Annually years 20 to 30
NSZD Each Event	$ -	$ -			$ 0	$ 0	Cap and wetlands inhibit
F) EUCs and SWMP							
Up-Front Documents and Fees	$ 10,500	$ -	1	1	$ 10,500	$ 10,500	
Annual Costs	$ -	$ 4,416	1	30	$ 132,480	$ 75,169	
G) Close-Out of Shared Components							
Confirmation Soil and GW Sampling	$ 30,791	$ -	20	20	$ 30,791	$ 13,342	AOC-specific close-out costs are
Well Abandonment & System Removal	$ 69,938	$ -	20	20	$ 69,938	$ 30,304	included within that component
Inspect and Maintain Cap							
Work Plan	$ -	$ -	1	1	$ 0	$ 0	
O&M - Annual Inspections	$ -	$ 4,640	1	30	$ 139,200	$ 78,982	
TOTAL	**$ 123,259**	**$ 34,543**			**$ 850,387**	**$ 523,405**	

TABLE 10-4
STORMWATER POND AREA (SPA)
REMEDIAL ALTERNATIVE COST SUMMARY
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Remedial Alternative Component and Task	Capital Cost	Annual O&M	Year First	Year Last	Total $	PV* 4.5%	Notes
Alternative 3 - MPE, Seep IT, and Cap Maintenance							
A) Existing IT Continued Operation							
Design and Construction	$ -	$ -	1	1	$ 0	$ 0	
O&M	$ -	$ 8,000	1	20	$ 160,000	$ 108,746	20 years operation
B) Groundwater Treatment System O&M							
Plan Modifications	$ 1,500	$ -	1	1	$ 1,500	$ 1,500	
O&M	$ -	$ 7,500	1	20	$ 150,000	$ 101,950	20 years operation
C) LNAPL/Product Skimming							
Initial Capital Costs	$ -	$ -	0	0	$ 0	$ 0	Included as contingency
Ongoing/O&M Costs	$ -	$ -	0	0	$ 0	$ 0	No free product present
D) LTM							
Initial Capital Costs	$ 930	$ -	1	1	$ 930	$ 930	
Annual Sampling (Equivalent of Annual O&M)	$ -	$ 6,512	1	30	$ 110,698	$ 79,663	Yrs:1-10,12,14,16,18,20,25,30
E) MNA and NSZD							
Work Plans, QAPP, Set-up	$ 9,600	$ -	1	1	$ 9,600	$ 9,600	
MNA Each Event	$ -	$ 3,475	20	30	$ 34,750	$ 12,719	Annually years 20 to 30
NSZD Each Event	$ -	$ -	0	0	$ 0	$ 0	Cap and wetlands inhibit
F) EUCs and SWMP							
Up-Front Documents and Fees	$ 10,500	$ -	1	1	$ 10,500	$ 10,500	
Annual Costs	$ -	$ 4,416	1	30	$ 132,480	$ 75,169	
G) Close-Out of Shared Components							
Confirmation Soil and GW Sampling	$ 30,791	$ -	20	20	$ 30,791	$ 13,342	AOC-specific close-out costs are
Well Abandonment & System Removal	$ 69,938	$ -	20	20	$ 69,938	$ 30,304	included within that component
Inspect and Maintain Cap							
Work Plan	$ -	$ -	1	1	$ 0	$ 0	
O&M - Annual Inspections	$ -	$ 4,640	1	30	$ 139,200	$ 78,982	
MPE in Seep IT and 2 Additional ITs							
Design and Construction	$ 1,988,609	$ -	1	1	$ 1,988,609	$ 1,988,609	
O&M	$ -	$ 69,600	1	20	$ 1,392,000	$ 946,093	
TOTAL	**$ 2,111,868**	**$ 104,143**			**$ 4,230,996**	**$ 3,458,107**	

Notes

*PV = Present value of current and future expenditures, using the listed net rate of return (value of money minus inflation).

A number prior to a description indicates an IRM activities. A letter prior to a description indicates an activity shared among the areas (AOCs).

TABLE 11-1
MAIN PROCESS AREA (MPA)
COMPARISON OF REMEDIAL ALTERNATIVES
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Screening Criteria	Alternative 1 No Additional Action	Alternative 2 Interceptor Trenches and Phytoremediation	Alternative 3 Seep Interceptor Trench and Excavation
Overall Protection of Health and the Environment	**Moderate** Exposure pathways remain.	**Very High** Exposure pathways broken and migration controlled/prevented.	**Very High** Exposure pathways broken and migration controlled/prevented.
Direct Contact/Soil Ingestion Protection	*Moderate - Much work already completed but exposure risks remain*	*Very High - Cover, EUCs, and SWMP*	*Very High - Soil/Rock excavated/treated, EUCs, and SWMP*
Groundwater Ingestion Existing/Future Protection	*Moderately Low - A chance of nearby drinking water well installation*	*Very High - Basin IT, Seep IT, and EUCs*	*Very High - Seep IT, and EUCs*
Environmental Protection	*Moderate - Vapor intrusion, resumption of discharge to river*	*Very High - Human/ecological receptors protected & plumes contained*	*Very High - Human/ecological receptors protected & plumes contained*
Compliance with ARARs	**Low** Several ARARs may not be obtained. Free product not addressed.	**Very High** Wastes have been addressed, free product has been/would be addressed, & soil/groundwater ARARs would eventually be achieved.	**Very High** Free product and wastes would be addressed and ARARs would be achieved for soil (rapidly) & groundwater (over time).
Chemical-Specific Compliance	*Low - Chemical-specific ARARs may not be achieved*	*High - Phytoremediation expedites obtaining soil/groundwater RBSLs*	*Very High - Excavation expedites soil/groundwater RBSLs*
Action-Specific Compliance	*No action-specific ARARs identified*	*Very High - Minor vapors and waste generation, NPDES limits readily met*	*High - Although significant vapor emissions and waste generation*
Location-Specific Compliance	*No location-specific ARARs identified*	*High - Seep IT was approved for construction within flood plain*	*High - Seep IT was approved for construction within flood plain*
Long-term Effectiveness and Permanence	**Moderately Low** Some human health and ecological risks remain unabated (VI, soil, drinking water, etc.) and remaining contaminant mass and LNAPL are not addressed.	**High** Waste consolidation/stabilization, MPA Basin (soil excavation, landfarming, LNAPL recovery), EUCs, and phytoremediation are effective and permanent	**High** Excavation removes/treats all impacted soil and weathered rock. Impacts in fractured rock (including AHA tar) would remain. Downgradient groundwater still impacted from SPA weathered rock.
Degree Magnitude of Residual Risks are Reduced	*Moderate risks remain without controls & remediation*	*High - IRM work, EUCs, and Phyto abate human and ecological risks*	*High - EUCs and excavation abate human & ecological risks*
Adequacy and Reliability of Controls	*Low - No controls*	*High - EUCs and ITs are adequate and reliable*	*High - Excavation is permanent, EUCs and ITs are reliable*
Reduction in Toxicity, Mobility, and Volume through Treatment	**Moderately High** Significant waste and source treatment have been completed, but no additional reduction will occur. (For the purposes of this criterion, MNA and NSZD are not considered "active treatment").	**Very High** Active treatment processes would be in place to enhanced previously completed work, destroying and/or immobilizing contaminant mass.	**Very High** All soil and weathered rock contaminant mass would be removed, leaving only mass in fractured rock.
Treatment Process	*Already-completed IRM work reduced much volume and mobility*	*IRM work, continued IT operation, and phytoremediation*	*IRM work and excavation*
Amount Destroyed or Treated	*Some contaminant mass has been removed (MPA Basin excavation and LNAPL recovery) but much remains that will not be addressed*	*Very High - Some contaminant mass has been removed. Most remaining mass would be treated over several decades*	*Very High - Some contaminant mass has been removed. Most remaining mass would be rapidly removed during excavation.*
Reduction in Toxicity, Mobility, and Volume	*The IRM work reduced toxicity, mobility and volume, but contaminant mass remains and is mobile (dissolved phase)*	*High - Gradual and eventually near-completed reduction in toxicity, mobility, and volume over time*	*Very High - Rapid reduction in toxicity, mobility, and volume and then gradual final fracture rock COC mass polishing*
Short-term Effectiveness *(During Construction and Implementation)*	**Moderate** No worker/community risks would occur from construction; however, numerous risks would not be effectively abated.	**High** See below, plus remedy mostly biologically degrades/destroys contaminants versus transferring them to another media (e.g. air).	**Moderate** The ratings below are not "Very High" because of vapor emissions and truck traffic during construction and significant transfer of contaminants to different media (landfill or air) vs. destruction.
Community Protection	*Moderate - Seeps in WBWR resume and could excavate & install wells if sold*	*High - Cover, ITs, and EUCs will protect the public*	*Moderate - Notable risks created from truck traffic and VOC vapors*
Worker Protection	*Moderate - Could excavate (contact soil) and build (vapor intrusion) if sold*	*High - Cover, EUCs, SWMP will protect Site workers*	*Modeate - Risks of exposure during excavation/transport managed*
Environmental Impacts	*Moderate - Most risks abated, but seeps to WBWR seeps could resume*	*High Effectiveness - All environmental risks eliminated or controlled*	*High Effectiveness - All environmental risks eliminated or controlled*
Time Until CAGs achieved	*None achieved within decades and many are indefinite*	*Restoration of groundwater to its most beneficial use may require several decades. Others have been (by IRM) or will be achieved within 3 years.*	*Restoration of groundwater to its most beneficial use may require several decades. Others have been (by IRM) or will be achieved within 3 years.*
Implementability	**Moderate** Mix of high and low rankings below.	**Very High** Proven technology and methods. Readily implemented.	**Moderately High** Proven technology and methods. Readily implemented.
Ability to Construct/Operate	*Very High - IRM already implemented and nothing more to construct*	*Very High - All components readily installed and operated*	*Moderate - Excavation volumes and rock pose some logistical challenges*
Ease of Additional Action if Required	*Very High - Nothing preventing additional remedial action*	*Very High - ITs could be used for future ISCO or other injections*	*High - Clean soil backfill allows future in-situ treatment*
Ability to Monitor Effectiveness	*Very Low - No monitoring/LTM*	*Very High - LTM and WBWR Inspection*	*Very High - LTM and WBWR Inspection*
Ability to Obtain Approvals from Agencies	*High - Nothing to approve, no permits required*	*Very High - Components either already in place or approved elsewhere*	*High - Although air emissions, landfarming, and waste disposal permits*
Availability of Equip., Material, & Service	*Very High - Nothing to construct*	*Very High - Equipment and materials are readily available*	*Very High - Equipment and materials are readily available*
Community Acceptance	**Moderate** Much remediation has been completed and the MPA appearance is good. Some likely unsatisfied with incomplete remediation.	**Very High** Much work has been completed. Protection of WBWR continues with wetlands and phytoremediation "forest" as visible components.	**Moderate** Much work has been completed. Protection of WBWR continues with wetlands but landfarm VOCs and large amount of truck traffic concerns.
Cost	**High**	**High**	**Very High**
Completed Interim Remedial Measures (IRM)	*$11,500,000*	*$11,500,000*	*$11,500,000*
Additional Capital + Annual O&M	*$0*	*$3,500,000*	*$55,300,000*
Additional Capital + Annual O&M Present Value	*$0*	*$2,380,000*	*$54,900,000*

TABLE 11-2
ASPHALT HANDLING AREA (AHA)
COMPARISON OF REMEDIAL ALTERNATIVES
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Screening Criteria	Alternative 1 No Additional Action	Alternative 2 MPA Spring, Basin IT, Plus	Alternative 3 Alternative 2 Plus Additional ITs
Overall Protection of Health and the Environment	**Moderately High** Relatively isolated/low risk groundwater exposure remains.	**Very High** Exposure pathways removed/broken & migration controlled/prevented.	**Very High** Same as Alternative 2
Direct Contact/Soil Ingestion Protection	*Very High - All impacted soil/waste removed*	*Very High - IRM removed all soil exposure risks*	*Same as Alternative 2*
Groundwater Ingestion Existing/Future Protection	*Moderate - Chance of exposure if well installed in AHA Pit area*	*Very High - MPA Spring system and EUCs protect*	*Same as Alternative 2*
Environmental Protection	*Moderate - MPA Spring tar would present exposure if not controlled*	*Very High - MPA Spring system*	*Same as Alternative 2*
Compliance with ARARs	**Moderately High** Tar and low dissolved-phase concentration remain beneath and downgradient of the AHA Pit.	**Very High** Wastes have been addressed, free product has been/would be addressed, and groundwater ARARs would eventually be achieved.	**Very High** Same as Alternative 2, except incrementally higher.
Chemical-Specific Compliance	*Moderate - Chemical-specific ARARs may not be achieved*	*Very High - Groundwater RBSLs may not be exceeded or soon won't be*	*Same as Alternative 2 - enhanced by additional trenches*
Action-Specific Compliance	*No action-specific ARARs identified*	*Very High - Minor tar in MPA Spring UOWS, NPDES limits readily met*	*Same as Alternative 2*
Location-Specific Compliance	*No location-specific ARARs identified*	*No location-specific ARARs identified*	*Same as Alternative 2*
Long-term Effectiveness and Permanence	**Moderately High** A single risk remains - drinking water near the AHA Pit. With no action, trace residual LNAPL (tar) mostly within MPA would remain unabated.	**Very High** All wastes have been removed from AHA, only trace tar in fractured rock and possible dissolved phase remain	**Very High** Same as Alternative 2
Degree Magnitude of Residual Risks are Reduced	*Very High - IRM work removed nearly all exposure risks*	*Very High - IRM work and MPA Spring system significantly reduce risks*	*Same as Alternative 2*
Adequacy and Reliability of Controls	*Moderate - No control, but only one needed (water well prohibition)*	*Very High - MPA Spring system robust gravity flow and EUCs are reliable*	*Same as Alternative 2*
Reduction in Toxicity, Mobility, and Volume through Treatment	**Moderately High** Significant waste and source treatment have been completed, but no additional reduction will occur. (For the purposes of this criterion, MNA and NSZD are not considered "active treatment").	**Very High** IRM work significantly reduced the asphaltic material mobility and volume and MPA Spring system will complete the work,	**Very High** Same as Alternative 2, except incrementally higher.
Treatment Process	*Already-completed IRM work reduced nearly all volume and mobility*	*Very High - IRM excavations, MPA Spring System*	*Same as Alternative 2*
Amount Destroyed or Treated	*Nearly all asphaltic wastes and soil-piles have been stabilized within the West Pond cap.*	*Very High - Nearly all contaminant mass has been removed from AHA and treated*	*Same as Alternative 2*
Reduction in Toxicity, Mobility, and Volume	*The IRM work significantly reduced toxicity, mobility and volume, but some contaminant mass remains & is mobile - dissolved phase/tar*	*Very High - IRM work resulted in large reduction in toxicity, mobility, and volume over time*	*Same as Alternative 2 - rate of tar removal enhanced by trenches*
Short-term Effectiveness *(During Construction and Implementation)*	**Moderately High** No worker/community risks would occur from construction; however, numerous risks would not be effectively abated.	**Very High** The IRM completed most of the remedial work and MPA Spring system and EUCs complete it.	**Very High** Same as Alternative 2, except incrementally higher.
Community Protection	*Moderate - Could still install wells and be exposed at MPA Spring*	*Very High - MPA Spring System and EUCs will protect the public*	*Same as Alternative 2*
Worker Protection	*High - Workers face no identified risks within the AHA*	*Very High - EUCs will protect AHA workers*	*Same as Alternative 2*
Environmental Impacts	*Moderate Effectiveness - Tar seeps still cause some impact*	*High Effectiveness - All environmental risks eliminated or controlled*	*Same as Alternative 2*
Time Until CAGs achieved	*Restoration of groundwater to its most beneficial use and addressing tar may require more than a decade. Others have been achieved via IRM*	*Restoration of groundwater to its most beneficial use and addressing tar may require more than a decade. Others have been achieved via IRM*	*Same as Alternative 2 - rate of tar removal enhanced by trenches*
Implementability	**Moderate** Mix of high and low rankings below.	**Very High** Proven technology and methods. Readily implemented.	**Very High** Proven technology & methods. Readily implemented, including trenches.
Ability to Construct/Operate	*Very High - IRM already implemented and nothing more to construct*	*Very High - All components readily installed and operated*	*Very High - Interceptor trenches have been successfully installed at the Site*
Ease of Additional Action if Required	*Very High - Nothing preventing additional remedial action*	*Very High - Nothing prevents/inhibits future remedial action*	*Same as Alternative 2*
Ability to Monitor Effectiveness	*Low - No monitoring/LTM*	*Very High - LTM which includes MPA Spring effluent*	*Same as Alternative 2*
Ability to Obtain Approvals from Agencies	*High - Nothing to approve, no permits required*	*Very High - Components either already in place or approved elsewhere*	*Same as Alternative 2*
Availability of Equip., Material, & Service	*Very High - Nothing to construct*	*Very High - All equipment already installed*	*Very High - Interceptor trenches have been successfully installed at the Site*
Community Acceptance	**Moderately High** Much remediation has been complete. Site appearance is good with low exposure risks. Some may be unsatisfied with incomplete remediation.	**Very High** Much work has been completed. Reuse of land is possible. Residual tar and groundwater impacts relatively minor and addressed	**Very High** Same as Alternative 2
Cost	**High**	**High**	**Very High**
Completed Interim Remedial Measures (IRM)	*$2,600,000*	*$2,600,000*	*$2,600,000*
Additional Capital + Annual O&M	*$0*	*$200,000*	*$1,000,000*
Additional Capital + Annual O&M Present Value	*$0*	*$130,000*	*$800,000*

TABLE 11-3
SOUTH TANK FARM (STF)
COMPARISON OF REMEDIAL ALTERNATIVES
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Screening Criteria	Alternative 1 No Additional Action	Alternative 2 Waste Excavation and Containment	Alternative 3 Source Excavation, Large-Scale Containment, and MPE
Overall Protection of Health and the Environment	**Moderately Low** Exposure pathways remain.	**High** Exposure pathways broken and migration controlled/prevented.	**Very High** Exposure pathways broken and migration controlled/prevented.
Direct Contact/Soil Ingestion Protection	*Low - Waste and soil remain and without EUCs exposure is possible*	*High - EUCs and SWMP*	*Very High - Soil excavated, MPE, EUCs, and SWMP*
Groundwater Ingestion Existing/Future Protection	*Moderate - Site owned by EPME-PC but future water wells could be installed*	*High - Basin IT, NE Plume IT, and EUCs*	*Very High - NE Plume IT, EUCs, MPE*
Environmental Protection	*Moderate - No confirmation STF Creek remains unimpacted*	*Very High - Human/ecological receptors protected & plumes contained*	*Very High - Human/ecological receptors protected & plumes contained*
Compliance with ARARs	**Low** Several ARARs may not be obtained. Free product not addressed.	**High** Wastes and free product would be addressed, & soil/groundwater ARARs would eventually be achieved.	**Very High** Free product and wastes would be aggressively addressed and ARARs would be achieved for soil (near-term) & groundwater (over time).
Chemical-Specific Compliance	*Low - Chemical-specific ARARs may not be achieved*	*High - Chemical ARARs eventually achieved. Waste/Product addressed*	*Very High - Excavation and MPE expedite soil/groundwater RBSLs*
Action-Specific Compliance	*No action-specific ARARs identified*	*Very High - Waste generated/properly disposed. Minor vapor emissions*	*High - Although significant vapor emissions and waste generation*
Location-Specific Compliance	*Jurisdictional STF wetlands not disturbed*	*Jurisdictional STF wetlands not disturbed*	*Jurisdictional STF wetlands not disturbed*
Long-term Effectiveness and Permanence	**Moderately Low** Some human health and ecological risks remain unabated (VI, soil, drinking water, etc.) and LNAPL and sol impacts are not addressed.	**High** Waste removal and EUCs/SWMP are effective and permanent. Seep and NE Plume IT is effective.	**Very High** Multiple trenches, MPE, and excavations combined with EUCs/SWMP provide very high effectiveness and permanence.
Degree Magnitude of Residual Risks are Reduced	*Moderate risks remain without controls & remediation*	*High - Excavation, EUCs, and ITs remove or control residual risks*	*High - Excavation, EUCs, ITs, and MPE remove or control residual risks*
Adequacy and Reliability of Controls	*Low - No controls*	*High - EUCs and ITs are adequate and reliable*	*High - Excavation is permanent, EUCs, ITs, and MPE are reliable*
Reduction in Toxicity, Mobility, and Volume through Treatment	**Low** No reduction in toxicity, mobility or volume would occur - For the purposes of this criterion, MNA & NSZD are not considered "active treatment".	**Moderate** Excavation would remove waste. Active treatment processes would be in place destroying and/or immobilizing contaminant mass.	**Very High** Waste and greatest soil impacts would be removed. MPE and IT would control COC mobility and reduce volume.
Treatment Process	*None*	*Waste excavation, free product skimming, IT operation*	*Waste and soil excavation, MPE, and multiple ITs*
Amount Destroyed or Treated	*None*	*Moderate - Above-processes will remove contaminant mass*	*Very High - Some contaminant mass would be rapidly removed during excavation. Other removed through MPE and ITs, but a long-term process.*
Reduction in Toxicity, Mobility, and Volume	*None*	*Moderate - Gradual and eventually near-completed reduction in toxicity, mobility, and volume over time*	*Very High - Rapid reduction in toxicity, mobility, and volume and then gradual reductions during final long-term polishing*
Short-term Effectiveness *(During Construction and Implementation)*	**Low** No worker/community risks would occur from construction; however, numerous risks would not be effectively abated.	**High** See below, plus remedy mostly biologically degrades/destroys contaminants versus transferring them to another media (e.g. air).	**High** The ratings below are not "Very High" because of vapor emissions and truck traffic during construction and significant transfer of contaminants to different media (landfill or air) vs. destruction.
Community Protection	*Low - Could still excavate and install wells if property sold*	*High - Waste excavation, ITs, and EUCs will protect the public*	*High - Although some risks created from truck traffic and VOC vapors*
Worker Protection	*Low - Could excavate (contact soil) and build (vapor intrusion)*	*High - Waste excavation, EUCs, SWMP will protect Site workers*	*High - Risks of exposure during excavation/transport managed*
Environmental Impacts	*Moderate -Eco risk assessment found no notable environmental impacts*	*High Effectiveness - All environmental risks eliminated or controlled*	*High Effectiveness - All environmental risks eliminated or controlled*
Time Until CAGs achieved	*None achieved within decades and many are indefinite*	*Restoration of groundwater to its most beneficial use may require several decades. Others will be achieved within 3 years.*	*Restoration of groundwater to its most beneficial use may require several decades. Others have been (by IRM) or will be achieved within 3 years.*
Implementability	**Moderate** Mix of high and low rankings below.	**Very High** Proven technology and methods. Readily implemented.	**High** Proven technology and methods. Readily implemented.
Ability to Construct/Operate	*Very High - Nothing more to construct*	*Very High - All components readily installed and operated*	*High - Excavation volumes pose some logistical challenges*
Ease of Additional Action if Required	*Very High - Nothing preventing additional remedial action*	*Very High - Nothing preventing additional remedial action*	*High - Clean soil backfill allows future in-situ treatment*
Ability to Monitor Effectiveness	*Very Low - No monitoring/LTM*	*Very High - LTM and STF Creek Sampling*	*Very High - LTM effectively monitors*
Ability to Obtain Approvals from Agencies	*High - Nothing to approve, no permits required*	*Very High - Components commonly implemented*	*High - Although air emissions, landfarming, and waste disposal permits*
Availability of Equip., Material, & Service	*Very High - Nothing to construct*	*Very High - Equipment and materials are readily available*	*Very High - Equipment and materials are readily available*
Community Acceptance	**Moderate** Site appearance is good and land usable. Some likely unsatisfied with incomplete remediation.	**High** Remedy addresses all risks without large excavations/dust/traffic, noisy equipment, or VOC emissions.	**High** Although large soil excavations with related truck traffic, VOC emissions & noise/VOC emissions during DPE may be perceived not worth the risks
Cost	**High**	**High**	**Very High**
Completed Interim Remedial Measures (IRM)	*$1,400,000*	*$1,400,000*	*$1,400,000*
Additional Capital + Annual O&M	*$0*	*$3,100,000*	*$8,900,000*
Additional Capital + Annual O&M Present Value	*$0*	*$2,400,000*	*$7,300,000*

TABLE 11-4
STORMWATER POND AREA (SPA)
COMPARISON OF REMEDIAL ALTERNATIVES
FORMER COASTAL-DERBY REFINERY, EL DORADO, KANSAS

Screening Criteria	Alternative 1 No Additional Action	Alternative 2 Seep IT, Cap, and EUCs	Alternative 3 MPE and Cap
Overall Protection of Health and the Environment	**Moderate** Most exposure pathways eliminated and all wastes were addressed.	**Very High** Exposure pathways broken and migration controlled/prevented.	**Very High** Same as Alternative 2
Direct Contact/Soil Ingestion Protection	*Moderate - All impacted soil and wastes at least 2 ft below grade, but no EUCs*	*Very High - Cap, EUCs, and SWMP*	*Same as Alternative 2*
Groundwater Ingestion Existing/Future Protection	*Moderate - A chance of nearby drinking water well installation*	*Very High - Seep IT, and EUCs*	*Same as Alternative 2*
Environmental Protection	*Moderate - Resumption of discharge to river when Seep IT O&M terminated*	*Very High - Human/ecological receptors protected & plumes contained*	*Same as Alternative 2*
Compliance with ARARs	**Low** Several ARARs may not be obtained. Residual free product may be present and not addressed.	**Very High** Wastes have been addressed, free product has been/would be addressed, & soil/groundwater ARARs would eventually be achieved.	**Very High** Same as Alternative 2
Chemical-Specific Compliance	*Low - Chemical-specific ARARs may not be achieved*	*High - Flushing of weathered rock zone will eventually meet RBSLs*	*Same as Alternative 2 plus additional MPE trenches may reduce time period*
Action-Specific Compliance	*No action-specific ARARs identified*	*Very High - Wetlands readily meets NPDES requirements, few vapors*	*Same as Alternative 2 - Air emissions should also be within acceptable limits*
Location-Specific Compliance	*Seep IT was approved for construction within flood plain*	*High - Seep IT was approved for construction within flood plain*	*Same as Alternative 2*
Long-term Effectiveness and Permanence	**Moderately Low** Some human health and ecological risks remain unabated (VI, soil contact, drinking water, WBWR seep resumption, etc.) and remaining contaminant mass and LNAPL are not addressed.	**High** Waste and soil consolidation/stabilization and EUCs/SWMP controls are effective and permanent. Seep IT effective at protecting WBWR.	**Very High** Same as Alternative 2
Degree Magnitude of Residual Risks are Reduced	*Moderate risks remain without controls & remediation*	*High - IRM work, EUCs, and Seep IT abate all human and ecological risks*	*Same as Alternative 2, plus MPE accelerates contaminant removal*
Adequacy and Reliability of Controls	*Low - No controls*	*High - EUCs, cap O&M plan, and ITs are adequate and reliable*	*Same as Alternative 2*
Reduction in Toxicity, Mobility, and Volume through Treatment	**Moderately High** Significant waste and source treatment have been completed, but no additional reduction will occur. (For the purposes of this criterion, MNA is not considered "active treatment").	**Moderately High** Active treatment processes would be in place to enhanced previously completed work, destroying and/or immobilizing contaminant mass.	**Very High** Same as Alternative 2
Treatment Process	*Already-completed IRM work significantly reduced volume and mobility*	*IRM work/waste stabilization, continued Seep IT operation/wetlands O&M*	*Same as Alternative 2 plus MPE*
Amount Destroyed or Treated	*Most contaminant mass has been treated (pond sediment consolidation/stabilization) but some remains that will not be addressed*	*Very High - Most contaminant mass has been treated. Most remaining mass would be removed and destroyed over several decades*	*Same as Alternative 2 except shorter duration*
Reduction in Toxicity, Mobility, and Volume	*The IRM work reduced toxicity, mobility and volume, but contaminant mass remains and is mobile (dissolved phase)*	*Moderately High - Gradual and eventually near-completed reduction in toxicity, mobility, and volume over time*	*Same as Alternative 2*
Short-term Effectiveness *(During Construction and Implementation)*	**Moderate** No worker/community risks would occur from construction; however, numerous risks would not be effectively abated.	**High** See below, plus remedy mostly biologically degrades/destroys contaminants versus transferring them to another media (e.g. air).	**High** Same as Alternative 2, except MPE will transfer some VOCs to the atmosphere.
Community Protection	*Moderate - Seeps in WBWR resume and could excavate & install wells if sold*	*High - Cap, Seep IT, and EUCs will protect the public*	*Same as Alternative 2*
Worker Protection	*Moderate - Could excavate (contact soil) and build (vapor intrusion) if sold*	*High - Caps, EUCs, SWMP will protect Site workers*	*Same as Alternative 2*
Environmental Impacts	*Moderate - Most risks abated, but seeps to WBWR seeps could resume*	*High Effectiveness - All environmental risks eliminated or controlled*	*Same as Alternative 2*
Time Until CAGs achieved	*None achieved within decades and many are indefinite*	*Restoration of groundwater to its most beneficial use may require several decades. Others have been (by IRM) or will be achieved within 3 years.*	*Same as Alternative 2 given that MPA water will continue to flow into and recontaminate/slow clean-up of the deep SPA-area rock.*
Implementability	**Moderate** Mix of high and low rankings below.	**Very High** Proven technology and methods. Most already implemented.	**High** Same as Alternative 2.
Ability to Construct/Operate	*Very High - IRM already implemented and nothing more to construct*	*Very High - All components readily installed and operated*	*High - MPE trenches viable but difficult given area constraints/saturation*
Ease of Additional Action if Required	*Moderate - Cap and wetlands may inhibit some types of additional action*	*Very High - ITs could be used for future ISCO or other injections*	*Same as Alternative 2*
Ability to Monitor Effectiveness	*Very Low - No monitoring/LTM*	*Very High - LTM and WBWR Inspection*	*Same as Alternative 2*
Ability to Obtain Approvals from Agencies	*High - Nothing to approve, no permits required*	*Very High - Components either already in place or approved elsewhere*	*Same as Alternative 2 - Air permit or exemption should be granted*
Availability of Equip., Material, & Service	*Very High - Nothing to construct*	*Very High - Equipment and materials are readily available*	*Same as Alternative 2*
Community Acceptance	**Moderate** Much remediation has been completed and SPA appearance is good. Some likely unsatisfied with incomplete remediation.	**Very High** Much work has been completed. Protection of WBWR continues with wetlands as visible components and grassy hillside cap.	**Very High** Much work has been completed. Protection of WBWR continues with wetlands as visible components and grassy hillside cap.
Cost	**High**	**High**	**Very High**
Completed Interim Remedial Measures (IRM)	*$4,900,000*	*$4,900,000*	*$4,900,000*
Additional Capital + Annual O&M	*$0*	*$900,000*	*$4,200,000*
Additional Capital + Annual O&M Present Value	*$0*	*$520,000*	*$3,500,000*

TABLE 11-5
SUMMARY OF THE PREFERRED ALTERNATIVE
FORMER COASTAL REFINERY, EL DORADO, KANSAS

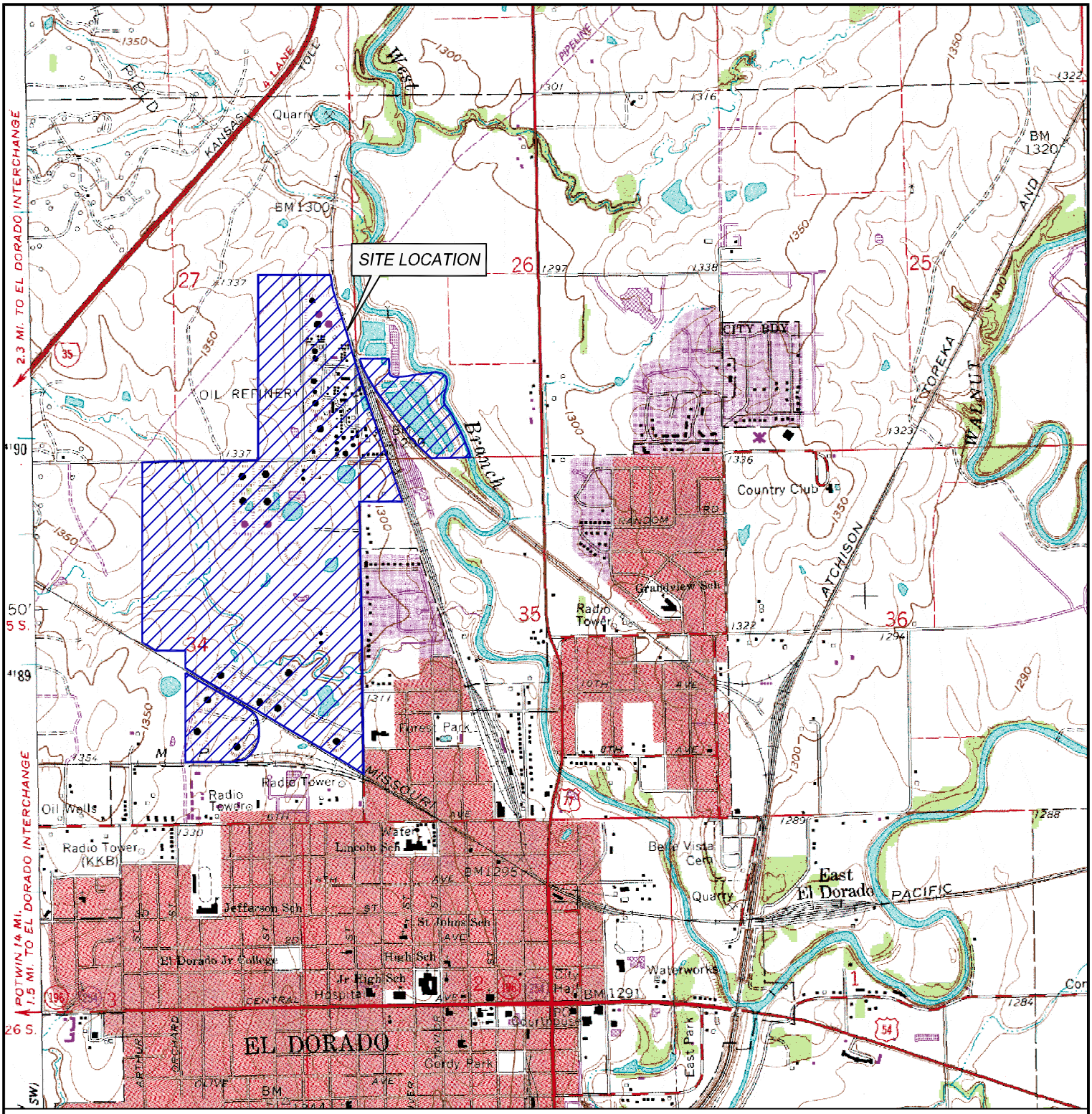
Media of Interest	Preferred Alternative	Pre-Design Data Acquisition	Contingency
Waste - LNAPL	**Alternative 2:** Excavate/Dispose of Waste (AHA), Continued IT Operation (MPA, SPA), LNAPL Skimming (MPA, SPA, STF), NSZD (if confirmed)	Waste classification and perhaps stabilization test (STF)	None
Soil	**Alternative 2:** Completed IRMs, Phytoremediation (MPA), Inspect and Maintain West Pond Cap (SPA), NSZD (if confirmed), EUCs/SWMP	Soil fertility testing (for phyto in the MPA), NSZD parameter collection and analysis	Additional excavation and MPE (STF)
Groundwater	**Alternative 2**: Completed IRMs (Seep IT, MPA Basin IT, etc.), Hydraulic Containment, MPA Spring System (AHA/MPA), LTM, MNA (if confirmed), EUCs	MNA parameter collection and analysis, Soil geotechnical data and depth to bedrock profile (STF NE Plume)	STF Creek ITs, Topeka Street IT (STF), Rehabilitation of existing ITs (MPA and SPA)
Surface Water	**Alternative 2:** Completed IRMs, Seep IT (SPA) Reinforced by Other ITs, STF Surface Water Sampling	None	STF Creek ITs, Rehabilitation or replacement of existing ITs (MPA and SPA), Increase IT pumping rates
Indoor Air	**Alternative 2**: No Additional Action	Confirm resident subslabs near the Site groundwater plumes do not exceed standards (STF)	Short-term vapor abatement and accelerated implementation of hydraulic containment (STF)

Note: Alternative components apply to all AOCs (MPA, AHA, STF, and SPA) unless a specific AOC is noted. Off-Site Areas (OSA) soil, groundwater, and surface water action requires only periodic water well surveys and associated contingency (e.g. treatment) if any are found and exceed standards.

TABLE 11-6
ESTIMATED COST OF THE PREFERRED ALTERNATIVE
FORMER COASTAL REFINERY, EL DORADO, KANSAS

Groundwater Unit	Preferred Alternative	%	Total Capital Cost	%	Total O&M Cost	%	Total Cost	%	Present Value Cost
Waste	Alternative 2	30%	$480,000	0%	$0	6%	$480,000	6%	$300,000
Soil	Alternative 2	20%	$320,000	4%	$240,000	7%	$560,000	7%	$400,000
Groundwater	Alternative 2	30%	$480,000	70%	$4,200,000	62%	$4,700,000	62%	$3,300,000
Surface Water	Alternative 2	20%	$320,000	25%	$1,500,000	24%	$1,800,000	24%	$1,300,000
Indoor Air	Alternative 2	0%	$0	1%	$60,000	1%	$60,000	1%	$40,000
TOTAL	**Alternative 2**	**100%**	**$1,600,000**	**100%**	**$6,000,000**	**100%**	**$7,600,000**	**100%**	**$5,400,000**
								Total Estimated Present Value Cost:	**$5,400,000**

FIGURES



SOURCE: U.S.G.S. 7.5' QUAD SHEET
EL DORADO, KANSAS
PHOTOREVISED 1979

SCALE

0 1,000' 2,000'

SCALE IN FEET

DESIGNED BY	M. WARNER	06/12
DRAWN BY	M. WARNER	06/12
CHECKED BY	C. PHILIPS	06/12
APPROVED BY	J. GARNSEY	06/12
PROJECT MANAGER	J. GARNSEY	06/12
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: SITE LOCATION MAP

MWH

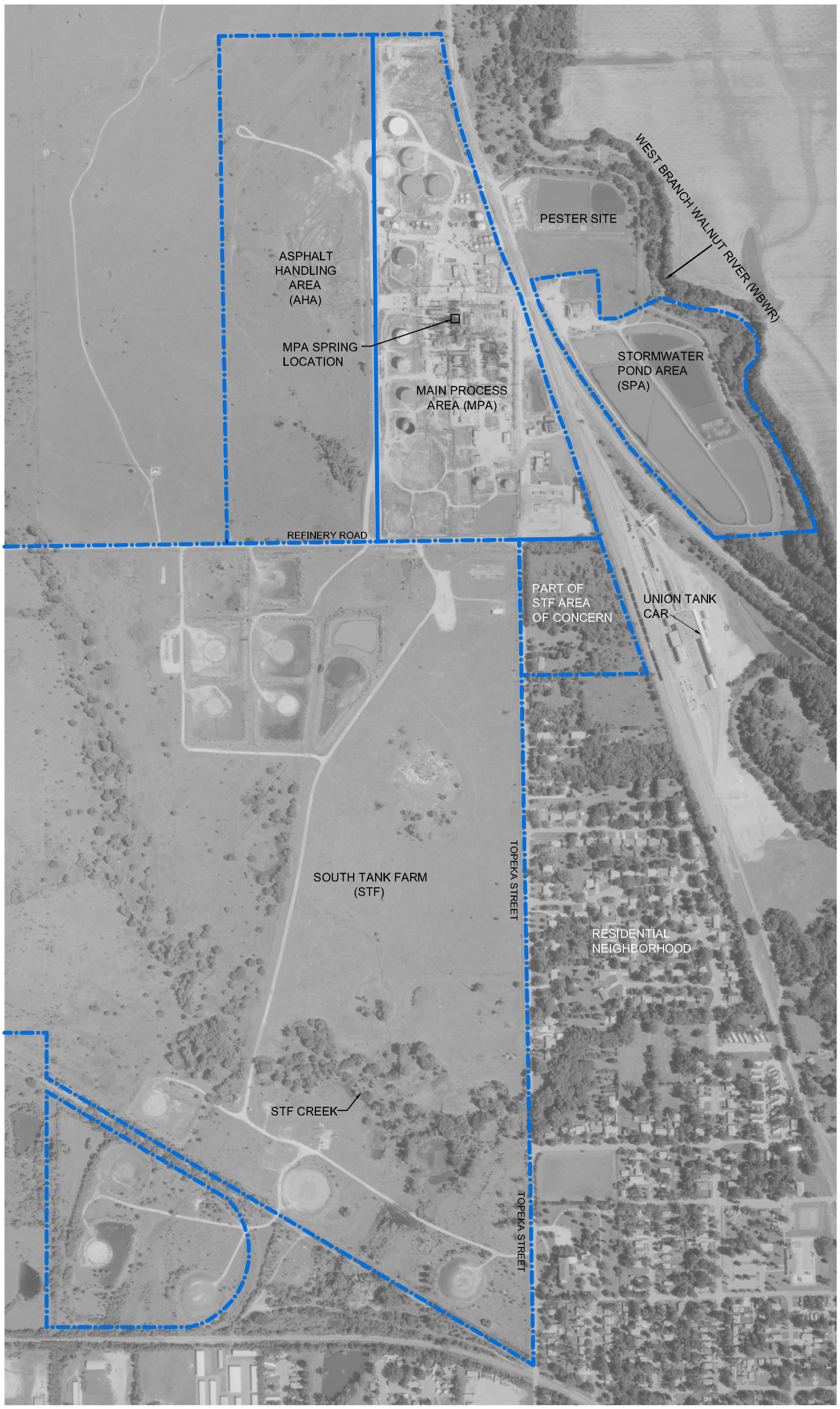
FIGURE 1-1

REVISION 1

FILE NAME: El Dorado Site Map.dwg

Print Date: June 28, 2012

Print Date: April 22, 2014



LEGEND

PROPERTY BOUNDARY

AERIAL DATE: 2005 – PRIOR TO DEMOLITION AND INTERIM REMEDIAL MEASURES (IRM)

SCALE

0 300' 600'

SCALE IN FEET

TITLE

SITE PLAN AND AREAS OF CONCERN (AOC)

FIGURE

1-2

DESIGNED BY	M. WARNER	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	C. PHILIPS	04/14
APPROVED BY	J. GARNSEY	04/14
PROJECT MANAGER	J. GARNSEY	04/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

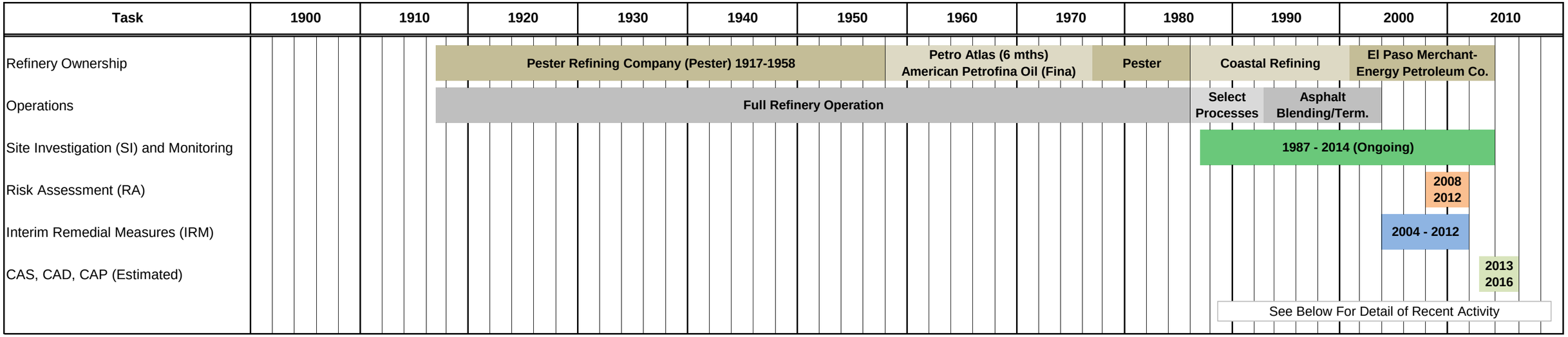
TITLE: SITE PLAN AND AREAS OF CONCERN (AOC)

MWH

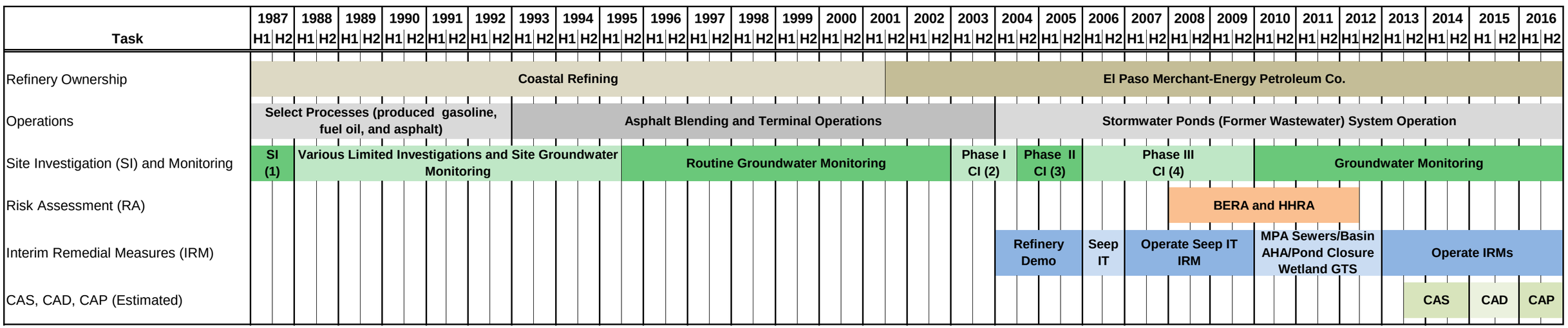
FIGURE 1-2

REVISION 1

FILE NAME: El Dorado Site Plan.dwg



DETAIL OF RECENT ACTIVITIES



(1) Site Investigation (SI) Conducted by Sunbelt Environmental Management and Mid-West Analytical Laboratories, Inc. (1986-1987)
(2) First Phase Comprehensive Investigation (CI) (March 2003 through January 2004) and Continued Site Groundwater Monitoring
(3) Second Phase CI (January 2005 through October 2005) and Continued Site Groundwater Monitoring
(4) Third Phase CI (September 2006 through September 2009) and Continued Site Groundwater Monitoring
Note: Events and schedule beyond first half of 2014 are forecast based upon proposed CAS recommendations.

Notes:
CAS - Corrective Action Study
CAD - Corrective Action Decision
CAP - Corrective Action Plan
BERA - Baseline Ecological Risk Assessment
GTS - Groundwater Treatment System
HHRA - Human Health Risk Assessment
IT - Interceptor Trench
MPA - Main Process Area

DESIGNED BY	J. TEGROTENHUIS	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	C. PHILIPS	04/14
APPROVED BY	J. TEGROTENHUIS	04/14
PROJECT MANAGER	D. MICK	04/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS
PROJECT: CORRECTIVE ACTION STUDY
TITLE: SITE ACTIVITIES TIMELINE

MWH

FIGURE: 1-3
REVISION: 0
FILE NAME: Site Timeline

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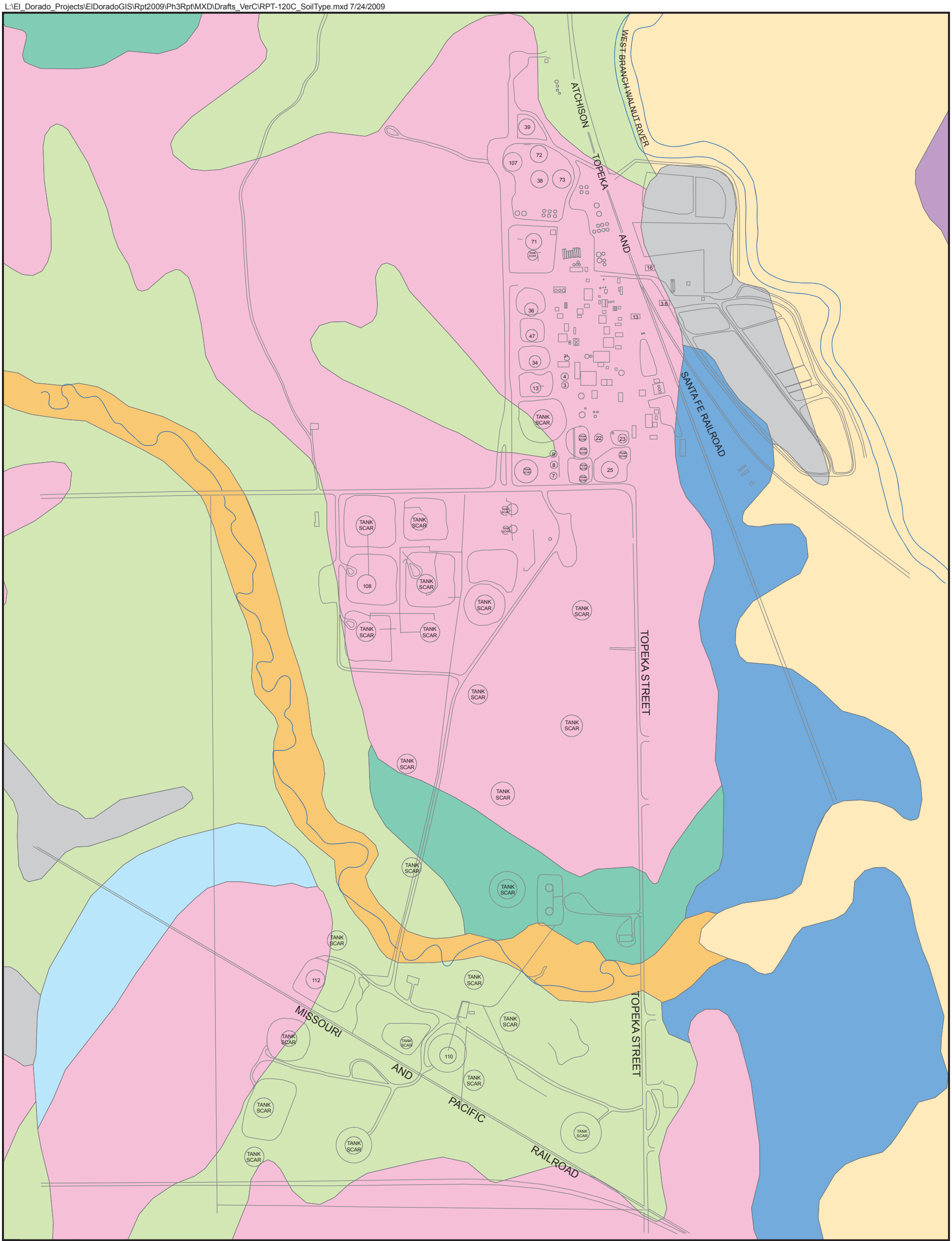


TITLE

BACKGROUND SOIL TYPE MAP

FIGURE

2-1

LEGEND:

SOIL TYPE CLASSIFICATIONS

- BREWER SILTY CLAY LOAM, RARELY FLOODED
- LABETTE SILTY CLAY LOAM, 1 TO 3 PERCENT SLOPES
- LABETTE-DWIGHT COMPLEX, 0 TO 3 PERCENT SLOPES
- LABETTE-SOGN SILTY CLAY LOAMS, 0 TO 8 PERCENT SLOPES
- NORGE SILT LOAM, 1 TO 3 PERCENT SLOPES
- OIL WASTE LAND
- SOGN SOILS, 0 TO 8 PERCENT SLOPES
- VERDIGRIS SILT LOAM, OCCASIONALLY FLOODED
- VERDIGRIS SOILS, FREQUENTLY FLOODED

N
W E
S

SCALE

0 600 1,200

SCALE IN FEET

NOTES:
SOURCE: NATURAL RESOURCES CONSERVATION SERVICE (NRCS) SOIL SURVEY, BUTLER COUNTY, KANSAS.

DRAWING REFERENCE(S):
1. LINE DRAWING SITE MAP BASED ON AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	07/09
CHECKED BY	R. Hultgren	07/09
APPROVED BY	W. Pickens	07/09
PROJECT MANAGER	D. Mick	07/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-120C_SoilType.mxd	

KINDER MORGAN

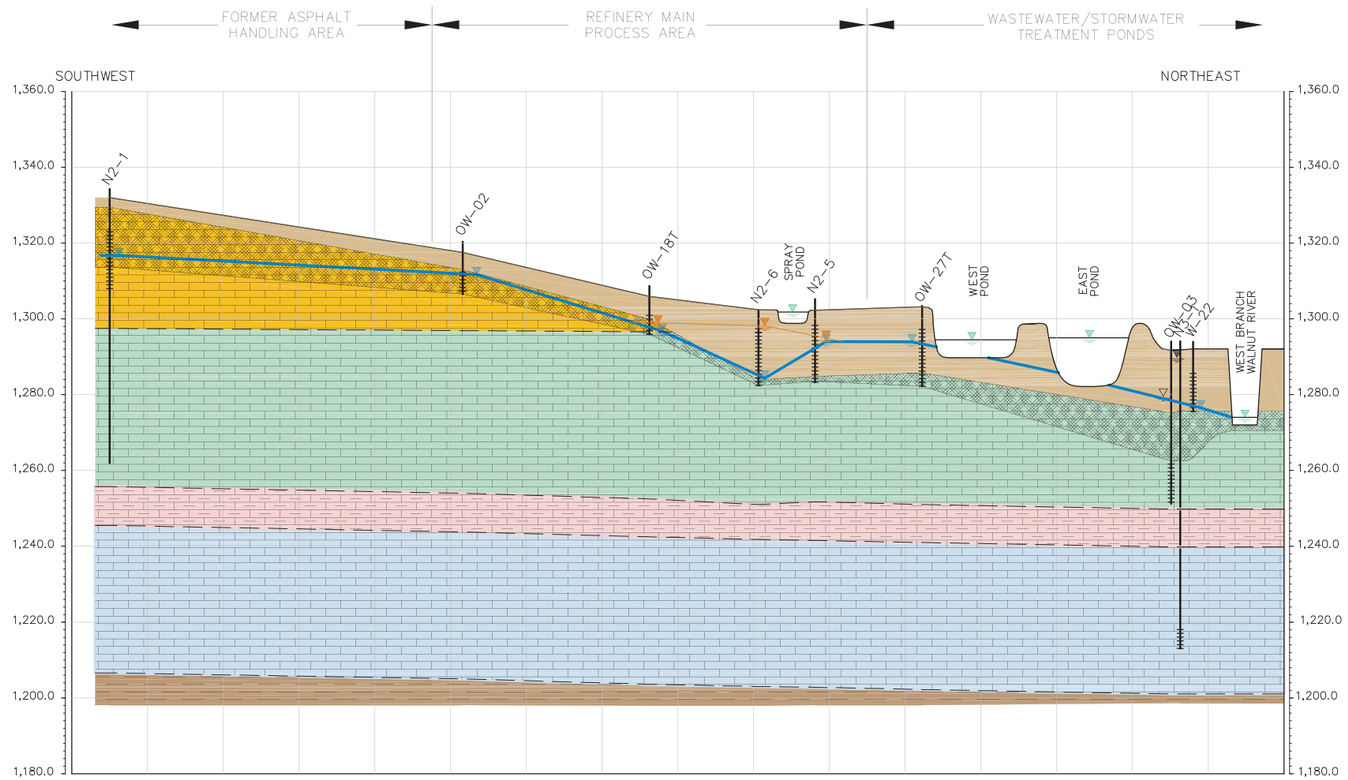
PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: BACKGROUND SOIL TYPE MAP

MWH

FIGURE: 2-1



LEGEND

- APPARENT TOP OF LNAPL ELEVATION, 8/02/05, FEET AMSL
- SURFACE WATER ELEVATION, 8/2/05, FEET AMSL
- SHALLOW WELL – GROUNDWATER TABLE ELEVATION, 8/2/05, FEET AMSL
- FORT RILEY WELL – GROUNDWATER POTENTIOMETRIC SURFACE ELEVATION, 8/2/05, FEET AMSL
- FLORENCE WELL – GROUNDWATER POTENTIOMETRIC SURFACE ELEVATION, 8/2/05, FEET AMSL
- FRACTURED ROCK
- LIMESTONE FORMATION
- SHALE FORMATION
- LIMESTONE/SHALE FORMATION
- ALLUVIUM / RESIDUUM
- DOYLE SHALE
- FORT RILEY LIMESTONE MEMBER (BARNESTON LIMESTONE)
- OKETO SHALE MEMBER (BARNESTON LIMESTONE)
- FLORENCE LIMESTONE MEMBER (BARNESTON LIMESTONE)
- BLUE SPRINGS SHALE MEMBER (MATFIELD SHALE)

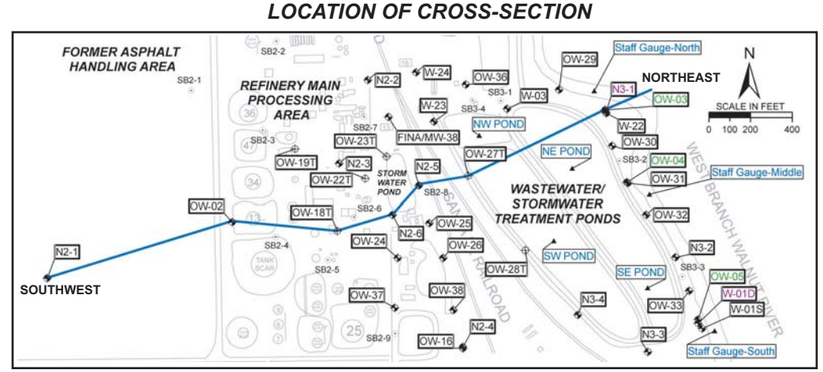
NOTE: THE DEPICTED REFINERY PONDS HAVE BEEN REPLACED BY THE MPA BASIN (SPRAY POND), CAPPED STABILIZED WASTE AREA (WEST PONDS), AND GROUNDWATER TREATMENT SYSTEM (GTS) WETLANDS (EAST PONDS).

- WELL SCREEN LOCATION
- SOIL BORING

40'
0
0
400'

HORIZONTAL SCALE: 1" = 400'
VERTICAL SCALE: 1" = 40'
VERTICAL EXAGGERATION 10X

LOCATION OF CROSS-SECTION



KINDER MORGAN

PROJECT LOCATION
FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT
CORRECTIVE ACTION STUDY

TITLE
GENERAL GEOLOGIC CROSS SECTION

MWH

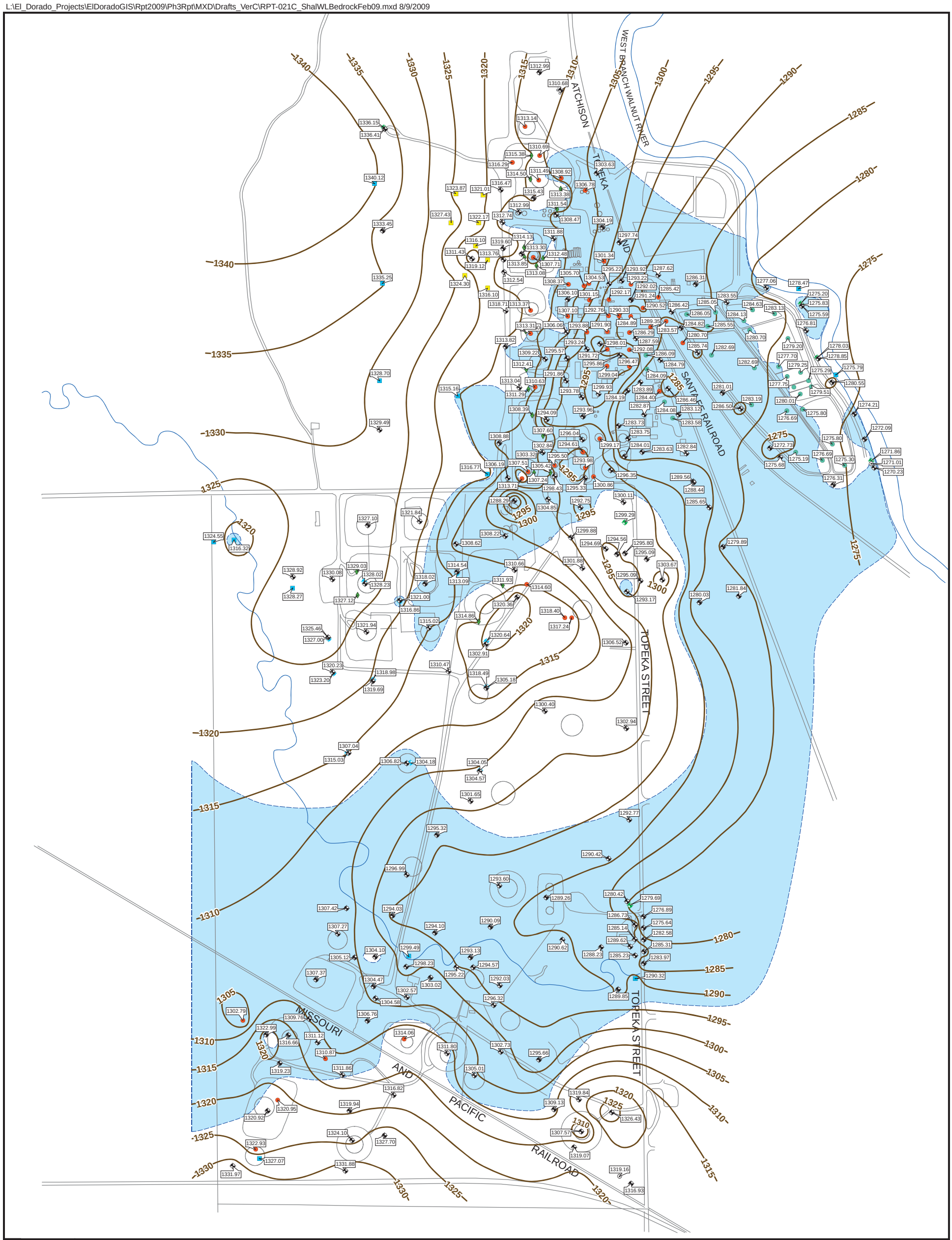
Sheet 21 Of 30 Sheets

SCALE: 1" = 400' (Horz)

FIGURE: 2-2

AutoCAD FILE: Cross-Sections.dwg PROJECT NUMBER: 1024317 L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\PDF\PrepFigs\Figure 05_GenGeologicXSect.ai

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-021C_ShalWLBedrockFeb09.mxd 8/9/2009



LEGEND:

- AHA BACKHOE SAMPLE
- SHALLOW SOIL SAMPLE
- SOIL BORING
- POND SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- DEEP WEATHERED BEDROCK MONITORING WELL (DOYLE SHALE OR SHALLOW FORT RILEY FORMATION)
- DEEP FORT RILEY MONITORING WELL
- FLORENCE MONITORING WELL
- EXTRACTION SUMP
- IN-TRENCH PIEZOMETER
- BEDROCK OUTCROP LOCATION

CONTOURS

- TOP OF BEDROCK STRUCTURE-CONTOUR, FEET AMSL (5 FOOT CONTOUR INTERVAL)
- GROUNDWATER POTENTIOMETRIC SURFACE, FEBRUARY 10-12, 2009, ABOVE TOP OF BEDROCK ELEVATION

N W E S

SCALE

0 600 1,200

SCALE IN FEET

NOTES:
WELLS AND SOIL BORING SYMBOLS LABELED WITH TOP OF BEDROCK ELEVATION IN FEET AMSL.
AMSL = ABOVE MEAN SEA LEVEL

TITLE
BEDROCK STRUCTURE-CONTOUR MAP AND SHALLOW GROUNDWATER POTENTIOMETRIC SURFACE MAP - FEBRUARY 2009

FIGURE
2-3

DRAWING REFERENCE(S):
1. LINE DRAWING SITE MAP BASED ON AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-021C_ShalWLBedrockFeb09.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

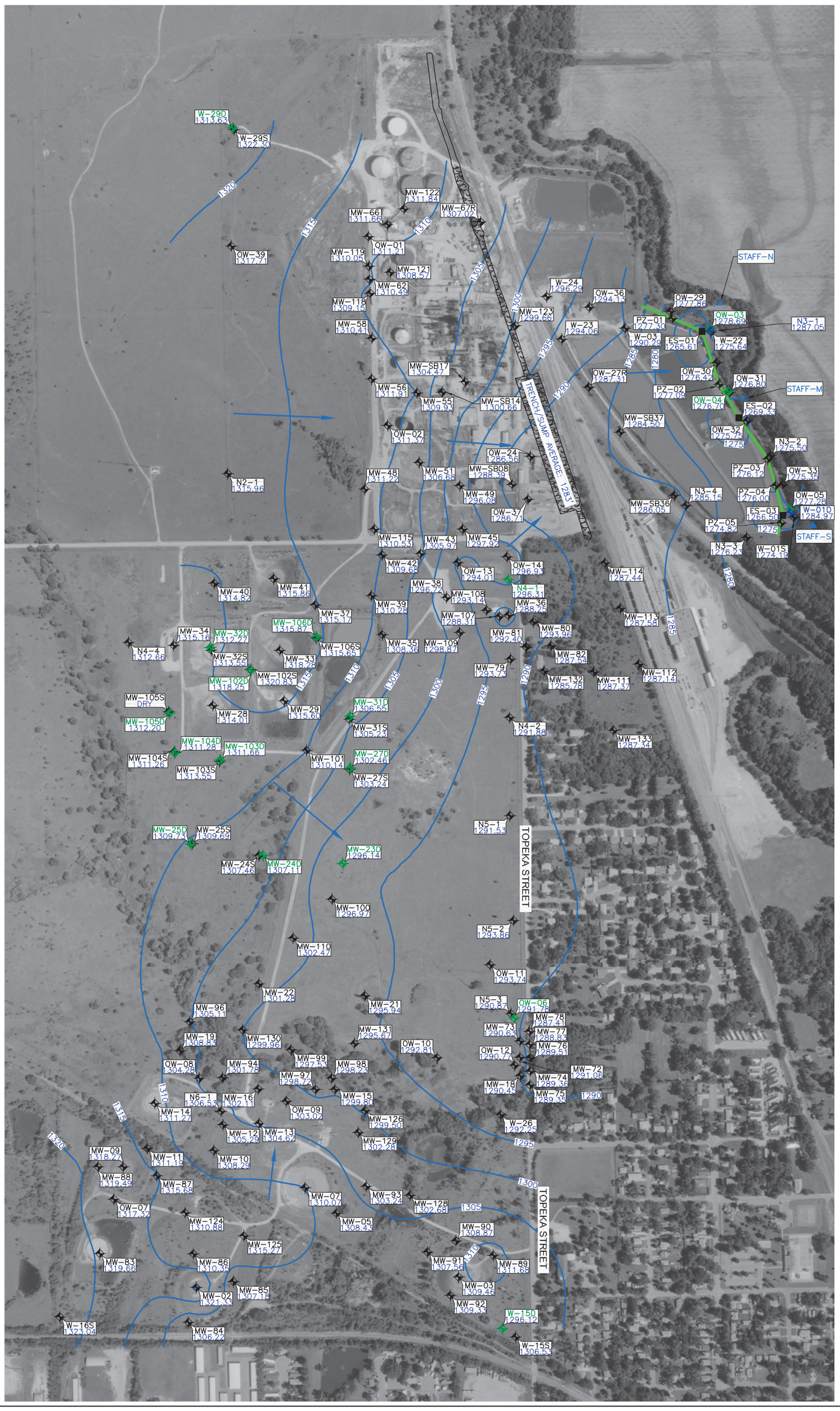
PROJECT: CORRECTIVE ACTION STUDY

TITLE: BEDROCK STRUCTURE-CONTOUR MAP AND SHALLOW GROUNDWATER POTENTIOMETRIC SURFACE MAP - FEBRUARY 2009

MWH

FIGURE: 2-3

Print Date: January 30, 2014



LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)	W-01D	FLORENCE LIMESTONE MONITORING WELL (NOT USED FOR CONTOURING)		POTENTIOMETRIC SURFACE CONTOUR (5 FOOT CONTOUR INTERVAL)
OW-06	FORT RILEY LIMESTONE MONITORING WELL (NOT USED FOR CONTOURING)	STAFF-S	SURFACE WATER GAUGE LOCATION		INFERRED POTENTIOMETRIC SURFACE CONTOUR
W-39	PESTER MONITORING WELL – WATER LEVEL ALSO GAUGED BY PESTER	STAFF-N	DESTROYED STAFF GAUGE LOCATION		GROUNDWATER FLOW DIRECTION
				NM	NOT MEASURED

SCALE

0 300' 600'

SCALE IN FEET

TITLE

POTENTIOMETRIC SURFACE MAP
OCTOBER 2, 2013

FIGURE

2-4

DESIGNED BY	M. WARNER	01/14
DRAWN BY	M. WARNER	01/14
CHECKED BY	C. PHILIPS	01/14
APPROVED BY	J. GARNSEY	01/14
PROJECT MANAGER	J. GARNSEY	01/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: POTENTIOMETRIC SURFACE MAP OCTOBER 2, 2013

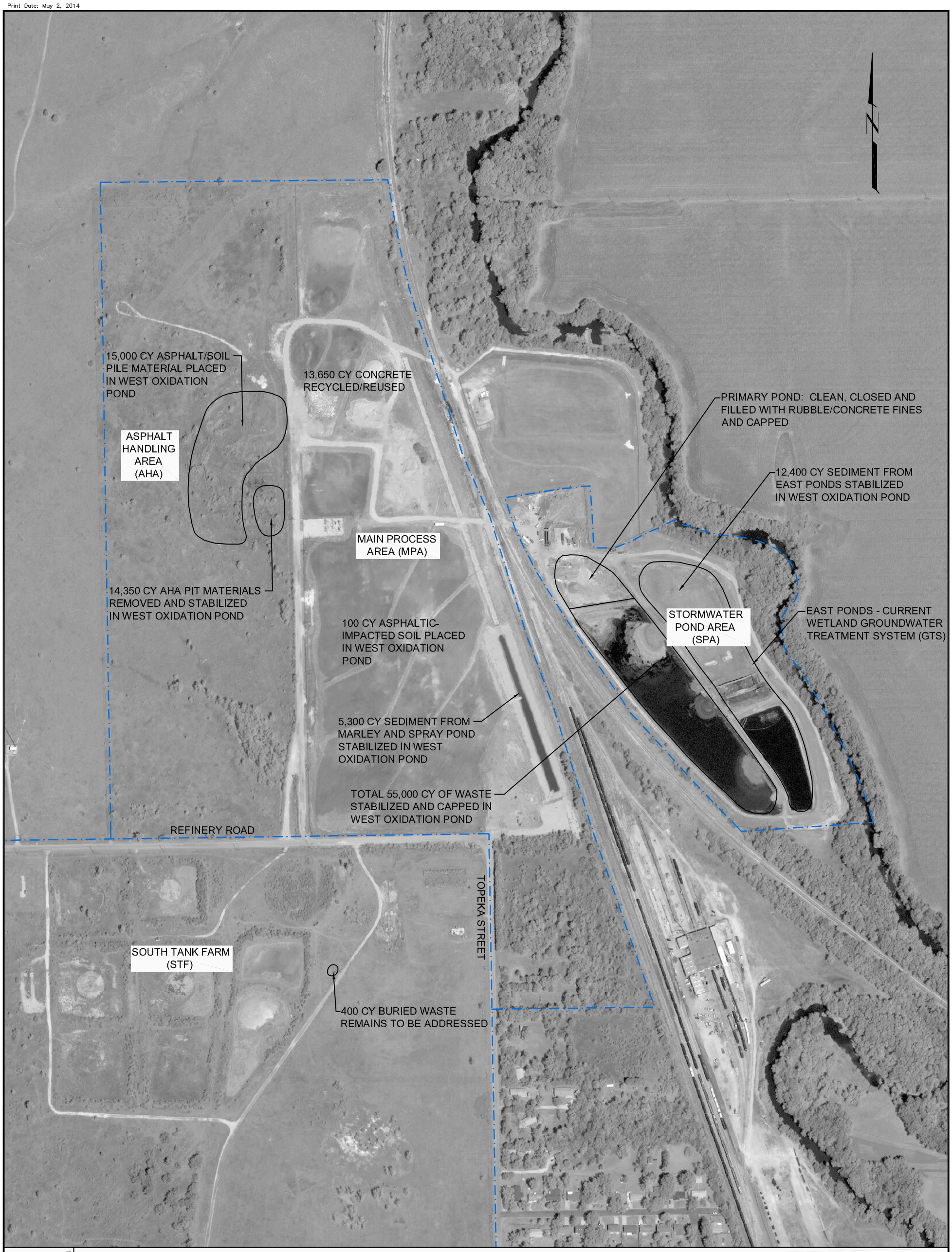
MWH

FIGURE 2-4

REVISION 1

FILE NAME: El Dorado PSM.dwg

Print Date: May 2, 2014



TITLE

WASTE MANAGEMENT SUMMARY

LEGEND

PROPERTY BOUNDARY

JULY 2011 AERIAL, MIDWAY THROUGH INTERIM REMEDIAL MEASURES (IRM)

SCALE

0 200' 400'

SCALE IN FEET

FIGURE

2-5

DESIGNED BY	J. TEGROTENHUIS	05/14
DRAWN BY	M. WARNER	05/14
CHECKED BY	C. PHILIPS	05/14
APPROVED BY	D. MICK	05/14
PROJECT MANAGER	D. MICK	05/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: WASTE MANAGEMENT SUMMARY

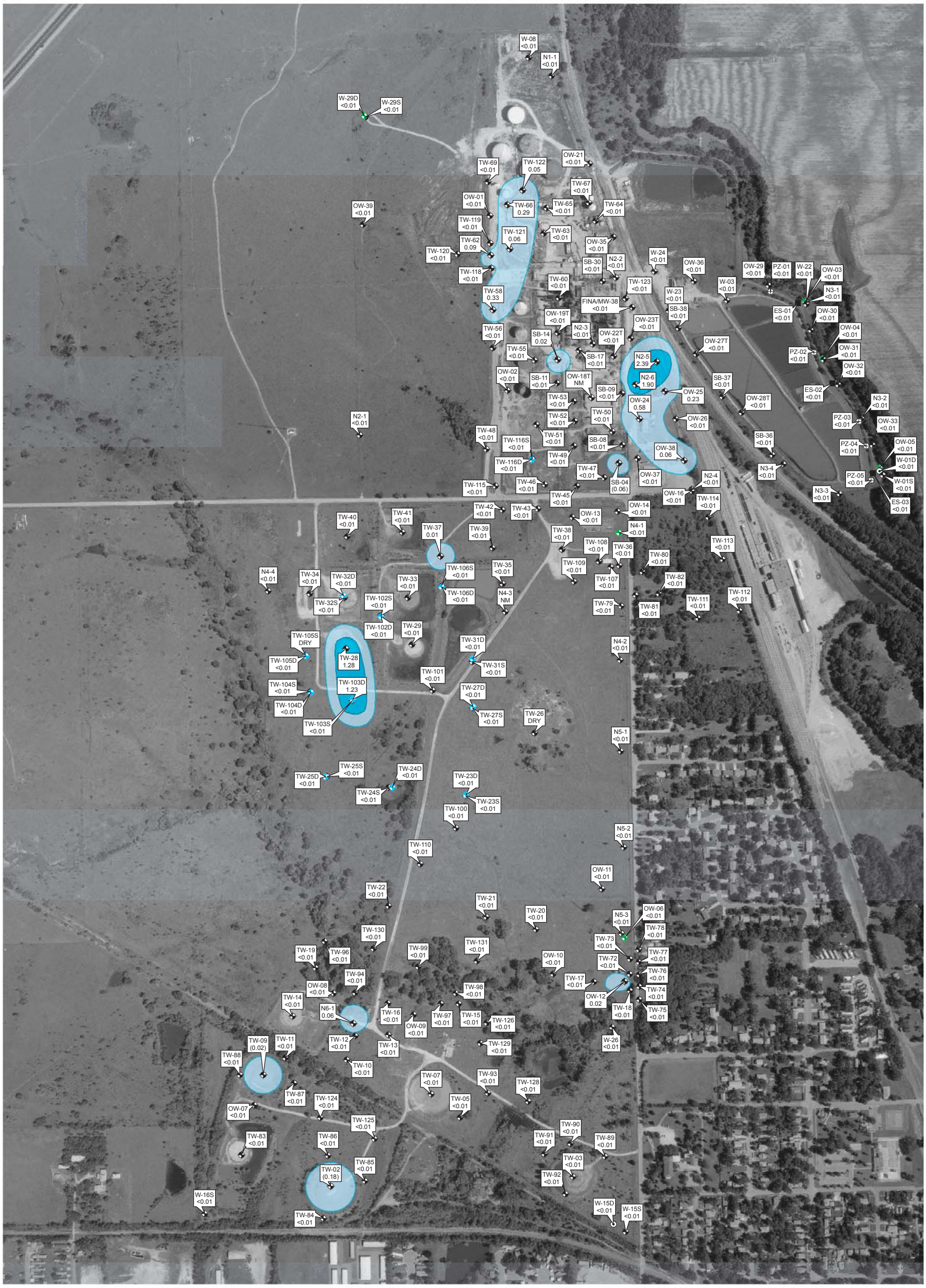
MWH

FIGURE 2-5

REVISION 1

FILE NAME: El Dorado Site Plan.dwg

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-020C_LNAPLFeb09.mxd 8/4/2009



TITLE

LNAPL ISOPACH MAP
FEBRUARY 2009

LEGEND:

- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- DEEP WEATHERED BEDROCK MONITORING WELL (DOYLE SHALE OR SHALLOW FORT RILEY FORMATION)
- DEEP FORT RILEY MONITORING WELL
- FLORENCE MONITORING WELL
- EXTRACTION SUMP
- IN-TRENCH PIEZOMETER

MEASURABLE LNAPL THICKNESS:

- LNAPL THICKNESS <0.01 FEET
- LNAPL THICKNESS 0.01-1 FEET
- LNAPL THICKNESS >1-5 FEET

N
W E
S

SCALE

0 600 1,200

SCALE IN FEET

NOTES:
SYMBOLS LABELED WITH WELL NAME AND APPARENT LNAPL THICKNESS IN WELL (FEET).
MONITORING WELLS GAUGED FEBRUARY 10, 11, AND 12, 2009.
<0.01 = WELL WITHOUT MEASURED LNAPL THICKNESS
NM = NOT MEASURED
( ) = WELLS SB-04, TW-02, AND TW-09 WERE NOT GAUGED DUE TO PONDING. LNAPL THICKNESSES FROM FEBRUARY 14, 2008 SHOWN.

DRAWING REFERENCE(S):
1. AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-020C_LNAPLFeb09.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT: CORRECTIVE ACTION STUDY

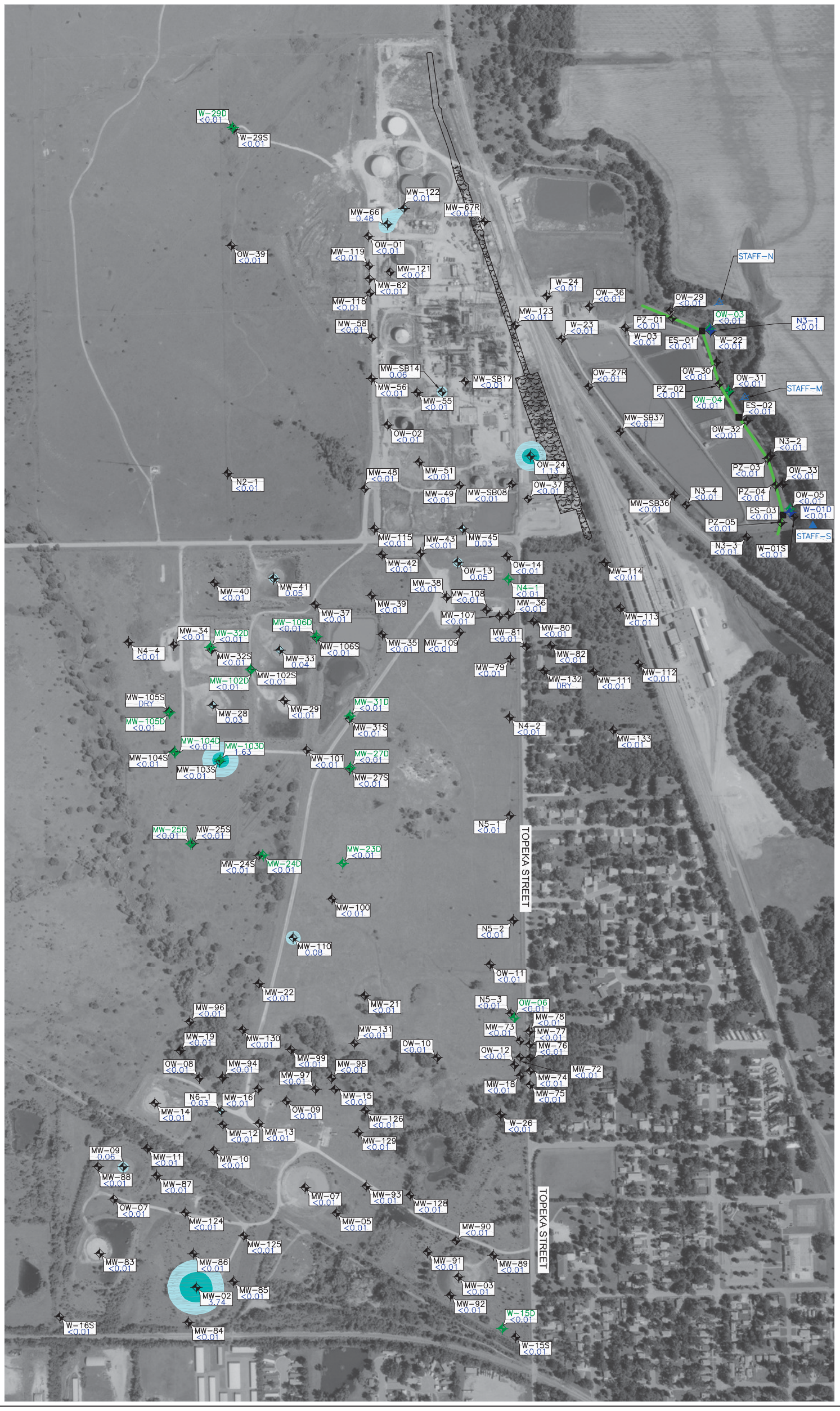
TITLE: LNAPL ISOPACH MAP FEBRUARY 2009

MWH

FIGURE: 2-6

FIGURE 2-6

Print Date: February 4, 2014



TITLE

LNAPL ISOPACH MAP
OCTOBER 2, 2013

LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)	STAFF-S	SURFACE WATER GAUGE LOCATION		APPARENT LNAPL THICKNESS 0.01–1 FEET
W-01D	FLORENCE LIMESTONE MONITORING WELL	STAFF-N	DESTROYED STAFF GAUGE LOCATION		APPARENT LNAPL THICKNESS >1–5 FEET
OW-06	FORT RILEY LIMESTONE MONITORING WELL	NM	NOT MEASURED		APPARENT LNAPL THICKNESS >5–10 FEET

SCALE

0 300' 600'

SCALE IN FEET

FIGURE 2-7

DESIGNED BY	M. WARNER	02/14
DRAWN BY	M. WARNER	02/14
CHECKED BY	C. PHILIPS	02/14
APPROVED BY	J. GARNSEY	02/14
PROJECT MANAGER	J. GARNSEY	02/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: LNAPL ISOPACH MAP OCTOBER 2, 2013

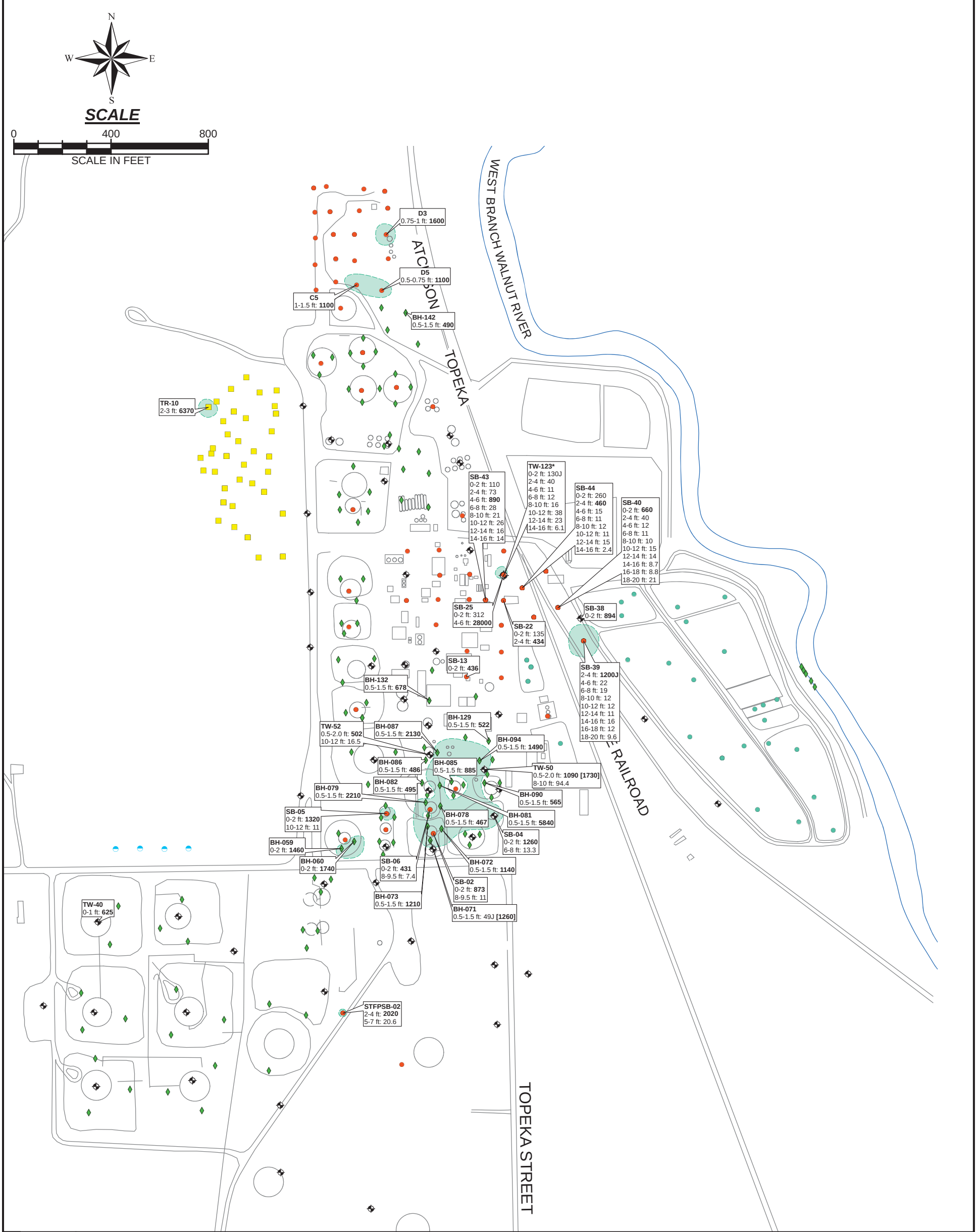
MWH

FIGURE 2-7

REVISION 1

FILE NAME: EDR 1st Half 2013 LNAPL Map.dwg

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-054C_SoilLead.mxd 8/31/2009



TITLE

LEAD IN SOIL MAP
NORTHERN AREA

LEGEND:

- BACKGROUND SOIL SAMPLE
- AHA BACKHOE SAMPLE
- SHALLOW SOIL SAMPLE
- SOIL BORING
- POND SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SHADED REGIONS

SOIL LEAD CONCENTRATION >= 1,000 mg/kg
(NON-RESIDENTIAL SCREENING LEVEL)

NOTES:

SB-04
0-2 ft: **1260**
6-8 ft: 13.3

LEAD IN SOIL RESULTS
KANSAS TIER 2 RISK-BASED STANDARD FOR RESIDENTIAL SOIL PATHWAY FOR LEAD = 400 mg/kg.
KANSAS TIER 2 RISK-BASED STANDARD FOR NON-RESIDENTIAL SOIL PATHWAY FOR LEAD = 1,000 mg/kg.
FOR SAMPLING LOCATIONS WITH AT LEAST ONE SAMPLE RESULT EXCEEDING THE RESIDENTIAL SCREENING LEVEL, LOCATIONS LABELED WITH NAME, SAMPLING DEPTH INTERVAL (FEET BGS) AND LEAD CONCENTRATION IN SOIL (mg/kg).

* ALL LEAD IN SOIL RESULTS FOR SHALLOW MONITORING WELL TW-123 WERE BELOW RESIDENTIAL AND NON-RESIDENTIAL STANDARDS. RESULTS ARE SHOWN FOR COMPARISON BETWEEN TW-123 AND SOIL BORING SB-25.

SAMPLING LOCATIONS WITHOUT ANY EXCEEDANCES ARE NOT LABELED.

RESULTS EXCEEDING RESIDENTIAL SCREENING LEVEL ARE SHOWN IN **BOLDFACE** TYPE.
J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
DUPLICATE SAMPLE RESULTS SHOWN IN BRACKETS [ ].

FIGURE
2-8

DRAWING REFERENCE(S):
1. LINE DRAWING SITE MAP BASED ON AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	07/09
CHECKED BY	R. Hultgren	07/09
APPROVED BY	W. Pickens	07/09
PROJECT MANAGER	D. Mick	07/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-054C_SoilLead.mxd	

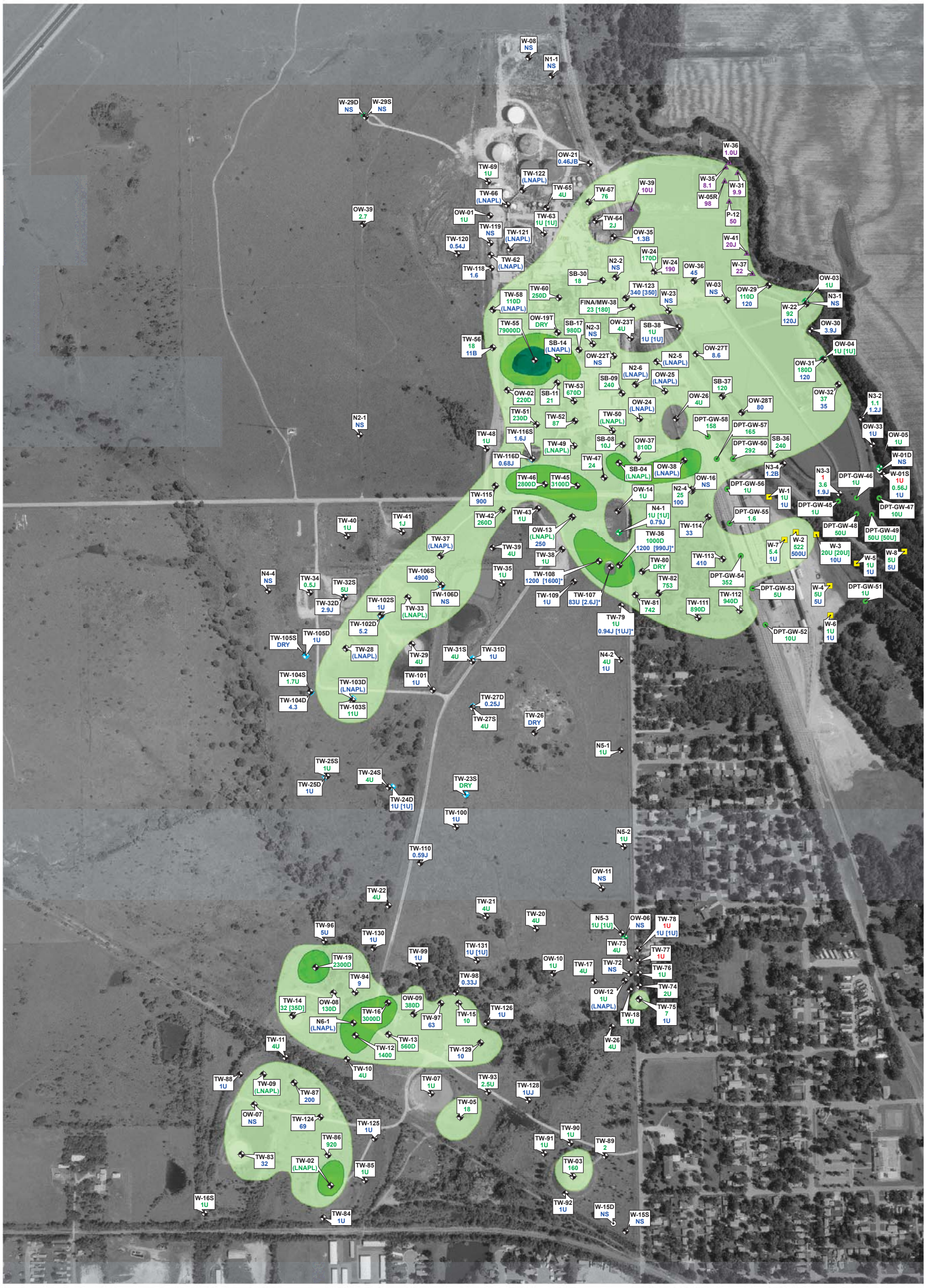
KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS
PROJECT: CORRECTIVE ACTION STUDY
TITLE: LEAD IN SOIL MAP NORTHERN AREA

MWH

FIGURE: 2-8

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-126C_GWBenzeneFeb09.mxd 8/14/2009



TITLE

BENZENE IN GROUNDWATER MAP - FEBRUARY 2009

FIGURE

2-9

LEGEND:

- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- DEEP WEATHERED BEDROCK MONITORING WELL (DOYLE SHALE OR SHALLOW FORT RILEY FORMATION)
- DEEP FORT RILEY MONITORING WELL
- FLORENCE MONITORING WELL
- UTC GEOPROBE BORING
- UTC MONITORING WELL
- PESTER MONITORING WELL

NOTES:
WELLS LABELED WITH NAME AND BENZENE CONCENTRATION IN GROUNDWATER (ug/L).
RESULTS COLOR-CODED BY SAMPLING YEAR: 2006, 2007, 2008, AND 2009.
[ ] = DUPLICATE SAMPLE RESULTS. [ ]* = RE-SAMPLED FOR LOWER DETECTION LIMIT. NS = NOT SAMPLED. N/A = NOT ANALYZED.
(LNAPL) = WELL NOT SAMPLED DUE TO PRESENCE OF LNAPL IN 2008 OR 2009. DRY = DRY MONITORING WELL NOT SAMPLED.
1U = BENZENE NOT DETECTED AT REPORTING LIMIT SHOWN. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
KANSAS TIER 2 RISK-BASED STANDARD FOR RESIDENTIAL GROUNDWATER PATHWAY FOR BENZENE = 5 ug/L.
UTC DATA SOURCE: Groundwater Monitoring Report, Union Tank Car, El Dorado, Kansas, July 2008 (The Forrester Group); and March 2009 (Foth).
PESTER DATA SOURCE: Fourth Quarter 2006 Groundwater Monitoring Report, Pester Burn Pond, El Dorado, Kansas, December 2006 (RMT, Inc.).

SHADED REGIONS:

- BENZENE <5 ug/L
- BENZENE 5 - 1,000 ug/L
- BENZENE >1,000 - 10,000 ug/L
- BENZENE >10,000 ug/L

N
W E
S

SCALE

0 600 1,200

SCALE IN FEET

DRAWING REFERENCE(S):
1. AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	C. Pappas	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-126C_GWBenzeneFeb09.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

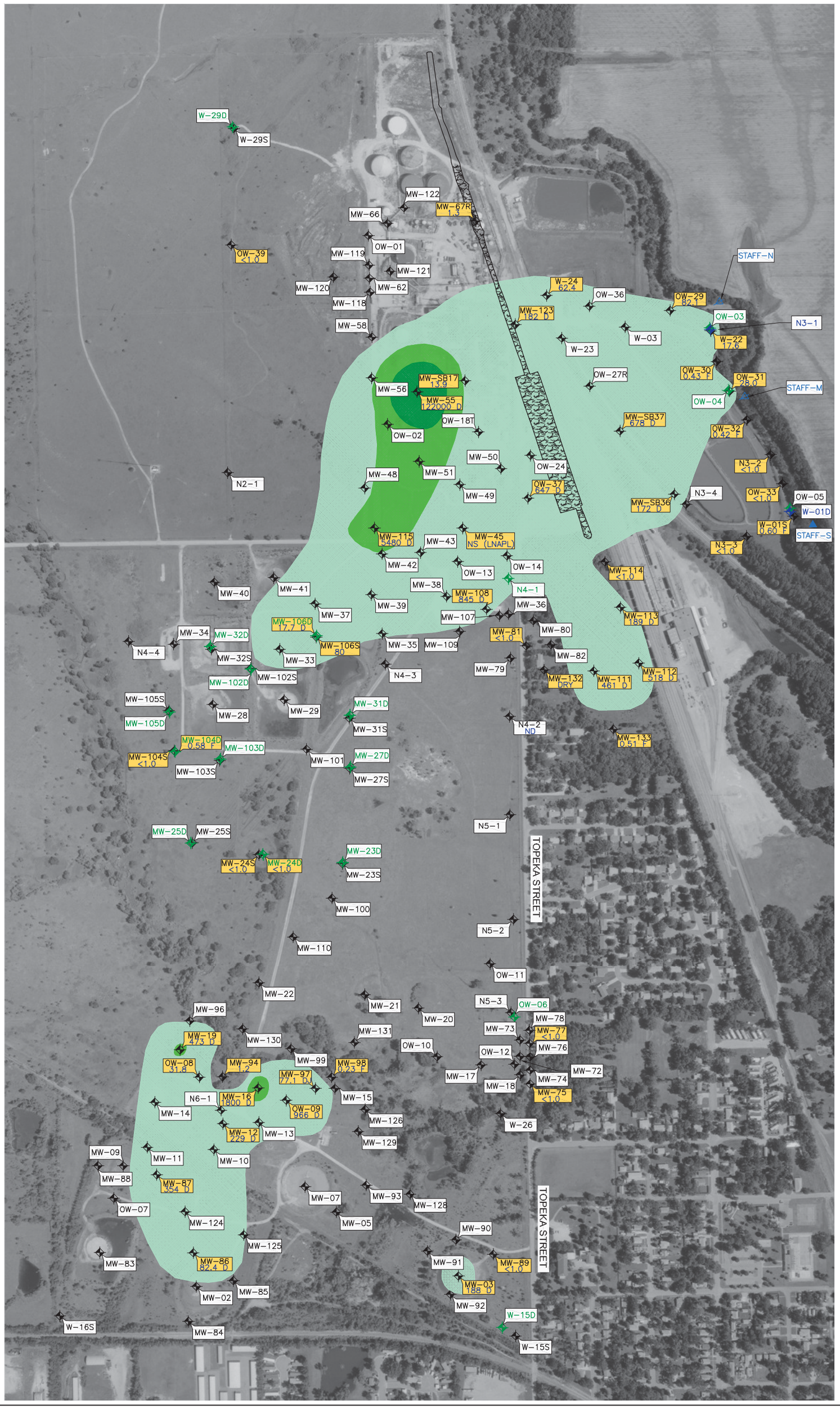
PROJECT: CORRECTIVE ACTION STUDY

TITLE: BENZENE IN GROUNDWATER MAP - FEBRUARY 2009

MWH

FIGURE: 2-9

Print Date: January 31, 2014



LEGEND

- OW-10 — SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- OW-06 — FORT RILEY LIMESTONE MONITORING WELL
- W-01D — FLORENCE LIMESTONE MONITORING WELL
- STAFF-S — SURFACE WATER GAUGE LOCATION
- MW-98 — WELL IN MONITORING PROGRAM

- BENZENE <5 ug/L
- BENZENE 5 – 1,000 ug/L
- BENZENE >1,000 – 10,000 ug/L
- BENZENE >10,000 ug/L

NOTES

1.6	BENZENE CONCENTRATION IN ug/L
<1.0	NOT DETECTED
NS	NOT SAMPLED
D	SAMPLE DILUTION REQUIRED FOR ANALYSIS. REPORTED VALUES REFLECT THE DILUTION.
F	ANALYTE WAS POSITIVELY IDENTIFIED BUT THE REPORTED CONCENTRATION IS ESTIMATED; REPORTED CONCENTRATION IS LESS THAN THE REPORTING LIMIT, BUT GREATER THAN THE METHOD DETECTION LIMIT.
J	DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.

KDHE RBSL FOR BENZENE: 5 ug/L

SCALE

0 300' 600'

SCALE IN FEET

TITLE: BENZENE IN GROUNDWATER OCTOBER 3 - OCTOBER 10 2013

FIGURE: 2-10

DESIGNED BY	W. PICKENS	01/14
DRAWN BY	M. WARNER	01/14
CHECKED BY	C. PHILIPS	01/14
APPROVED BY	D. MICK	01/14
PROJECT MANAGER	D. MICK	01/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT: CORRECTIVE ACTION STUDY

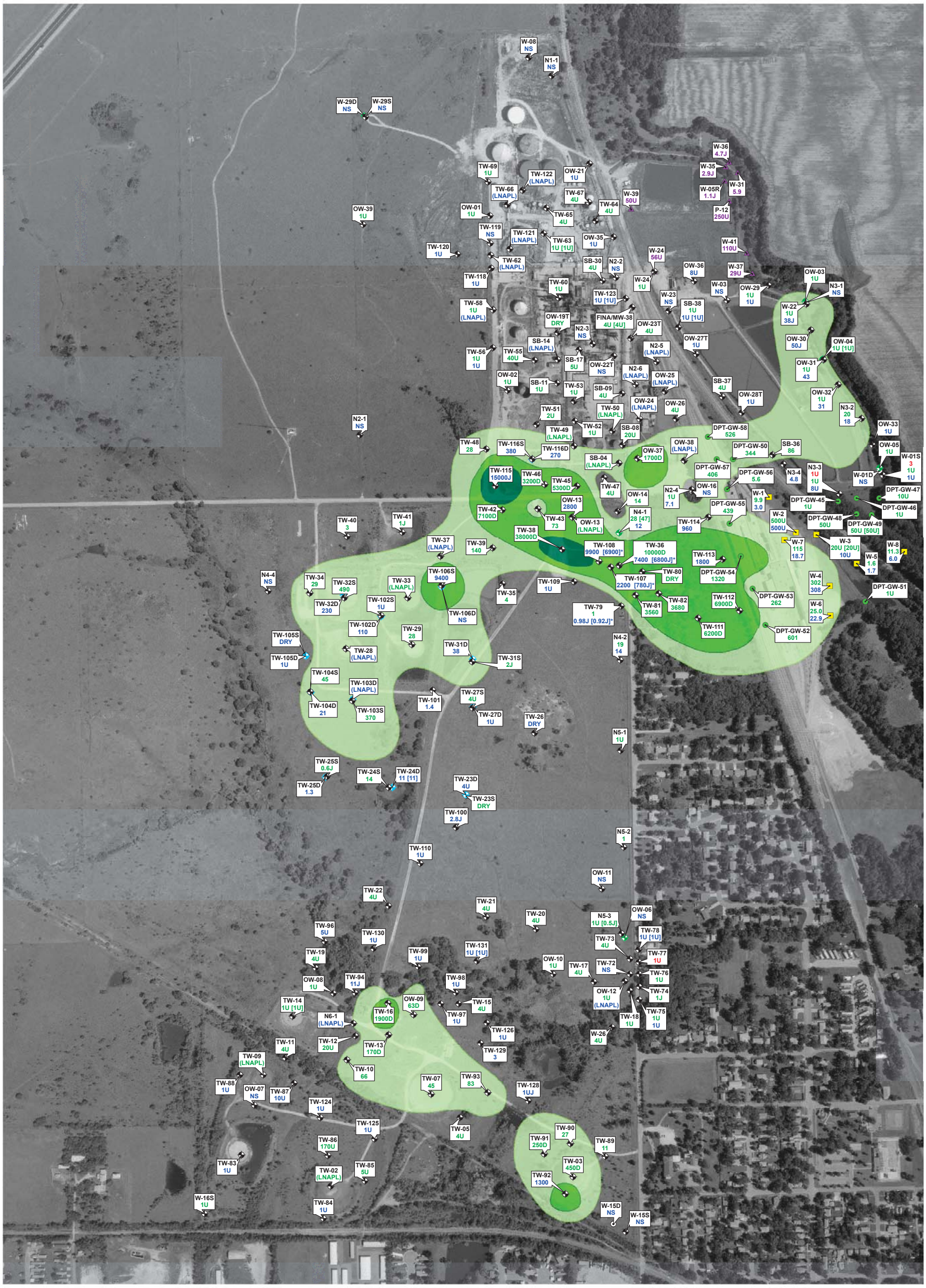
TITLE: BENZENE IN GROUNDWATER OCTOBER 3 - OCTOBER 10, 2013

MWH

FIGURE 2-10 REVISION 1

FILE NAME: EDR Fig 4-1 Benzene Conc Map.dwg

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-129C_GWMTBEFeb09.mxd 8/14/2009



TITLE

MTBE IN GROUNDWATER MAP - FEBRUARY 2009

FIGURE

2-11

LEGEND:

- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- DEEP WEATHERED BEDROCK MONITORING WELL (DOYLE SHALE OR SHALLOW FORT RILEY FORMATION)
- DEEP FORT RILEY MONITORING WELL
- FLORENCE MONITORING WELL
- UTC GEOPROBE BORING
- UTC MONITORING WELL
- PESTER MONITORING WELL

NOTES:
WELLS LABELED WITH NAME AND MTBE CONCENTRATION IN GROUNDWATER (ug/L).
RESULTS COLOR-CODED BY SAMPLING YEAR: 2006, 2007, 2008, AND 2009.
[ ] = DUPLICATE SAMPLE RESULTS. [ ]* = RE-SAMPLED FOR LOWER DETECTION LIMIT. NS = NOT SAMPLED. N/A = NOT ANALYZED.
(LNAPL) = WELL NOT SAMPLED DUE TO PRESENCE OF LNAPL IN 2008 OR 2009. DRY = DRY MONITORING WELL NOT SAMPLED.
1U = MTBE NOT DETECTED AT REPORTING LIMIT SHOWN. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
KANSAS TIER 2 RISK-BASED STANDARD FOR RESIDENTIAL GROUNDWATER PATHWAY FOR MTBE = 20 ug/L.
UTC DATA SOURCE: Groundwater Monitoring Report, Union Tank Car, El Dorado, Kansas, July 2008 (The Forrester Group); and March 2009 (Foth).
PESTER DATA SOURCE: Fourth Quarter 2006 Groundwater Monitoring Report, Pester Burn Pond, El Dorado, Kansas, December 2006 (RMT, Inc.).

SHADED REGIONS:

- MTBE <20 ug/L
- MTBE 20 - 1,000 ug/L
- MTBE >1,000 - 10,000 ug/L
- MTBE >10,000 ug/L

N
W E
S

SCALE

0 600 1,200

SCALE IN FEET

DRAWING REFERENCE(S):
1. AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	C. Pappas	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-129C_GWMTBEFeb09.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

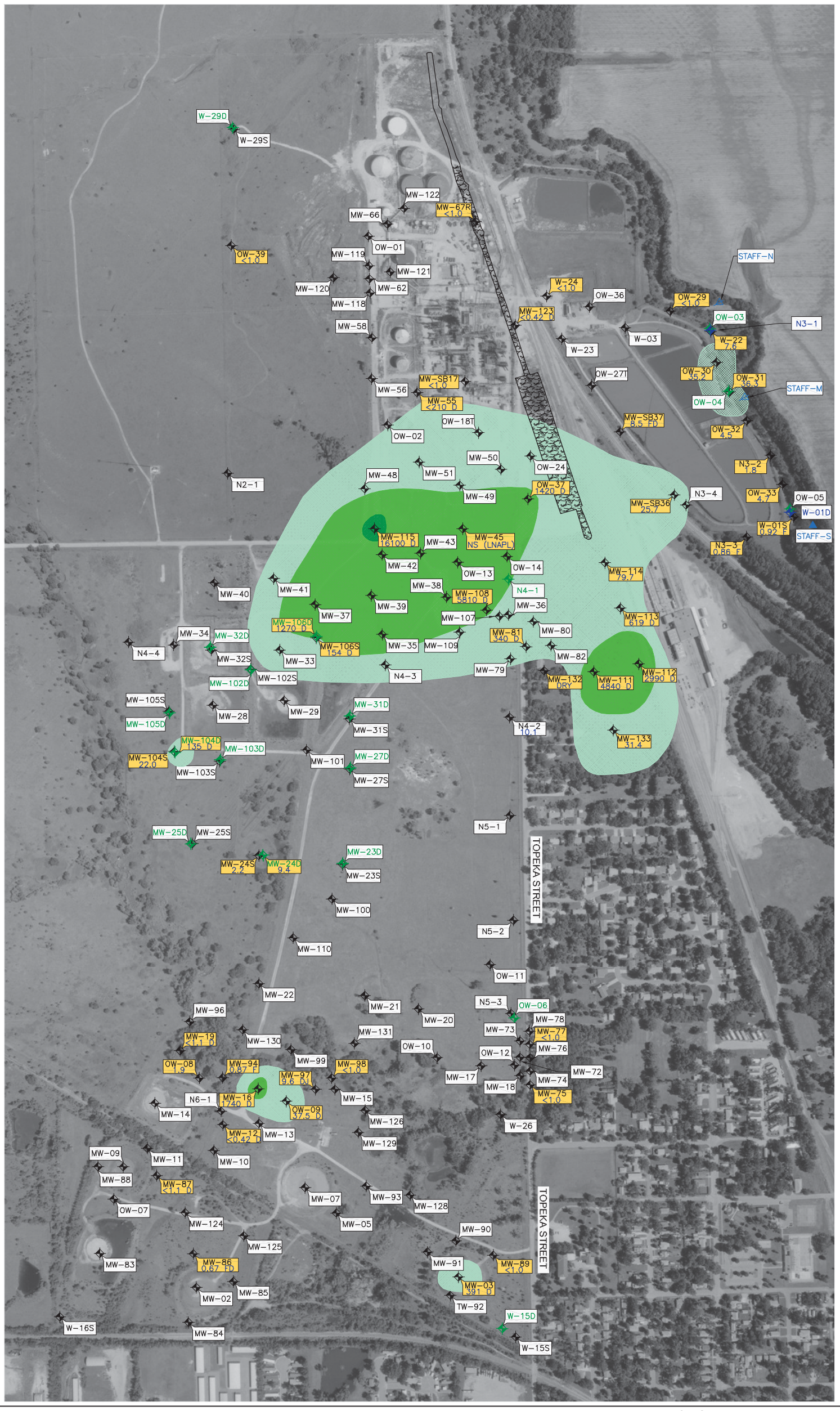
PROJECT: CORRECTIVE ACTION STUDY

TITLE: MTBE IN GROUNDWATER MAP - FEBRUARY 2009

MWH

FIGURE: 2-11

Print Date: January 31, 2014



LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
OW-06	FORT RILEY LIMESTONE MONITORING WELL
W-01D	FLORENCE LIMESTONE MONITORING WELL
STAFF-S	SURFACE WATER GAUGE LOCATION
MW-98	WELL IN MONITORING PROGRAM

	MTBE <20 ug/L
	MTBE 20 – 1,000 ug/L
	MTBE >1,000 – 10,000 ug/L
	MTBE >10,000 ug/L

NOTES

1.8	MTBE CONCENTRATION IN ug/L
<1.0	NOT DETECTED
NS	NOT SAMPLED
D	SAMPLE DILUTION REQUIRED FOR ANALYSIS. REPORTED VALUES REFLECT THE DILUTION.
F	ANALYTE WAS POSITIVELY IDENTIFIED BUT THE REPORTED CONCENTRATION IS ESTIMATE; REPORTED CONCENTRATION IS LESS THAN THE REPORTING LIMIT, BUT GREATER THAN THE METHOD DETECTION LIMIT.
J	DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.

KDHE RBSL FOR MTBE: 133 ug/L

SCALE

0 300' 600'

SCALE IN FEET

TITLE

MTBE IN GROUNDWATER
OCTOBER 3 - OCTOBER 10, 2013

FIGURE

2-12

DESIGNED BY	W. PICKENS	01/14
DRAWN BY	M. WARNER	01/14
CHECKED BY	C. PHILIPS	01/14
APPROVED BY	D. MICK	01/14
PROJECT MANAGER	D. MICK	01/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: MTBE IN GROUNDWATER OCTOBER 3 - OCTOBER 10, 2013

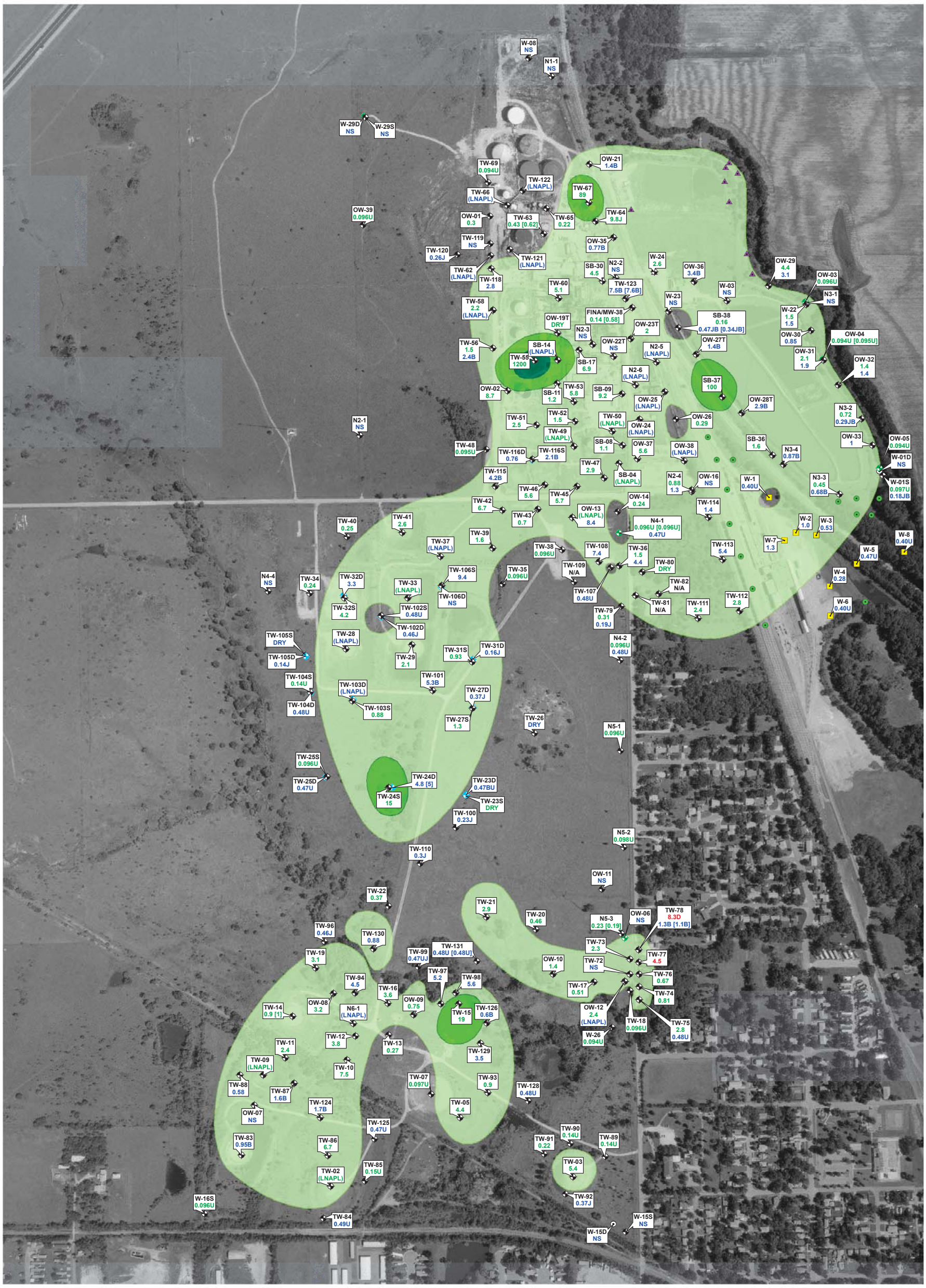
MWH

FIGURE 2-12

REVISION 1

FILE NAME: EDR Fig 4-2 MTBE Conc Map.dwg

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-128C_GWDROFeb09.mxd 8/13/2009



TITLE

TPH DRO IN GROUNDWATER MAP - FEBRUARY 2009

FIGURE

2-13

LEGEND:

- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- DEEP WEATHERED BEDROCK MONITORING WELL (DOYLE SHALE OR SHALLOW FORT RILEY FORMATION)
- DEEP FORT RILEY MONITORING WELL
- FLORENCE MONITORING WELL
- UTC GEOPROBE BORING - NOT ANALYZED FOR TPH DRO
- UTC MONITORING WELL - NOT ANALYZED FOR TPH DRO
- PESTER MONITORING WELL - NOT ANALYZED FOR TPH DRO

SHADED REGIONS:

- TPH DRO <0.5 mg/L
- TPH DRO 0.5 - 10 mg/L
- TPH DRO 10 - 100 mg/L
- TPH DRO >100 mg/L

N
W E
S

SCALE

0 600 1,200

SCALE IN FEET

NOTES:
WELLS LABELED WITH NAME AND TPH DRO CONCENTRATION IN GROUNDWATER (mg/L).
RESULTS COLOR-CODED BY SAMPLING YEAR: 2006, 2007, 2008, AND 2009.
[ ] = DUPLICATE SAMPLE RESULTS. [ ]* = RE-SAMPLED FOR LOWER DETECTION LIMIT. NS = NOT SAMPLED. N/A = NOT ANALYZED.
(LNAPL) = WELL NOT SAMPLED DUE TO PRESENCE OF LNAPL IN 2008 OR 2009. DRY = DRY MONITORING WELL NOT SAMPLED.
1U = TPH DRO NOT DETECTED AT REPORTING LIMIT SHOWN. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
KANSAS TIER 2 RISK-BASED STANDARD FOR RESIDENTIAL GROUNDWATER PATHWAY FOR TPH DRO = 0.5 mg/L.
UTC DATA SOURCE: Groundwater Monitoring Report, Union Tank Car, El Dorado, Kansas, July 2008 (The Forrester Group); and March 2009 (Foth).
PESTER DATA SOURCE: Fourth Quarter 2006 Groundwater Monitoring Report, Pester Burn Pond, El Dorado, Kansas, December 2006 (RMT, Inc.).

DRAWING REFERENCE(S):
1. AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	C. Pappas	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-128C_GWDROFeb09.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

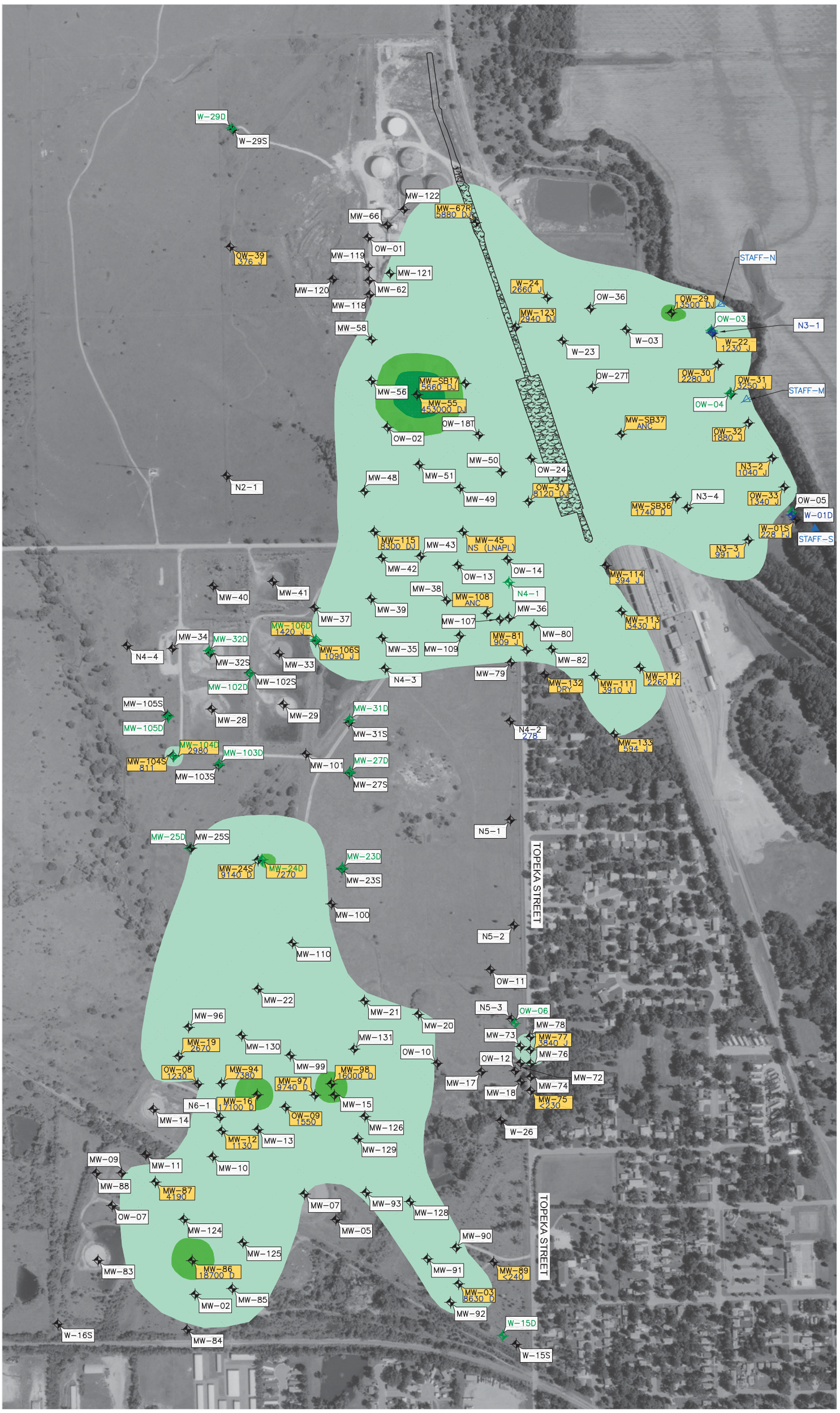
PROJECT: CORRECTIVE ACTION STUDY

TITLE: TPH DRO IN GROUNDWATER MAP - FEBRUARY 2009

MWH

FIGURE: 2-13

Print Date: February 3, 2013



LEGEND

- OW-10 — SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- OW-06 — FORT RILEY LIMESTONE MONITORING WELL
- W-01D — FLORENCE LIMESTONE MONITORING WELL
- STAFF-S — SURFACE WATER GAUGE LOCATION
- MW-98 — WELL IN MONITORING PROGRAM

- TPH-DRO <500 ug/L
- TPH-DRO 500 – 10,000 ug/L
- TPH-DRO >10,000 – 100,000 ug/L
- TPH-DRO >100,000 ug/L

NOTES

123	TPH-DRO CONCENTRATION IN ug/L
<240	NOT DETECTED
NS	NOT SAMPLED
ANC	ANALYTE NOT COLLECTED DUE TO LOW SAMPLE VOLUME
D	SAMPLE DILUTION REQUIRED FOR ANALYSIS. REPORTED VALUES REFLECT THE DILUTION.
F	ANALYTE WAS POSITIVELY IDENTIFIED BUT THE REPORTED CONCENTRATION IS ESTIMATE.
J	DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.

KDHE RBSL FOR TPH-DRO: 500 ug/L

SCALE

0 300' 600'

SCALE IN FEET

TITLE: TPH-DRO IN GROUNDWATER OCTOBER 3 - OCTOBER 10, 2013

FIGURE: 2-14

DESIGNED BY	W. PICKENS	02/14
DRAWN BY	M. WARNER	02/14
CHECKED BY	C. PHILIPS	02/14
APPROVED BY	D. MICK	02/14
PROJECT MANAGER	D. MICK	02/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT: CORRECTIVE ACTION STUDY

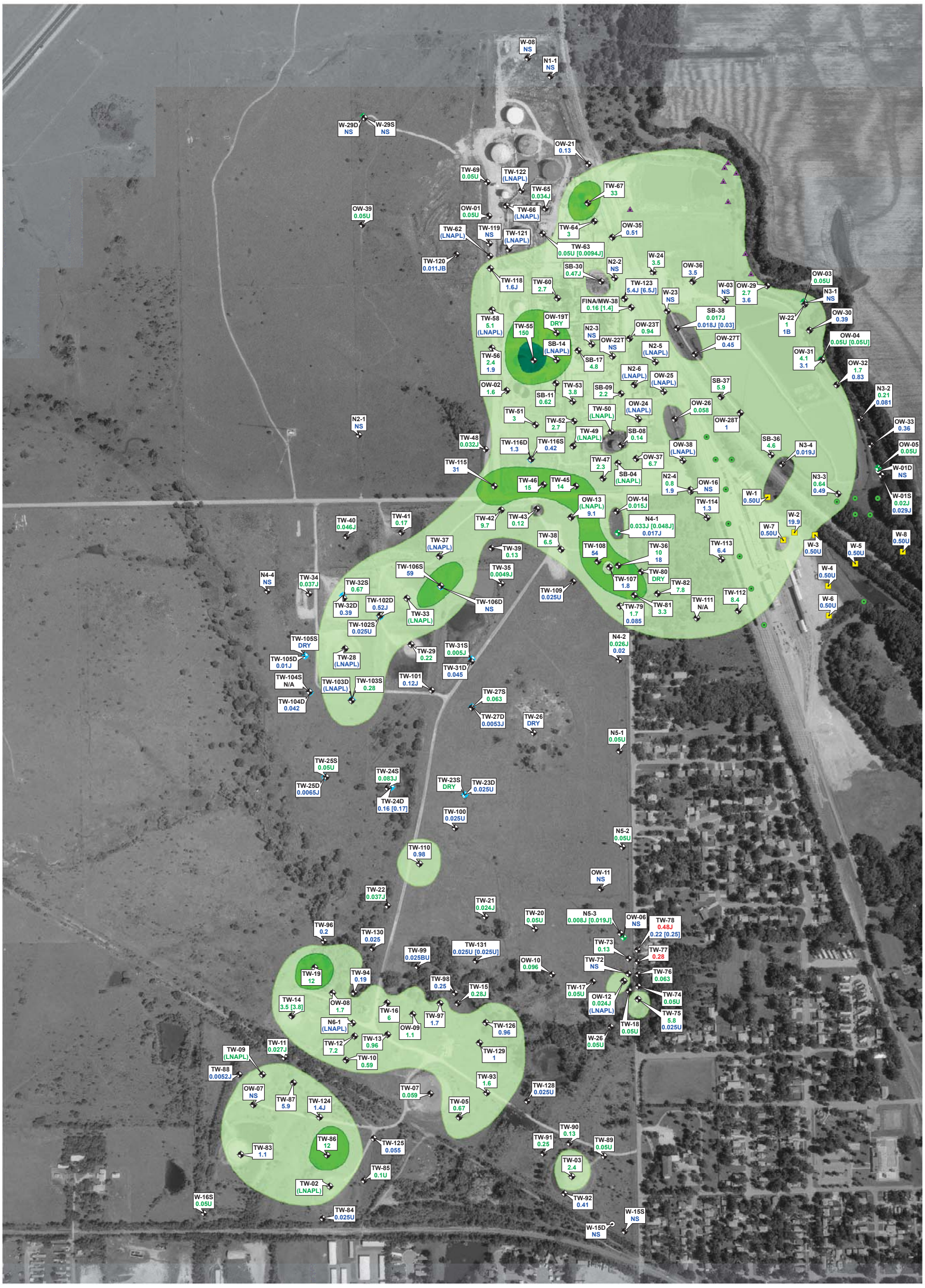
TITLE: TPH-DRO IN GROUNDWATER OCTOBER 3 - OCTOBER 10, 2013

MWH

FIGURE 2-14 REVISION 1

FILE NAME: EDR Fig 4-3 TPH-DRO Conc Map.dwg

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-127C_GWGROFeb09.mxd 8/14/2009



LEGEND:

- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- DEEP WEATHERED BEDROCK MONITORING WELL (DOYLE SHALE OR SHALLOW FORT RILEY FORMATION)
- DEEP FORT RILEY MONITORING WELL
- FLORENCE MONITORING WELL
- UTC GEOPROBE BORING
- UTC MONITORING WELL
- PESTER MONITORING WELL - NOT ANALYZED FOR TPH GRO

NOTES:
WELLS LABELED WITH NAME AND TPH GRO CONCENTRATION IN GROUNDWATER (mg/L).
RESULTS COLOR-CODED BY SAMPLING YEAR: 2006, 2007, 2008, AND 2009.
[ ] = DUPLICATE SAMPLE RESULTS. [ ]* = RE-SAMPLED FOR LOWER DETECTION LIMIT. NS = NOT SAMPLED. N/A = NOT ANALYZED.
(LNAPL) = WELL NOT SAMPLED DUE TO PRESENCE OF LNAPL IN 2008 OR 2009. DRY = DRY MONITORING WELL NOT SAMPLED.
1U = TPH GRO NOT DETECTED AT REPORTING LIMIT SHOWN. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
KANSAS TIER 2 RISK-BASED STANDARD FOR RESIDENTIAL GROUNDWATER PATHWAY FOR TPH GRO = 0.5 mg/L.
UTC DATA SOURCE: Groundwater Monitoring Report, Union Tank Car, El Dorado, Kansas, July 2008 (The Forrester Group); and March 2009 (Foth).
PESTER DATA SOURCE: Fourth Quarter 2006 Groundwater Monitoring Report, Pester Burn Pond, El Dorado, Kansas, December 2006 (RMT, Inc.).

SHADED REGIONS:

- TPH GRO <0.5 mg/L
- TPH GRO 0.5 - 10 mg/L
- TPH GRO 10 - 100 mg/L
- TPH GRO >100 mg/L

N
W E
S

SCALE

0 600 1,200
SCALE IN FEET

TITLE
TPH GRO IN GROUNDWATER MAP - FEBRUARY 2009

FIGURE
2-15

DRAWING REFERENCE(S):
1. AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

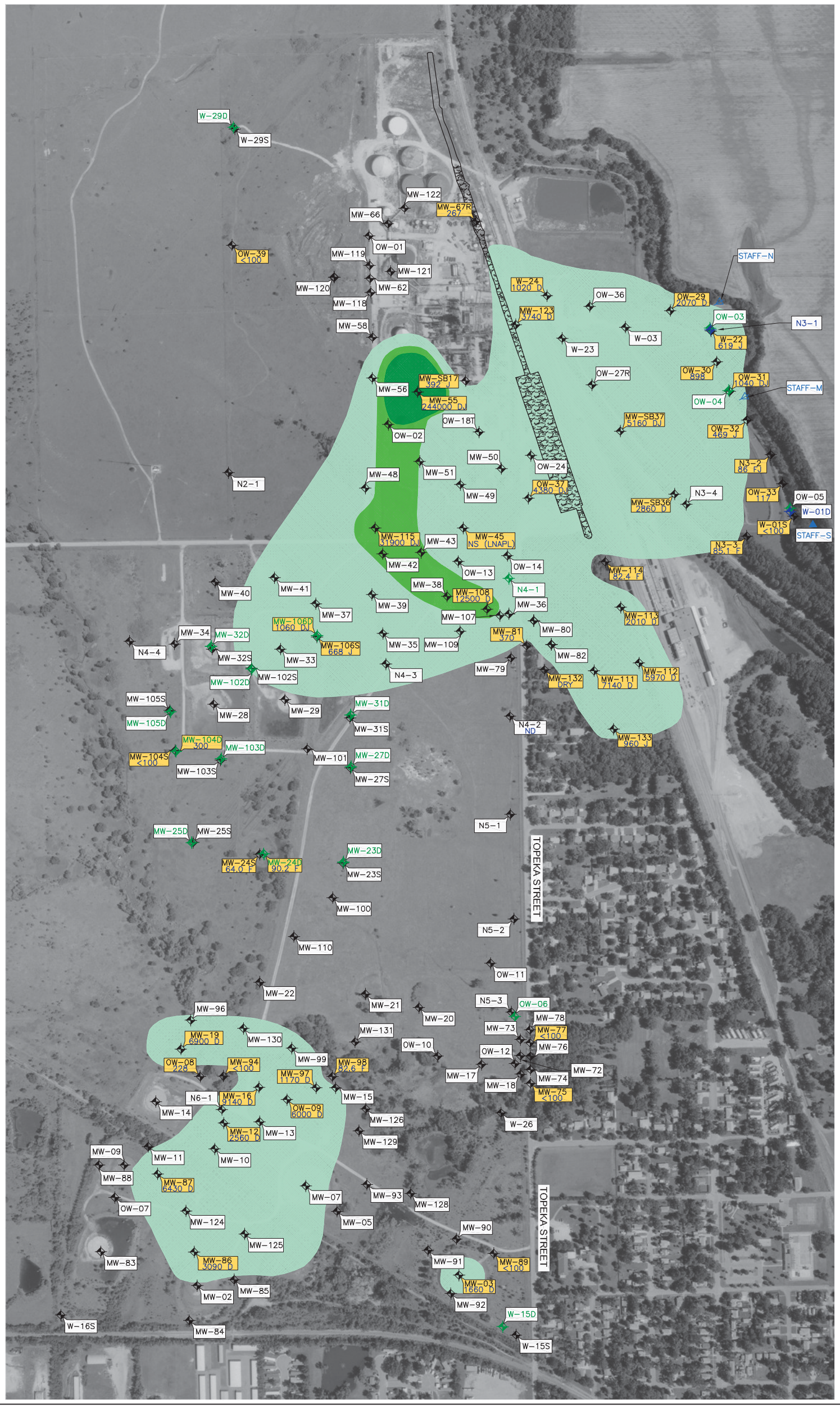
DESIGNED BY	R. Hultgren	07/09
DRAWN BY	C. Pappas	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-127C_GWGROFeb09.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS
PROJECT: CORRECTIVE ACTION STUDY
TITLE: TPH GRO IN GROUNDWATER MAP - FEBRUARY 2009
FIGURE: 2-15

MWH

Print Date: February 3, 2013



LEGEND

- OW-10 — SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- OW-06 — FORT RILEY LIMESTONE MONITORING WELL
- W-01D — FLORENCE LIMESTONE MONITORING WELL
- STAFF-S — SURFACE WATER GAUGE LOCATION
- MW-98 — WELL IN MONITORING PROGRAM

- TPH-GRO <500 ug/L
- TPH-GRO 500 – 10,000 ug/L
- TPH-GRO >10,000 – 100,000 ug/L
- TPH-GRO >100,000 ug/L

NOTES

133	TPH-GRO CONCENTRATION IN ug/L
<100	NOT DETECTED
NS	NOT SAMPLED
ANC	ANALYTE NOT COLLECTED DUE TO LOW SAMPLE VOLUME
D	SAMPLE DILUTION REQUIRED FOR ANALYSIS. REPORTED VALUES REFLECT THE DILUTION.
F	ANALYTE WAS POSITIVELY IDENTIFIED BUT THE REPORTED CONCENTRATION IS ESTIMATED.
J	DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.

KDHE RBSL FOR TPH-GRO: 500 ug/L

SCALE

0 300' 600'

SCALE IN FEET

TITLE: TPH-GRO IN GROUNDWATER OCTOBER 3 - OCTOBER 10, 2013

FIGURE: 2-16

DESIGNED BY	W. PICKENS	02/14
DRAWN BY	M. WARNER	02/14
CHECKED BY	C. PHILIPS	02/14
APPROVED BY	D. MICK	02/14
PROJECT MANAGER	D. MICK	02/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT: CORRECTIVE ACTION STUDY

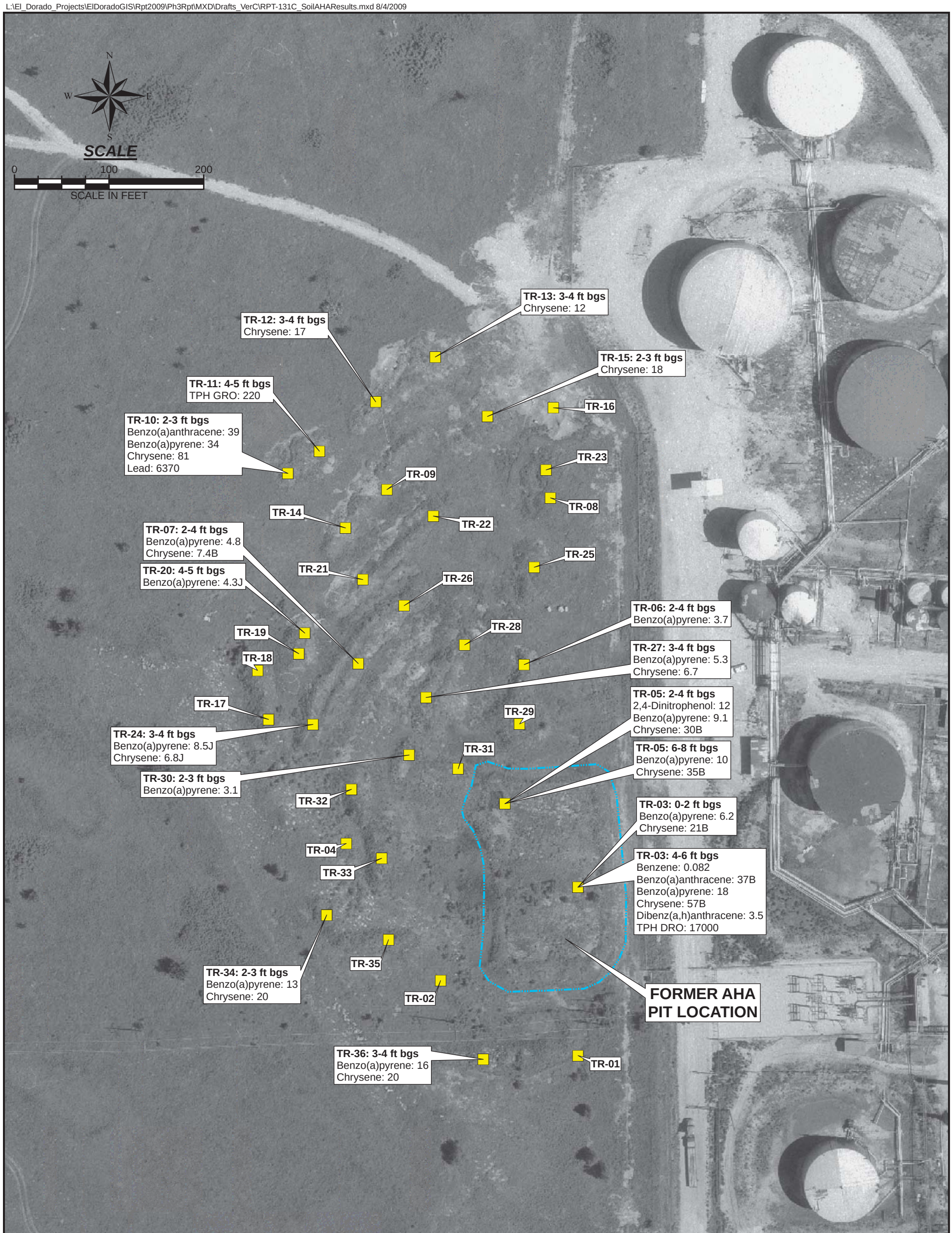
TITLE: TPH-GRO IN GROUNDWATER OCTOBER 3 - OCTOBER 10, 2013

MWH

FIGURE 2-16 REVISION 1

FILE NAME: EDR Fig 4-4 TPH-GRO Conc Map.dwg

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-131C_SoilAHAResults.mxd 8/4/2009



TITLE
ASPHALT HANDLING AREA
SOIL SAMPLE DATA MAP

FIGURE
2-17

LEGEND:

- AHA BACKHOE SAMPLE
- FORMER ASPHALT HANDLING AREA PIT LOCATION

NOTES:
SAMPLING LOCATIONS LABELED WITH NAME, SAMPLING DEPTH, ANALYTE, AND CONCENTRATION IN SOIL (mg/kg). DATA ARE ONLY SHOWN WHERE RESULTS EXCEEDED THE CORRESPONDING SCREENING LEVEL FOR AT LEAST ONE OF THE ANALYTES LISTED ON THE RIGHT.
DATA ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA ARE NOT SHOWN ON THIS FIGURE.
ft bgs = FEET BELOW GROUND SURFACE

KANSAS TIER 2 RISK-BASED STANDARDS FOR NON-RESIDENTIAL (INDUSTRIAL) PATHWAYS:

ANALYTE	LEVEL	UNITS	PATHWAY(S)
2,4-DINITROPHENOL	2.1	mg/kg	SOIL TO GROUNDWATER
BENZENE	0.08	mg/kg	SOIL TO GROUNDWATER
BENZO(A)ANTHRACENE	26	mg/kg	SOIL
BENZO(A)PYRENE	2.6	mg/kg	SOIL
CHRYSENE	6.4	mg/kg	SOIL/SOIL TO GROUNDWATER
DIBENZ(A,H)ANTHRACENE	2.6	mg/kg	SOIL
TPH DRO	15000	mg/kg	SOIL TO GROUNDWATER
TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
LEAD	1000	mg/kg	SOIL

DRAWING REFERENCE(S):
1. AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

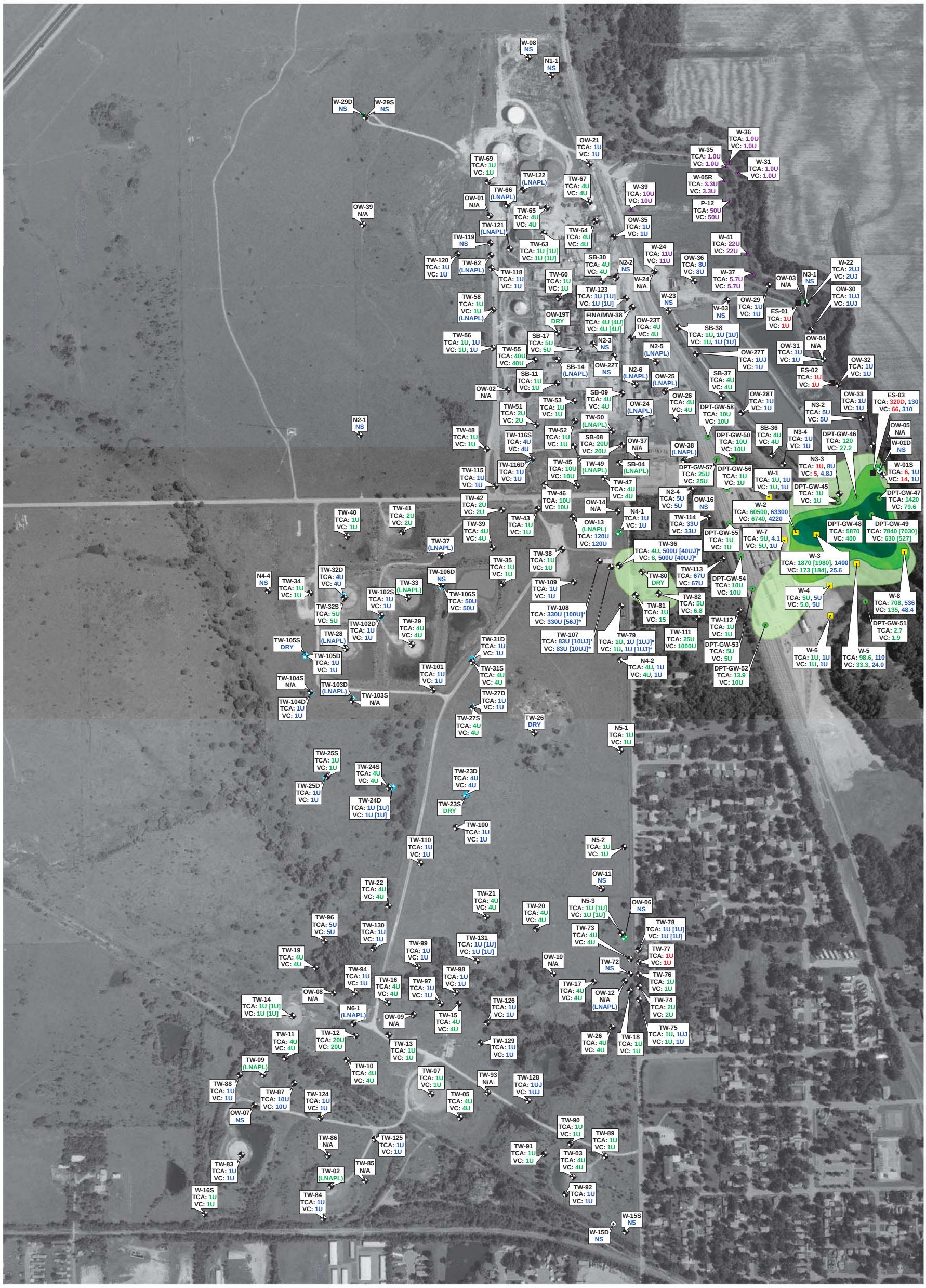
DESIGNED BY	R. Hultgren	07/09
DRAWN BY	C. Pappas	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-131C_SoilAHAResults.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS
PROJECT: CORRECTIVE ACTION STUDY
TITLE: ASPHALT HANDLING AREA SOIL SAMPLE DATA MAP
FIGURE: 2-17

MWH

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-125C_GWClSolventsFeb09.mxd 8/14/2009



LEGEND:

- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- DEEP WEATHERED BEDROCK MONITORING WELL (DOYLE SHALE OR SHALLOW FORT RILEY FORMATION)
- DEEP FORT RILEY MONITORING WELL
- FLORENCE MONITORING WELL
- EXTRACTION SUMP
- UTC GEOPROBE BORING
- UTC MONITORING WELL
- PESTER MONITORING WELL

NOTES:
WELLS LABELED WITH NAME AND 1,1,2-TCA AND VINYL CHLORIDE (VC) CONCENTRATIONS IN GROUNDWATER (ug/L).
RESULTS COLOR-CODED BY SAMPLING YEAR: 2006, 2007, 2008, AND 2009.
[ ] = DUPLICATE SAMPLE RESULTS. [ ]* = RE-SAMPLED FOR LOWER DETECTION LIMIT. NS = NOT SAMPLED. N/A = NOT ANALYZED.
(LNAPL) = WELL NOT SAMPLED DUE TO PRESENCE OF LNAPL IN 2008 OR 2009. DRY = DRY MONITORING WELL NOT SAMPLED.
1U = 1,1,2-TCA OR VC NOT DETECTED AT REPORTING LIMIT SHOWN. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
KANSAS TIER 2 RISK-BASED STANDARD FOR RESIDENTIAL GROUNDWATER PATHWAY FOR 1,1,2-TCA = 5 ug/L; VC = 2 ug/L.
UTC DATA SOURCE: Groundwater Monitoring Report, Union Tank Car, El Dorado, Kansas, July 2008 (The Forrester Group); and March 2009 (Foth).
PESTER DATA SOURCE: Fourth Quarter 2006 Groundwater Monitoring Report, Pester Burn Pond, El Dorado, Kansas, December 2006 (RMT, Inc.).

SHADED REGIONS:

- 1,1,2-TCA < 5 ug/L; VC < 2 ug/L
- 1,1,2-TCA 5 - 100 ug/L; VC 2 - 100 ug/L
- 1,1,2-TCA and/or VC >100 - 1,000 ug/L
- 1,1,2-TCA and/or VC >1,000 ug/L

N
W E
S

SCALE
0 600 1,200
SCALE IN FEET

TITLE
1,1,2-TCA AND VINYL CHLORIDE IN GROUNDWATER MAP - FEBRUARY 2009

FIGURE
2-18

DRAWING REFERENCE(S):
1. AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

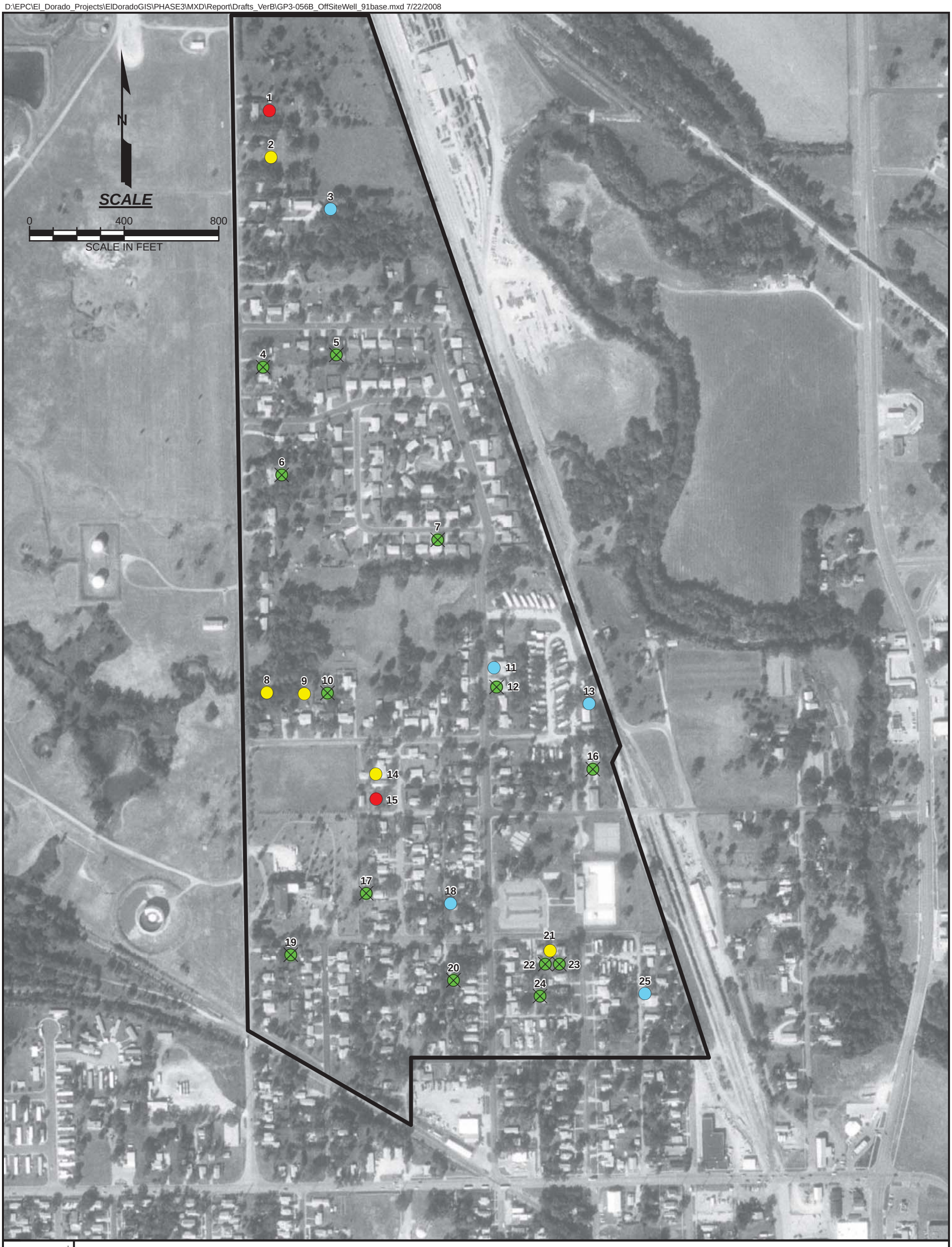
DESIGNED BY	R. Hultgren	07/09
DRAWN BY	C. Pappas	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-125C_GWClSolventsFeb09.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS
PROJECT: CORRECTIVE ACTION STUDY
TITLE: 1,1,2-TCA AND VINYL CHLORIDE IN GROUNDWATER MAP - FEBRUARY 2009
FIGURE: 2-18

MWH

D:\EPC\El_Dorado_Projects\ElDoradoGIS\PHASE3\MXD\Report\Drafts_VerB\GP3-056B_OffSiteWell_91base.mxd 7/22/2008



LEGEND:

- ACTIVE WELL (LAWN & GARDEN) IN USE OR COULD BE USED EASILY
- INACTIVE WELL (LAWN & GARDEN) NO LONGER USED
- PLUGGED WELL
- POSSIBLE WELL
- STUDY BOUNDARY

PROPERTY #	ADDRESS	PROPERTY #	ADDRESS	PROPERTY #	ADDRESS
1	1800 N Topeka St.	11	1108 N Taylor St	21	827 N Washington St
2	1730 N Topeka St	12	1106 N Taylor St	22	827 N Washington St
3*	1618 1/2 N Topeka St	13**	1110 N Washington St	23	827 N Washington St
4	1460 N Topeka St	14	1009 N Denver St	24	819 N Washington St
5	625 W 14th Ave	15	1005 N Denver St	25	822 N Railroad St
6	1320 N Topeka St	16	330 W 9th Ave		
7	517 W 12th Ave	17	915 N Denver St		
8	720 W 10th Ave	18	907 N Taylor St		
9	706 W 10th Ave	19	845 N Atchison St		
10	702 W 10th Ave	20	827 N Taylor St		

* Legal description of property provided due to suspect property address: BEG 410.5N & 200E NE/C TOPEKA ST & 14TH AVE N109 E200 S109 W200 TO POB

** Conflicting reports regarding this property. Current owner reported no wells and past property owner reported that ther is an abandoned well on the property.

TITLE: OFF-SITE WELL SURVEY RESULTS

FIGURE: 2-19

DRAWING REFERENCE(S):
AERIAL PHOTOGRAPH PRODUCED BY TERRASERVER-USA FROM OCTOBER 2, 1991 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	06/08
DRAWN BY	R. Hultgren	07/08
CHECKED BY	R. Hultgren	07/08
APPROVED BY	W. Pickens	07/08
PROJECT MANAGER	D. Mick	07/08
PROJECT NO.	1914029.710107	
FILE NAME	GP3-056B_OffSiteWell_91base.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY EL DORADO, KANSAS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: OFF-SITE WELL SURVEY RESULTS

MWH

FIGURE: 2-19

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-124C_SWResults.mxd 8/25/2009

TITLE

SURFACE WATER SAMPLE LOCATION DATA MAP SOUTHERN AREA

FIGURE 2-20

LEGEND:

▲ SURFACE WATER SAMPLING LOCATION

NOTES:
SURFACE WATER SAMPLE LOCATIONS LABELED WITH NAME, ANALYTE, AND CONCENTRATION IN SURFACE WATER (ug/L OR mg/L).
EXCEEDANCES OF THE CORRESPONDING KANSAS SURFACE WATER QUALITY STANDARD (SWQS) FOR CHLORIDE AS Cl (250 mg/L), CYANIDE (0.0052 mg/L), AND MERCURY (0.000146 mg/L) WERE OBSERVED IN RIVER AND CREEK SAMPLES. THERE ARE NO APPLICABLE KANSAS SWQS LEVELS AVAILABLE FOR TPH GRO, TPH DRO, AND SEVERAL VOCs AND SVOCs. THEREFORE, RESULTS FOR CHLORIDE, CYANIDE, MERCURY, TPH GRO, AND TPH DRO ARE SHOWN FOR ALL SURFACE WATER SAMPLES, AND DETECTIONS OF ADDITIONAL VOCs AND SVOCs ARE SHOWN AS APPLICABLE. KANSAS SWQS FOR BENZENE = 5 ug/L.
RESULTS EXCEEDING SCREENING LEVEL ARE SHOWN IN **BOLDFACE** TYPE.
TRANSECT #1 THROUGH #5 SAMPLES COLLECTED FEBRUARY 5, 2009. SW-POND AND SW-CREEK SAMPLES COLLECTED FEBRUARY 25, 2009.
1U = NOT DETECTED AT REPORTING LIMIT SHOWN. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
D = COMPOUND DETECTED AT A SECONDARY DILUTION FACTOR. N/A = NOT ANALYZED.

N W E S

SCALE

0 400 800

SCALE IN FEET

DRAWING REFERENCE(S):
AERIAL PHOTOGRAPH PRODUCED BY TERRASERVER-USA FROM OCTOBER 2, 1991 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	07/09
CHECKED BY	R. Hultgren	07/09
APPROVED BY	W. Pickens	####
PROJECT MANAGER	D. Mick	####
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-124C_SWResults.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: SURFACE WATER SAMPLE LOCATION DATA MAP SOUTHERN AREA FEBRUARY 5, 2009

MWH

FIGURE: 2-20

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-002CRC_RivCrkSedLocs.mxd 8/3/2009

LEGEND:

SEDIMENT SAMPLE

NOTES:
SEDIMENT SAMPLE LOCATIONS LABELED WITH NAME, SAMPLING DEPTH, ANALYTE, AND CONCENTRATION IN SEDIMENT (mg/kg).
EXCEEDANCES OF THE CORRESPONDING CONSENSUS-BASED THRESHOLD EFFECT CONCENTRATION (TEC) FOR LEAD (35.8 mg/kg) AND NICKEL (22.7 mg/kg) WERE OBSERVED IN RIVER AND CREEK SEDIMENT SAMPLES. THERE ARE NO APPLICABLE TECs AVAILABLE FOR TPH DRO, TPH GRO, AND SEVERAL VOCs AND SVOCs. THEREFORE, RESULTS FOR LEAD, NICKEL, TPH DRO, AND TPH GRO ARE SHOWN FOR ALL SEDIMENT SAMPLES, AND DETECTIONS OF ADDITIONAL VOCs AND SVOCs ARE SHOWN AS APPLICABLE.
RESULTS EXCEEDING SCREENING LEVEL ARE SHOWN IN **BOLDFACE** TYPE.
DUPLICATE RESULTS SHOWN IN BRACKETS [ ] FOR APPLICABLE ANALYTE(S) AND RESULT(S).
in bgs = INCHES BELOW GROUND SURFACE
1U = NOT DETECTED AT REPORTING LIMIT SHOWN. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.

N
W E
S

SCALE
0 400 800
SCALE IN FEET

TITLE
RIVER AND CREEK SEDIMENT
SAMPLE LOCATION DATA MAP
SOUTHERN AREA

FIGURE
2-21

DRAWING REFERENCE(S):
AERIAL PHOTOGRAPH PRODUCED BY TERRASERVER-USA FROM OCTOBER 2, 1991 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	07/09
CHECKED BY	R. Hultgren	07/09
APPROVED BY	W. Pickens	07/09
PROJECT MANAGER	D. Mick	07/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-002CRC_RivCrkSedLocs.mxd	

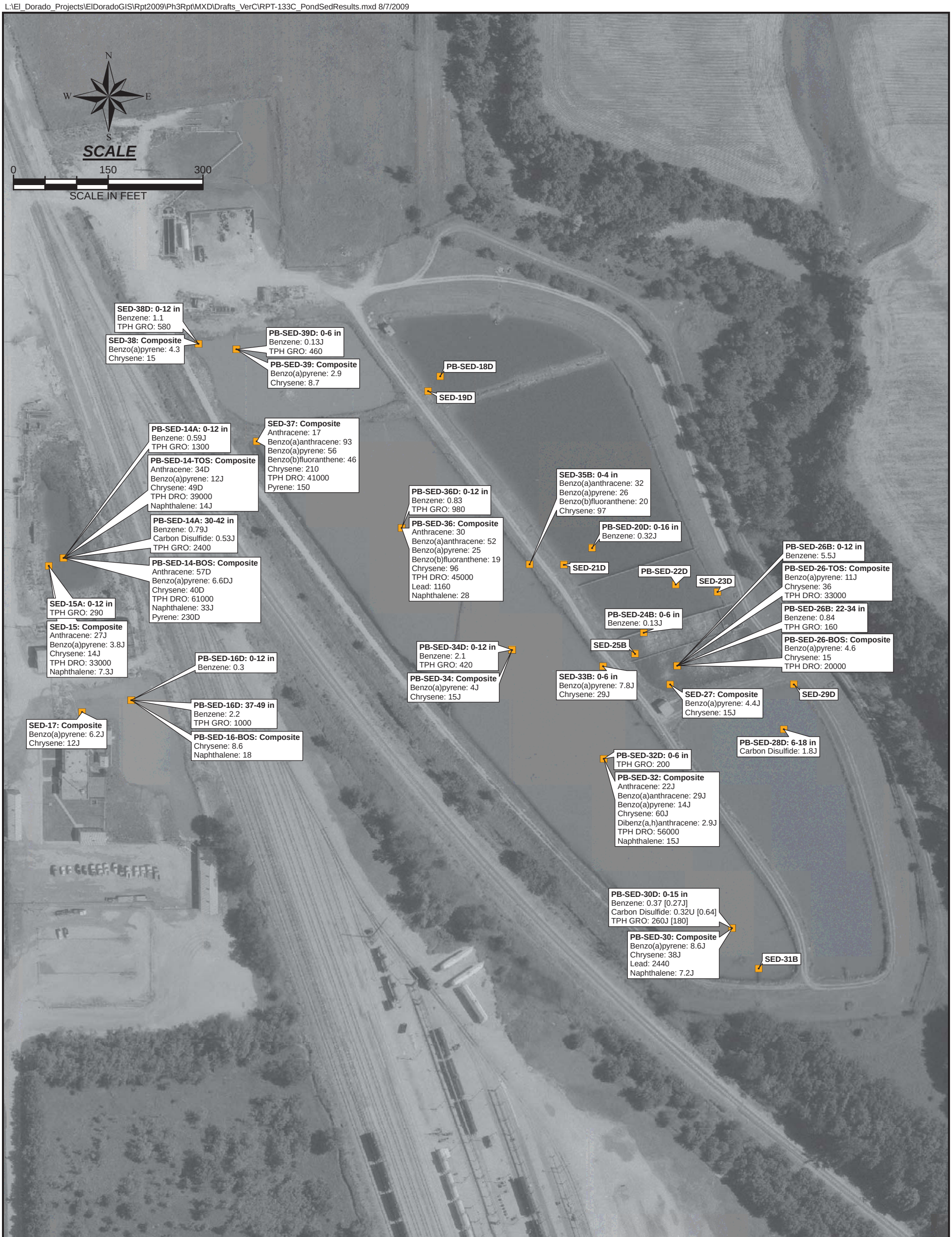
KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS
PROJECT: CORRECTIVE ACTION STUDY
TITLE: RIVER AND CREEK SEDIMENT SAMPLE LOCATION - SOUTHERN AREA JANUARY 7, 2008

MWH

FIGURE: 2-21

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-133C_PondSedResults.mxd 8/7/2009



LEGEND:

POND SEDIMENT SAMPLE LOCATION

KANSAS TIER 2 RISK-BASED STANDARDS FOR NON-RESIDENTIAL (INDUSTRIAL) PATHWAYS:

ANALYTE	LEVEL	UNITS	PATHWAY(S)
ANTHRACENE	13	mg/kg	SOIL/SOIL TO GROUNDWATER
BENZENE	0.08	mg/kg	SOIL TO GROUNDWATER
BENZO(A)ANTHRACENE	26	mg/kg	SOIL
BENZO(A)PYRENE	2.6	mg/kg	SOIL
BENZO(B)FLUORANTHENE	19	mg/kg	SOIL/SOIL TO GROUNDWATER
CHRYSENE	6.4	mg/kg	SOIL/SOIL TO GROUNDWATER
DIBENZ(A,H)ANTHRACENE	2.6	mg/kg	SOIL
TPH DRO	15000	mg/kg	SOIL TO GROUNDWATER
TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
LEAD	1000	mg/kg	SOIL
NAPHTHALENE	3.52	mg/kg	SOIL TO GROUNDWATER
PYRENE	140	mg/kg	SOIL/SOIL TO GROUNDWATER

NOTES:
SAMPLE LOCATIONS LABELED WITH NAME, SAMPLING DEPTH, ANALYTE, AND CONCENTRATION IN SOIL (mg/kg). DATA ARE ONLY SHOWN WHERE RESULTS EXCEEDED THE CORRESPONDING SCREENING LEVEL FOR AT LEAST ONE OF THE ANALYTES LISTED ON THE RIGHT.
DUPLICATE RESULTS SHOWN IN BRACKETS [ ] FOR APPLICABLE ANALYTE(S) AND RESULT(S).
J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
in = SAMPLE DEPTH INTERVAL IN INCHES BELOW TOP OF POND SEDIMENT
Composite = A COMPOSITE SAMPLE WAS PREPARED FROM MULTIPLE ALIQUOT LOCATIONS. DATA SHOWN AT POND SEDIMENT SAMPLE LOCATION FOR VOLATILE ORGANIC COMPOUNDS.

TITLE
POND SEDIMENT SAMPLE DATA MAP

FIGURE
2-22

DRAWING REFERENCE(S):
1. AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

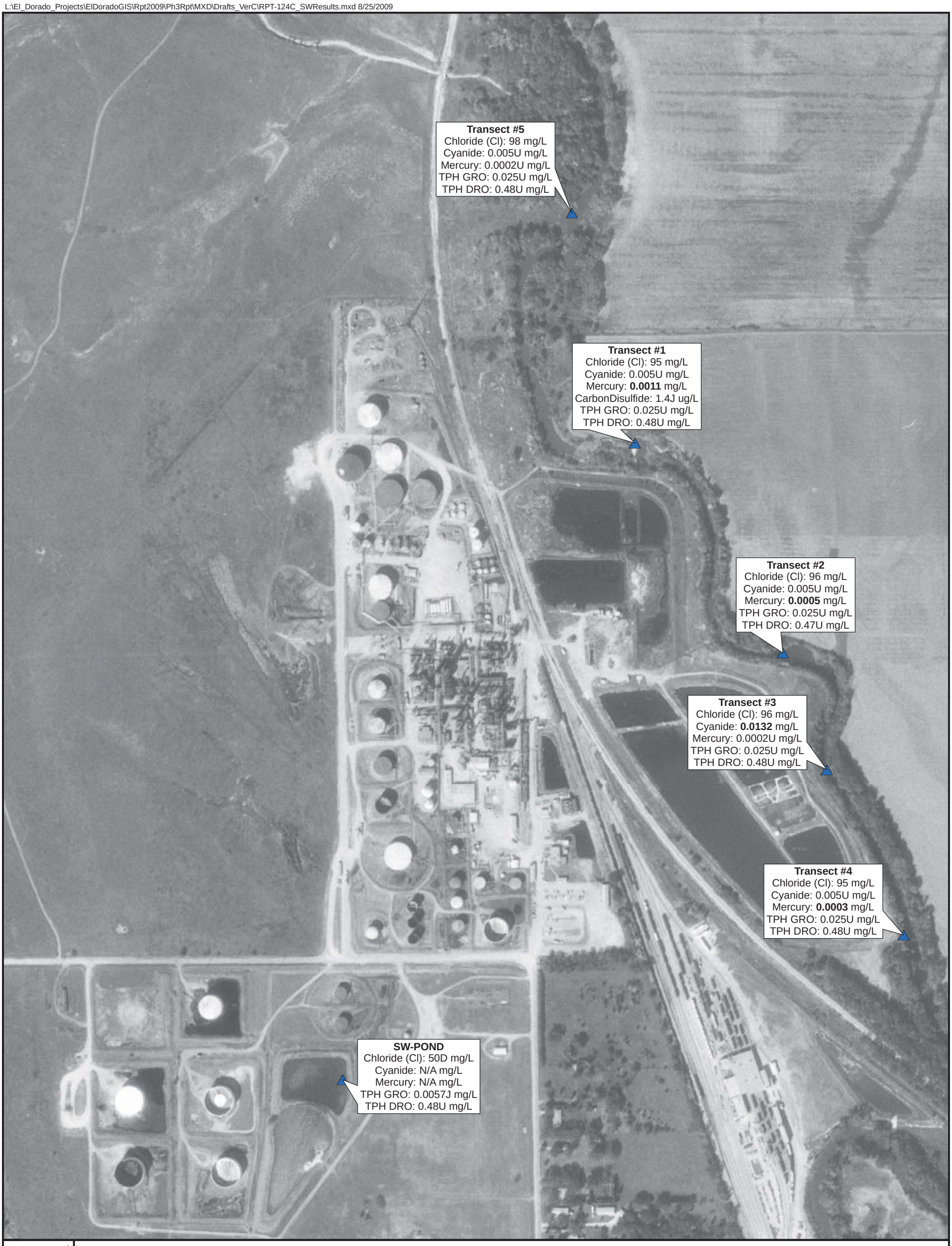
DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	07/09
CHECKED BY	R. Hultgren	07/09
APPROVED BY	W. Pickens	07/09
PROJECT MANAGER	D. Mick	07/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-133C_PondSedResults.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS
PROJECT: CORRECTIVE ACTION STUDY
TITLE: POND SEDIMENT SAMPLE DATA MAP NOVEMBER 2008 AND JANUARY 2009
FIGURE: 2-22

MWH

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-124C_SWResults.mxd 8/25/2009



TITLE
SURFACE WATER SAMPLE
LOCATION DATA MAP
NORTHERN AREA

FIGURE
2-23

LEGEND:

▲ SURFACE WATER SAMPLING LOCATION

NOTES:
SURFACE WATER SAMPLE LOCATIONS LABELED WITH NAME, ANALYTE, AND CONCENTRATION IN SURFACE WATER (ug/L OR mg/L).
EXCEEDANCES OF THE CORRESPONDING KANSAS SURFACE WATER QUALITY STANDARD (SWQS) FOR CHLORIDE AS Cl (250 mg/L), CYANIDE (0.0052 mg/L), AND MERCURY (0.000146 mg/L) WERE OBSERVED IN RIVER AND CREEK SAMPLES. THERE ARE NO APPLICABLE KANSAS SWQS LEVELS AVAILABLE FOR TPH GRO, TPH DRO, AND SEVERAL VOCs AND SVOCs. THEREFORE, RESULTS FOR CHLORIDE, CYANIDE, MERCURY, TPH GRO, AND TPH DRO ARE SHOWN FOR ALL SURFACE WATER SAMPLES, AND DETECTIONS OF ADDITIONAL VOCs AND SVOCs ARE SHOWN AS APPLICABLE. KANSAS SWQS FOR BENZENE = 5 ug/L.
RESULTS EXCEEDING SCREENING LEVEL ARE SHOWN IN **BOLDFACE** TYPE.
TRANSECT #1 THROUGH #5 SAMPLES COLLECTED FEBRUARY 5, 2009. SW-POND AND SW-CREEK SAMPLES COLLECTED FEBRUARY 25, 2009.
1U = NOT DETECTED AT REPORTING LIMIT SHOWN. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
D = COMPOUND DETECTED AT A SECONDARY DILUTION FACTOR. N/A = NOT ANALYZED.

N
W E
S

SCALE
0 400 800
SCALE IN FEET

DRAWING REFERENCE(S):
AERIAL PHOTOGRAPH PRODUCED BY TERRASERVER-USA FROM OCTOBER 2, 1991 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

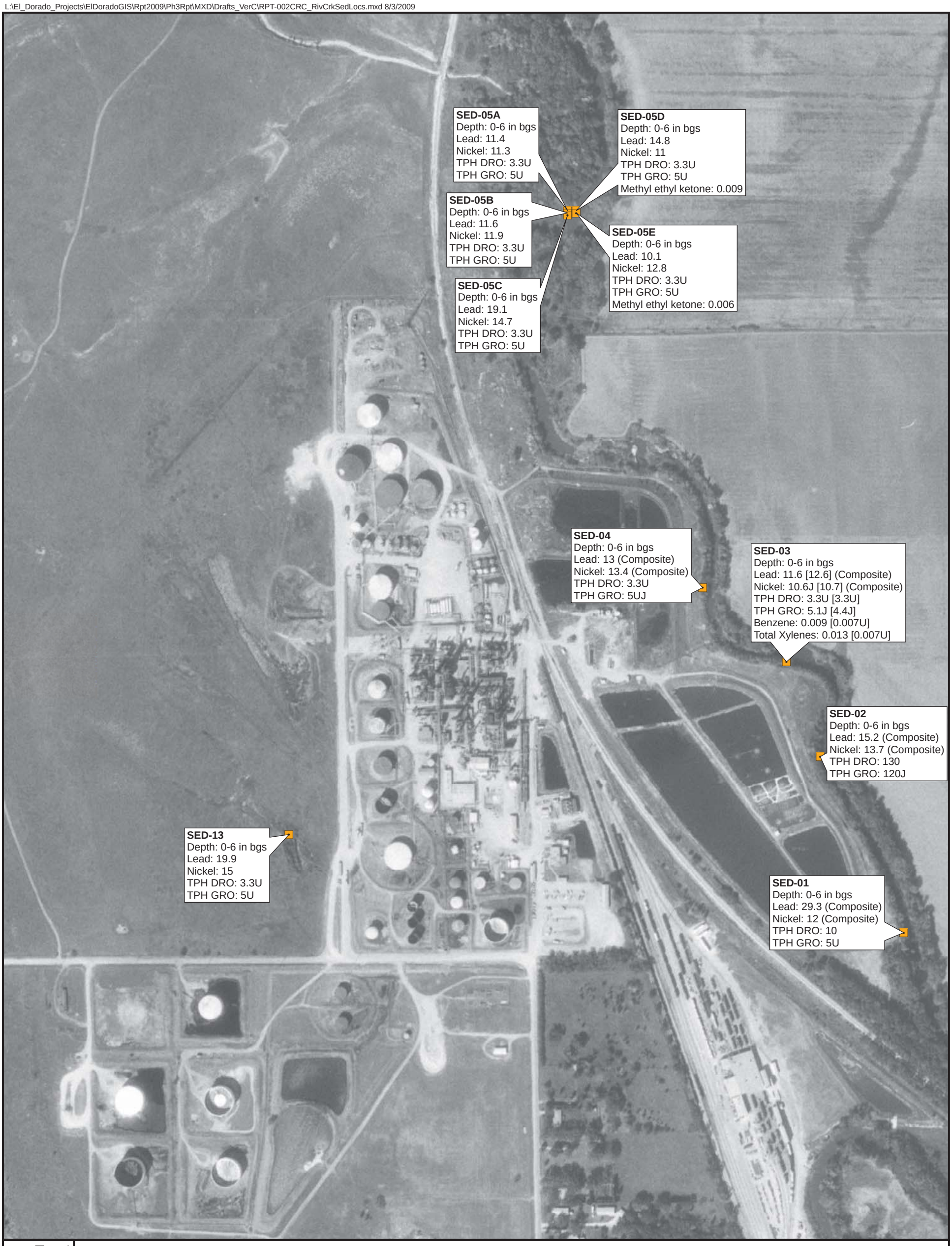
DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	07/09
CHECKED BY	R. Hultgren	07/09
APPROVED BY	W. Pickens	####
PROJECT MANAGER	D. Mick	####
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-124C_SWResults.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS
PROJECT: CORRECTIVE ACTION STUDY
TITLE: SURFACE WATER SAMPLE LOCATION DATA MAP - NORTHERN AREA FEBRUARY 5, 2009
FIGURE: 2-23

MWH

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-002CRC_RivCrkSedLocs.mxd 8/3/2009



LEGEND:

SEDIMENT SAMPLE

NOTES:
SEDIMENT SAMPLE LOCATIONS LABELED WITH NAME, SAMPLING DEPTH, ANALYTE, AND CONCENTRATION IN SEDIMENT (mg/kg).
EXCEEDANCES OF THE CORRESPONDING CONSENSUS-BASED THRESHOLD EFFECT CONCENTRATION (TEC) FOR LEAD (35.8 mg/kg) AND NICKEL (22.7 mg/kg) WERE OBSERVED IN RIVER AND CREEK SEDIMENT SAMPLES. THERE ARE NO APPLICABLE TECs AVAILABLE FOR TPH DRO, TPH GRO, AND SEVERAL VOCs AND SVOCs. THEREFORE, RESULTS FOR LEAD, NICKEL, TPH DRO, AND TPH GRO ARE SHOWN FOR ALL SEDIMENT SAMPLES, AND DETECTIONS OF ADDITIONAL VOCs AND SVOCs ARE SHOWN AS APPLICABLE.
RESULTS EXCEEDING SCREENING LEVEL ARE SHOWN IN **BOLDFACE** TYPE.
DUPLICATE RESULTS SHOWN IN BRACKETS [ ] FOR APPLICABLE ANALYTE(S) AND RESULT(S).
in bgs = INCHES BELOW GROUND SURFACE
1U = NOT DETECTED AT REPORTING LIMIT SHOWN. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.

N
W E
S

SCALE
0 400 800
SCALE IN FEET

TITLE
RIVER AND CREEK SEDIMENT SAMPLE LOCATION DATA MAP NORTHERN AREA

FIGURE
2-24

DRAWING REFERENCE(S):
AERIAL PHOTOGRAPH PRODUCED BY TERRASERVER-USA FROM OCTOBER 2, 1991 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

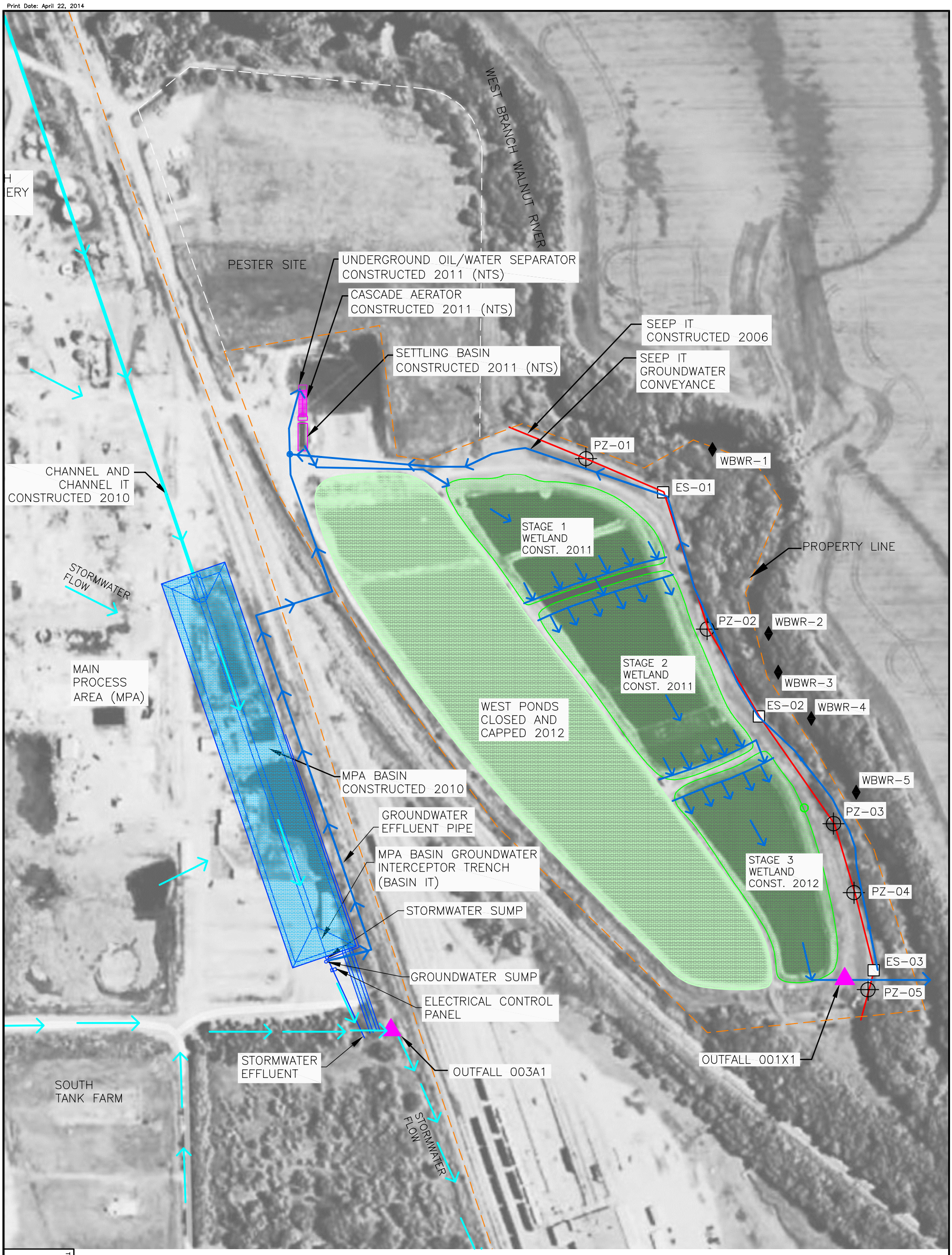
DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	07/09
CHECKED BY	R. Hultgren	07/09
APPROVED BY	W. Pickens	07/09
PROJECT MANAGER	D. Mick	07/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-002CRC_RivCrkSedLocs.mxd	

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KANSAS
PROJECT: CORRECTIVE ACTION STUDY
TITLE: RIVER AND CREEK SEDIMENT SAMPLE LOCATION DATA MAP - NORTHERN AREA OCTOBER 2007
FIGURE: 2-24

MWH

Print Date: April 22, 2014



TITLE

INTERIM REMEDIAL MEASURE COMPONENTS

FIGURE

4-1

LEGEND

PZ-03	EXISTING IN-TRENCH PIEZOMETER
ES-01	EXISTING EXTRACTION SUMP
	INTERCEPTOR TRENCH ALIGNMENT
	PROPERTY LINE
IT	INTERCEPTOR TRENCH
NTS	NOT TO SCALE
	STORMWATER FLOW
	GROUNDWATER CONVEYANCE/FLOW
	OUTFALL LOCATION
WBWR-1	SEEP LOCATION

SCALE

0 100 200

SCALE IN FEET

DESIGNED BY	W. PICKENS	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	D. MICK	04/14
APPROVED BY	J. TEGROTENHUIS	04/14
PROJECT MANAGER	D. MICK	04/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: INTERIM REMEDIAL MEASURE COMPONENTS

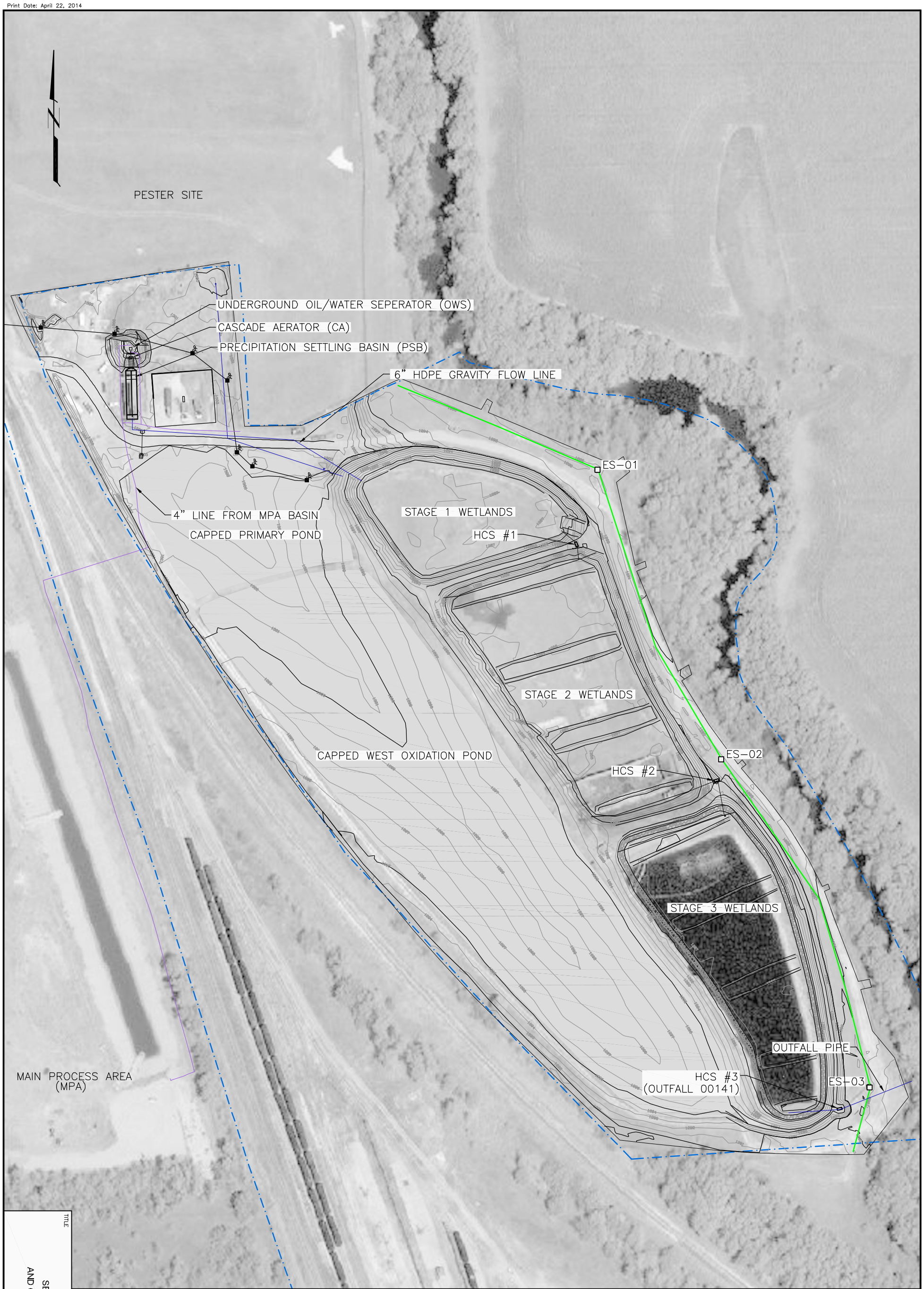
MWH

FIGURE 4-1

REVISION 1

FILE NAME EDR Figure 4-1 Process Flow.dwg

Print Date: April 22, 2014



LEGEND

- PROPERTY BOUNDARY
- OVERHEAD ELECTRIC AND POWER POLE
- STONE RIPRAP
- SEEP INTERCEPTOR TRENCH

ES = EXTRACTION SUMP
HCS = HYDRAULIC CONTROL STRUCTURE
GTS = GROUNDWATER TREATMENT SYSTEM

SCALE

0 75' 150'
SCALE IN FEET

TITLE: SEEP IT, GTS AND CAPPED AREA

FIGURE: 4-2

DESIGNED BY	M. WARNER	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	C. PHILIPS	04/14
APPROVED BY	J. TEGROTENHUIS	04/14
PROJECT MANAGER	D. MICK	04/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

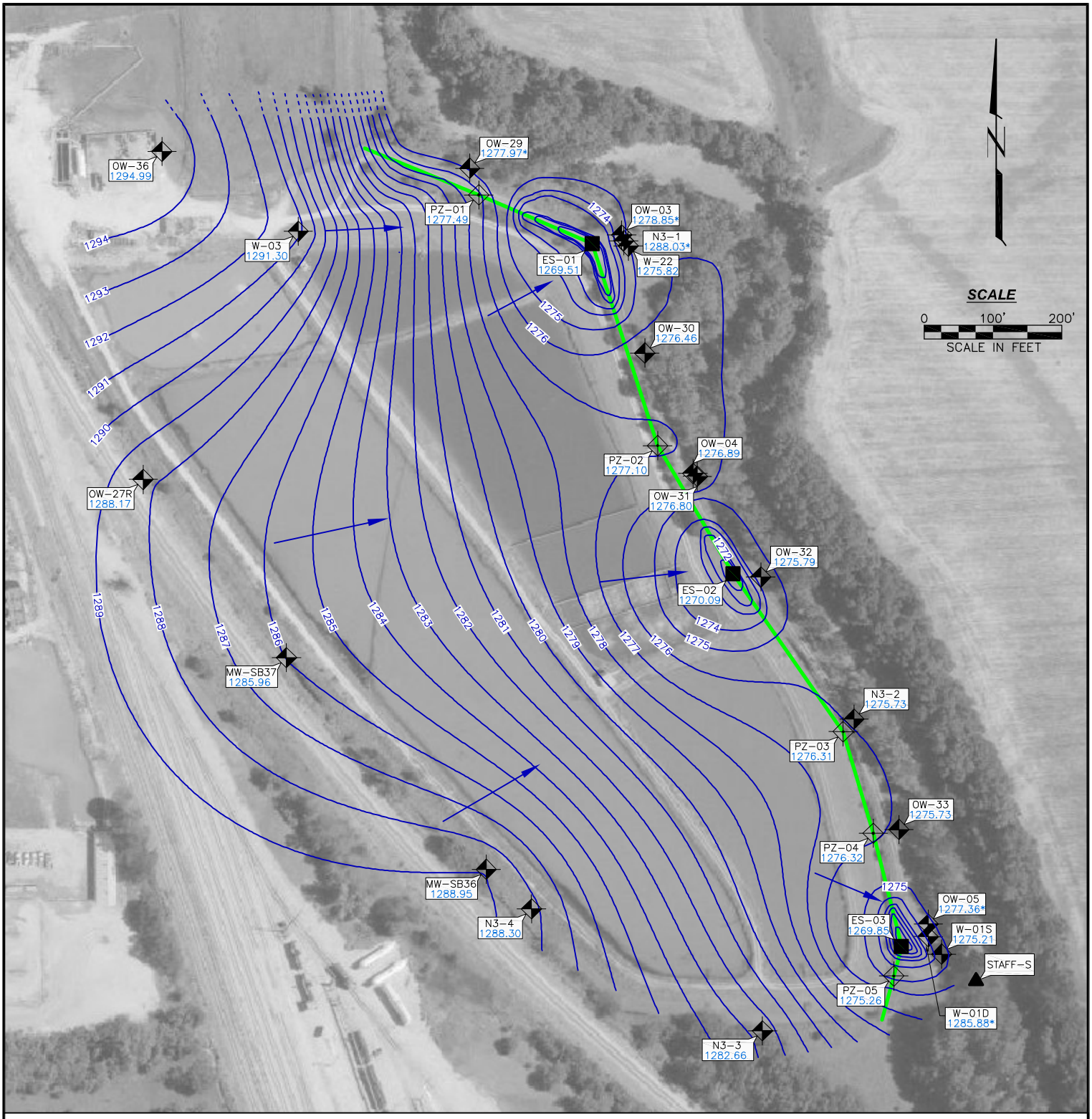
TITLE: SEEP IT, GTS AND CAPPED AREA

MWH

FIGURE: 4-2

REVISION: 1

FILE NAME: Current Site Plan - Pond Area.dwg



LEGEND

N3-4	EXISTING MONITORING/OBSERVATION WELL		POTENTIOMETRIC SURFACE CONTOUR
PZ-01	EXISTING IN-TRENCH PIEZOMETER		INFERRED POTENTIOMETRIC SURFACE CONTOUR
ES-01	EXISTING EXTRACTION SUMP	1282.66	POTENTIOMETRIC SURFACE ELEVATION (ft)
STAFF-N	EXISTING STAFF GAUGE LOCATION	1285.88*	DATA NOT USED FOR CONTOURING
	INTERCEPTOR TRENCH ALIGNMENT		FLOW DIRECTIONAL ARROW

DESIGNED BY	M. WARNER	01/14
DRAWN BY	M. WARNER	01/14
CHECKED BY	C. PHILIPS	01/14
APPROVED BY	J. GARNSEY	01/14
PROJECT MANAGER	J. GARNSEY	01/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: INTERCEPTOR TRENCH AREA GROUNDWATER POTENTIOMETRIC SURFACE MAP 11/13/13

MWH

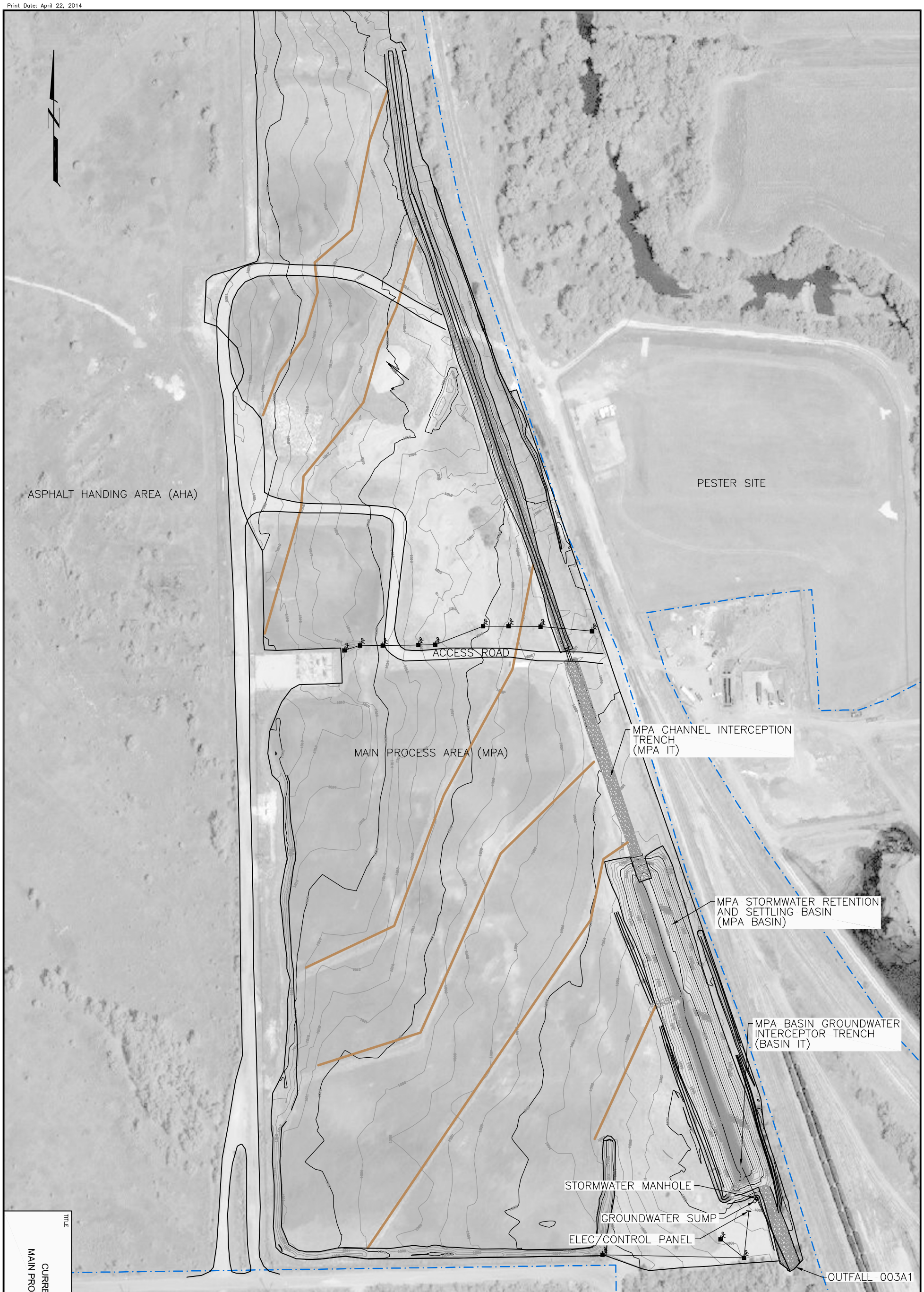
FIGURE: 4-3

REVISION: 1

FILE NAME: EDR November 2013 PSM.dwg

Print Date: April 22, 2014

Print Date: April 22, 2014



LEGEND

PROPERTY BOUNDARY

OVERHEAD ELECTRIC AND POWER POLE

STONE RIPRAP

STORMWATER SWALE/TERRACE

SCALE

0 100' 200'

SCALE IN FEET

TITLE: CURRENT SITE PLAN MAIN PROCESS AREA (MPA)

FIGURE: 4-4

DESIGNED BY	M. WARNER	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	C. PHILIPS	04/14
APPROVED BY	J. TEGROTENHUIS	04/14
PROJECT MANAGER	D. MICK	04/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

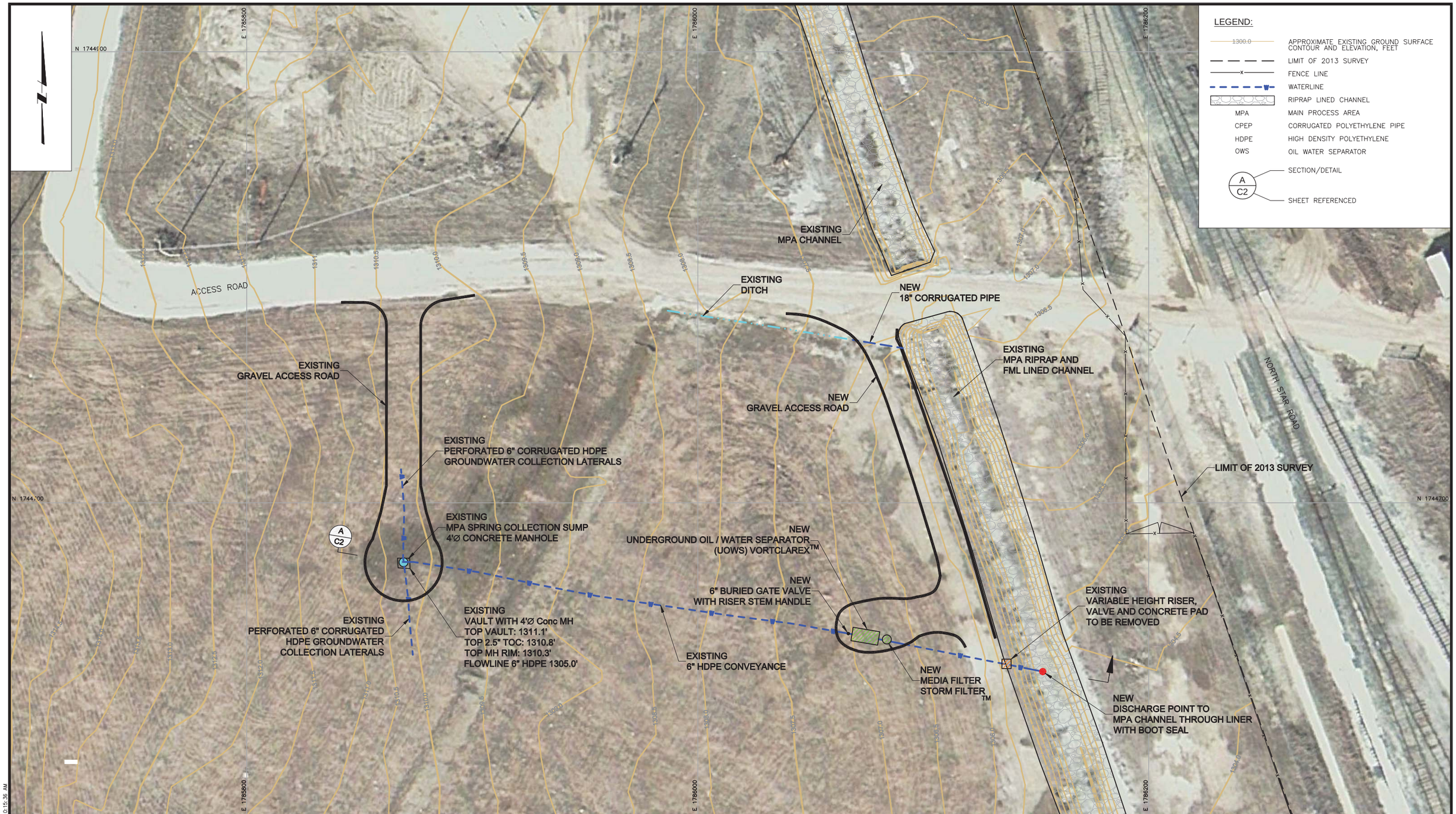
TITLE: CURRENT SITE PLAN MAIN PROCESS AREA (MPA)

MWH

FIGURE: 4-4

REVISION: 1

FILE NAME: Current Site Plan - MPA.dwg



PLAN

SCALE

20 0 20 40 FEET

CONTOUR INTERVAL = 0.5'

ISSUE REV	DESCRIPTION	TECH	ENG	DATE
A	ISSUED FOR REVIEW AND COMMENT	CHF	JDT	10/10/13

DISCLAIMER:
THIS DRAWING WAS DEVELOPED THROUGH THE APPLICATION OF PROFESSIONAL ENGINEERING SKILL AND PROPRIETARY METHODOLOGIES, PROCESSES, AND KNOW HOW OF MWH AS AUTHOR, ALL PURSUANT TO THE TERMS OF A CONTRACTUAL SCOPE OF WORK GOVERNING ITS PREPARATION. THIS DRAWING MAY NOT BE USED OR MODIFIED OTHER THAN IN STRICT ACCORDANCE WITH THE TERMS OF THE GOVERNING CONTRACT AND SCOPE OF WORK OR OTHERWISE ABSENT THE INVOLVEMENT AND CONSENT OF THE AUTHOR. ANY ALTERATION OR ADAPTATION OF THIS DRAWING SHALL BE CONSISTENT WITH THE AUTHOR'S CONTRACTUAL AND PROPRIETARY RIGHTS AND BE AT USER'S SOLE RISK AND WITHOUT ANY LIABILITY OR LEGAL RESPONSIBILITY OF MWH.

DRAWING REFERENCE(S):
TOPOGRAPHIC CONTOURS GENERATED FROM FINAL TOPO SURVEY PROVIDED BY CARLSON BAUGHMAN CO., DATED APRIL 11, 2011.
AERIAL IMAGERY: 2011 NON-ORTHO FLY BY.
PROJECTION: STATE PLANE COORDINATES
ZONE: KANSAS SOUTH
HORIZONTAL DATUM: NAD83
VERTICAL DATUM: NAVD 88
UNITS: U.S. FEET

DESIGNED BY	J. TEGROTENHUIS	10/10/13
DRAWN BY	C. FOWLER	10/10/13
CHECKED BY	J. TEGROTENHUIS	10/10/13
APPROVED BY	J. TEGROTENHUIS	10/10/13
PROJECT MANAGER	D. MICK	10/10/13
CLIENT APPROVAL		
CLIENT REFERENCE NO.		

KINDER MORGAN

PROJECT LOCATION
FORMER COASTAL REFINERY, EL DORADO, KANSAS

PROJECT
CORRECTIVE ACTION STUDY

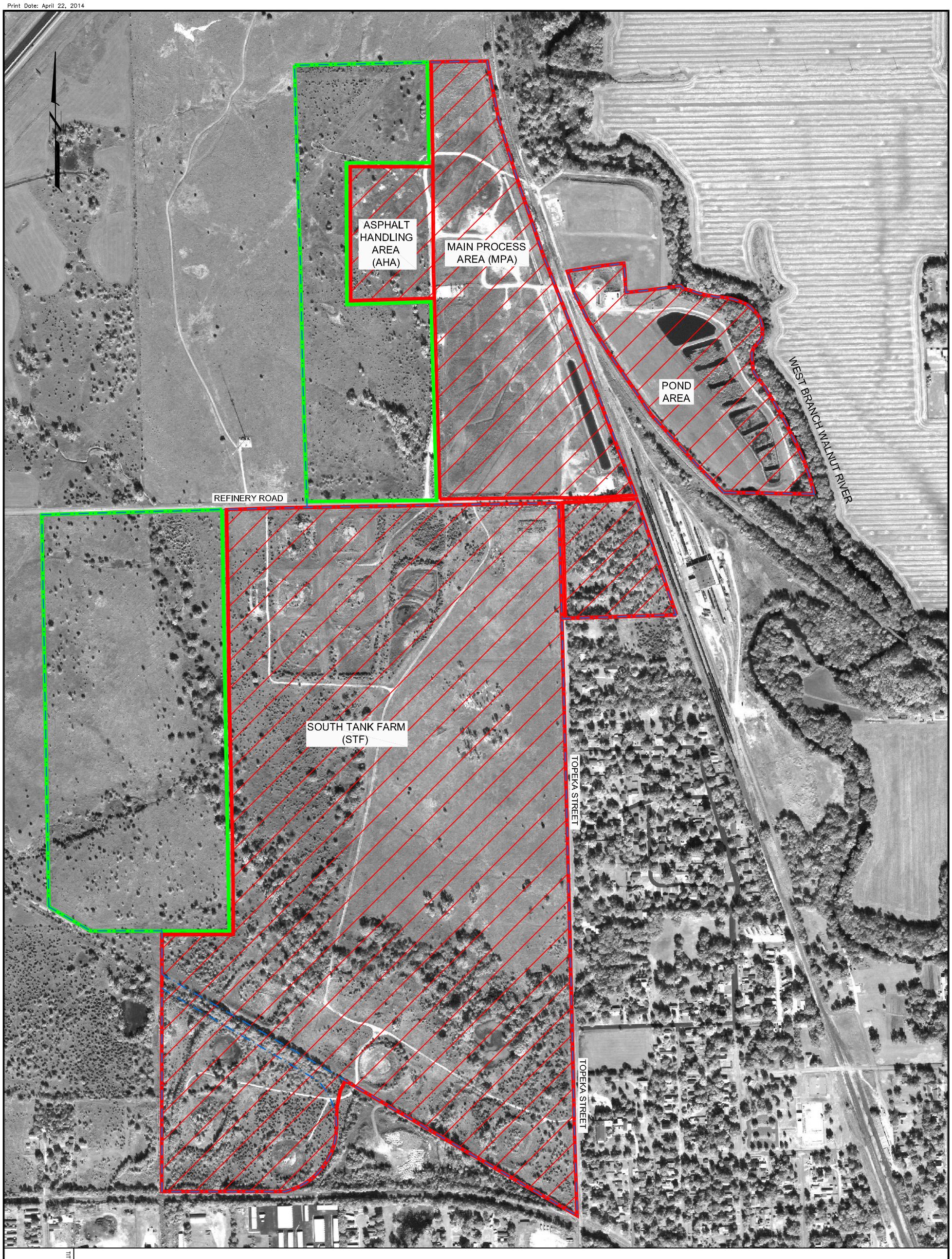
TITLE
MPA SPRING COLLECTION AND TREATMENT SYSTEM

MWH

FIGURE 4-5
REVISION A
FILE NAME 10500597D003

C:\pwworkdir\dms06510\10500597D003 10/8/2013 10:15:36 AM

Print Date: April 22, 2014



TITLE

ENVIRONMENTAL USE CONTROL (EUC) AREAS

FIGURE

10-1

LEGEND

PROPERTY BOUNDARY

EUC AREA

EXCLUDED AREA

SCALE

0 300' 600'

SCALE IN FEET

DESIGNED BY	M. WARNER	02/14
DRAWN BY	M. WARNER	02/14
CHECKED BY	C. PHILIPS	02/14
APPROVED BY	D. MICK	02/14
PROJECT MANAGER	J. GARNSEY	02/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: ENVIRONMENTAL USE CONTROL (EUC) AREAS

MWH

FIGURE 10-1

REVISION 1

FILE NAME EUC Areas.dwg

Print Date: April 22, 2014

LEGEND

- PLANTING AREA
- PROPERTY BOUNDARY
- OVERHEAD ELECTRIC AND POWER POLE
- STONE RIPRAP
- STORMWATER SWALE/TERRACE

SCALE

0 100' 200'

SCALE IN FEET

TITLE: MPA ALTERNATIVE 2 PHYTOREMEDIATION TREATMENT AREA

FIGURE: 10-2

DESIGNED BY	M. WARNER	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	C. PHILIPS	04/14
APPROVED BY	J. TEGROTENHUIS	04/14
PROJECT MANAGER	D. MICK	04/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: MPA ALTERNATIVE 2 PHYTOREMEDIATION TREATMENT AREA

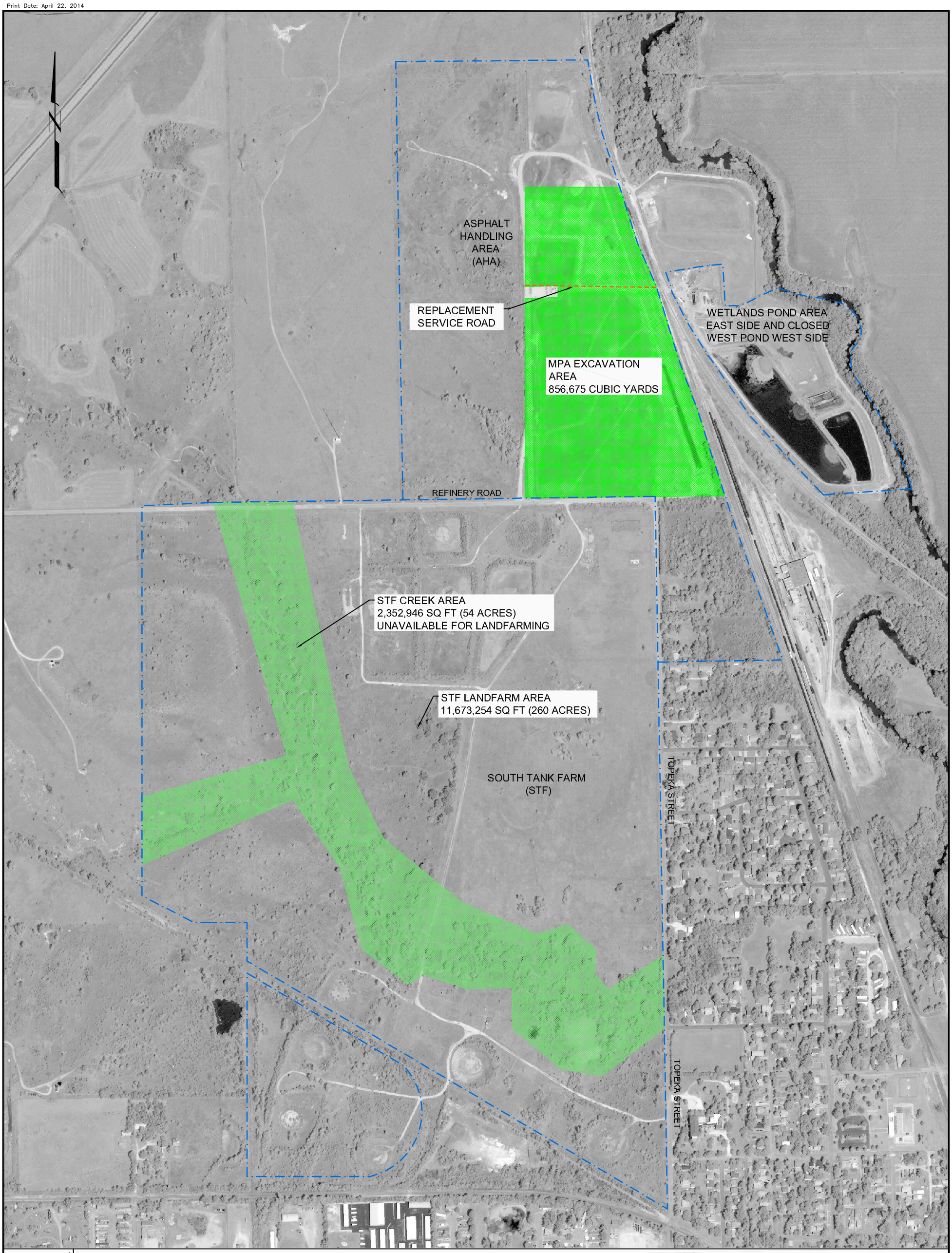
MWH

FIGURE: 10-2

REVISION: 1

FILE NAME: Current Site Plan - MPA.dwg

Print Date: April 22, 2014



TITLE

MPA ALTERNATIVE 3 EXCAVATION

LEGEND

PROPERTY BOUNDARY

SCALE

0 300' 600'

SCALE IN FEET

FIGURE

10-3

DESIGNED BY	M. WARNER	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	C. PHILIPS	04/14
APPROVED BY	J. GARNSEY	04/14
PROJECT MANAGER	J. GARNSEY	04/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: MPA ALTERNATIVE 3 EXCAVATION

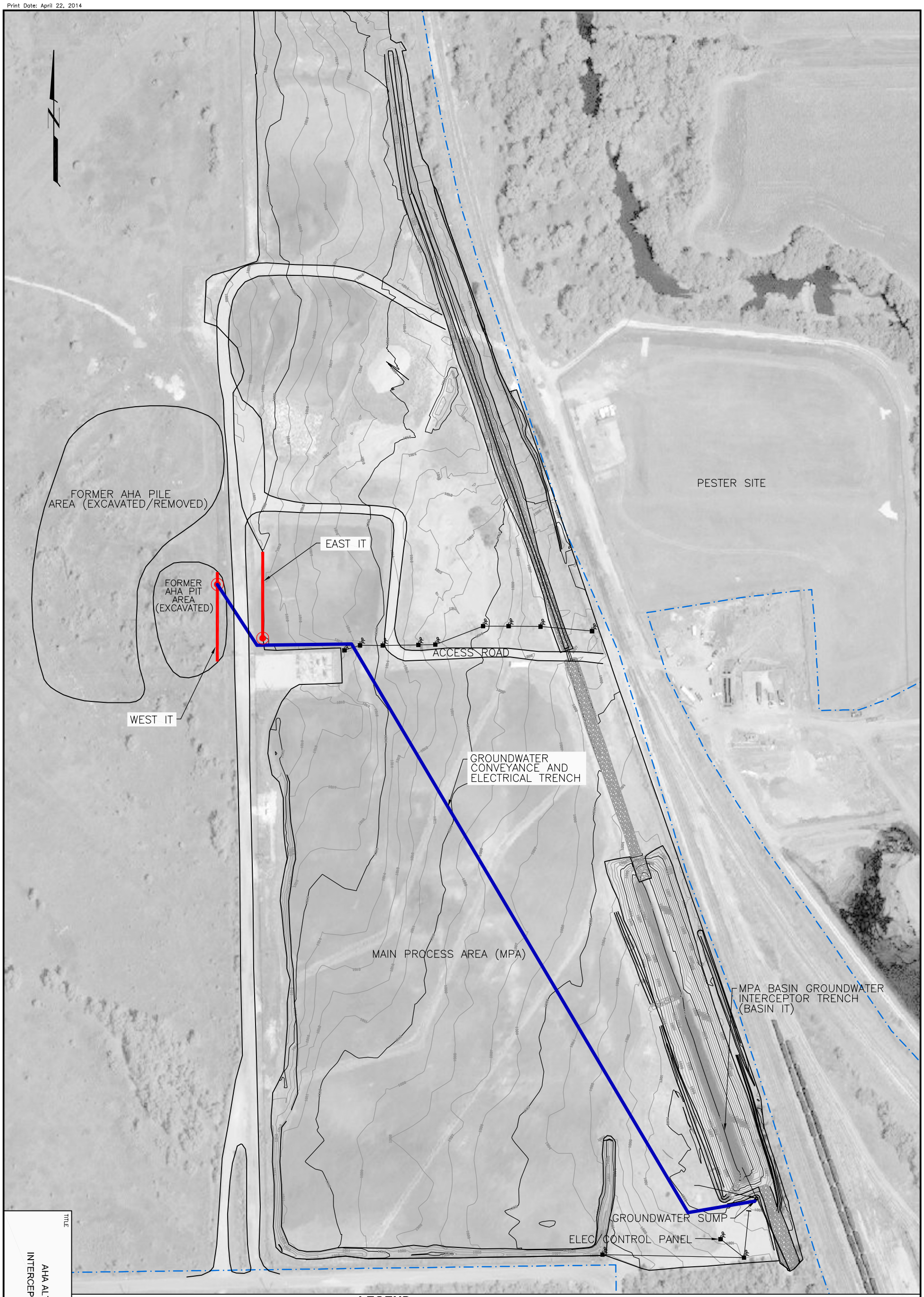
MWH

FIGURE 10-3

REVISION 1

FILE NAME: El Dorado Site Plan.dwg

Print Date: April 22, 2014



LEGEND

- CONVEYANCE AND ELECTRICAL TRENCH
- PROPERTY BOUNDARY
- OVERHEAD ELECTRIC AND POWER POLE
- STONE RIPRAP
- SUMP AND RECOVERY WELL
- INTERCEPTOR TRENCH (IT)

SCALE

0 100' 200'

SCALE IN FEET

TITLE: AHA ALTERNATIVE 3 INTERCEPTOR TRENCHES

FIGURE: 10-4

DESIGNED BY	M. WARNER	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	C. PHILIPS	04/14
APPROVED BY	J. TEGROTENHUIS	04/14
PROJECT MANAGER	D. MICK	04/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: AHA ALTERNATIVE 3 INTERCEPTOR TRENCHES

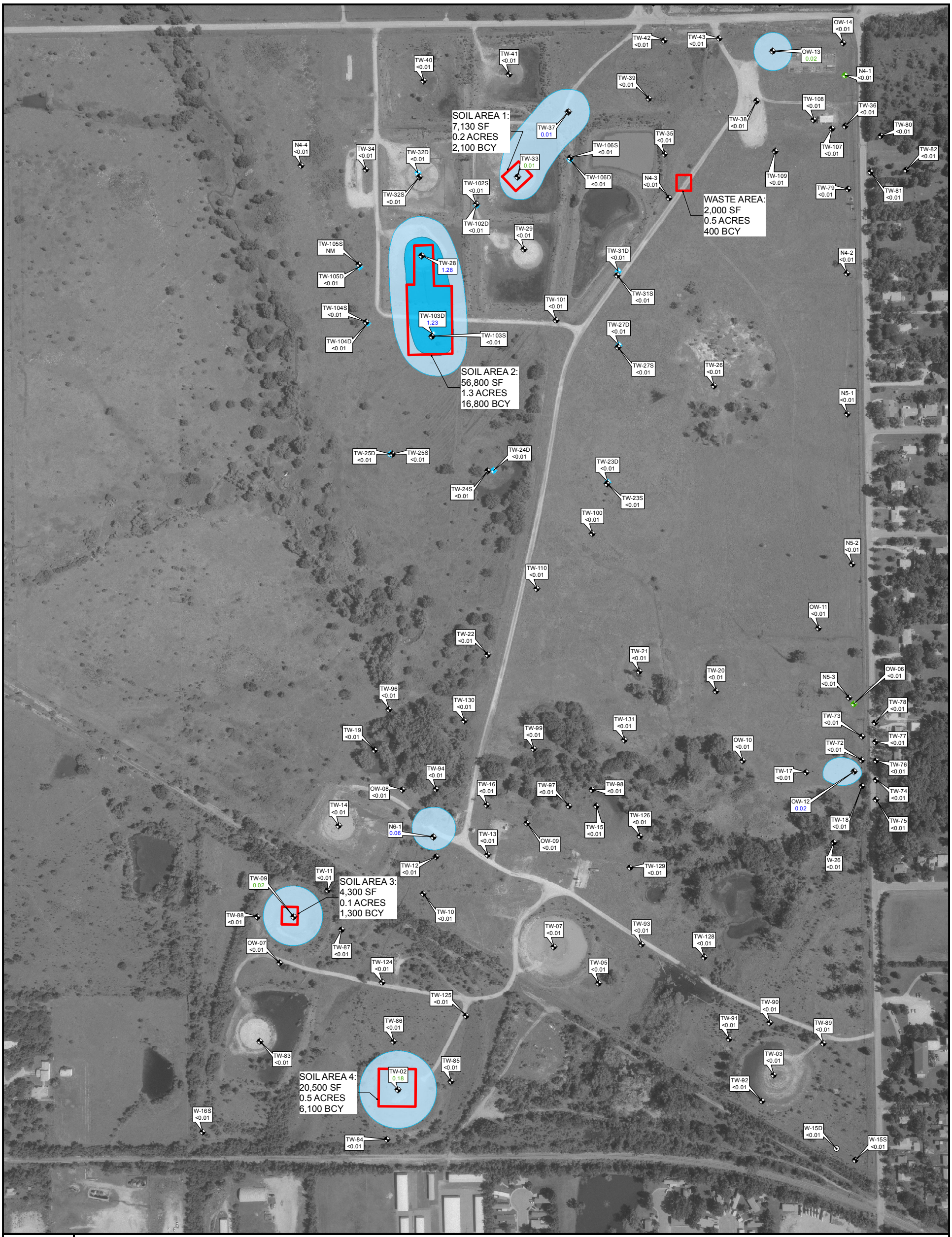
MWH

FIGURE: 10-4

REVISION: 1

FILE NAME: Current Site Plan - MPA.dwg

L:\El_Dorado_Projects\ElDoradoGIS\GIS2014\MXD\RPT-STF Corrective Action Study.mxd



LEGEND:

- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- DEEP WEATHERED BEDROCK MONITORING WELL (DOYLE SHALE OR SHALLOW FORT RILEY FORMATION)
- DEEP FORT RILEY MONITORING WELL
- FLORENCE MONITORING WELL
- EXCAVATION AREA

MEASURABLE LNAPL THICKNESS:

- <0 LNAPL THICKNESS <0.01 FEET
- 0.01 LNAPL THICKNESS 0.01-1 FEET
- 1 LNAPL THICKNESS >1-5 FEET

N
W E
S

SCALE

0 400 800

SCALE IN FEET

NOTES:
SYMBOLS LABELED WITH WELL NAME AND HISTORIC APPARENT LNAPL THICKNESS IN WELL (FEET).
HISTORIC DATA RANGES BETWEEN DECEMBER 5, 2005 AND FEBRUARY 11, 2009.
<0.01 = WELL WITHOUT MEASURED LNAPL THICKNESS.
NM = NOT MEASURED TRACE = TRACE OF LNAPL DETECTED

TITLE
STF ALTERNATIVES 2 AND 3 WASTE AND SOIL EXCAVATION AREAS

FIGURE
10-5

DRAWING REFERENCE(S):
1. AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	J. TeGrotenhuis	5/6/14
DRAWN BY	S. Gardner	5/6/14
CHECKED BY	C. Philips	5/6/14
APPROVED BY	J. TeGrotenhuis	5/6/14
PROJECT MANAGER	D. Mick	5/6/14
PROJECT NO.	1914351.90010408	
FILE NAME		

KINDER MORGAN

PROJECT LOCATION
FORMER COASTAL REFINERY, EL DORADO, KANSAS

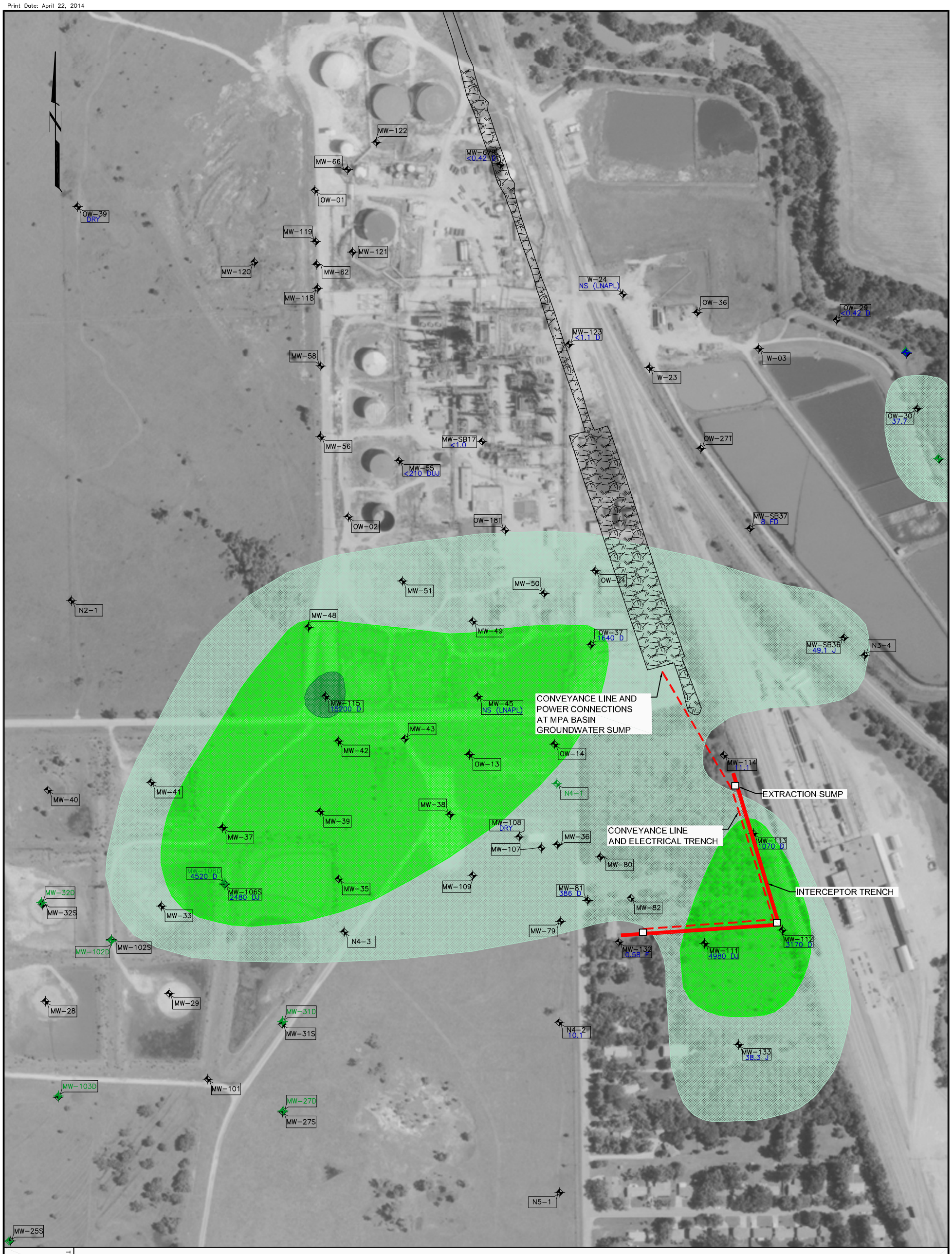
PROJECT
CORRECTIVE ACTION STUDY

TITLE
STF ALTERNATIVES 2 AND 3
WASTE AND SOIL EXCAVATION AREAS

MWH

FIGURE
10-5

Print Date: April 22, 2014



LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
OW-06	FORT RILEY LIMESTONE MONITORING WELL
W-01D	FLORENCE LIMESTONE MONITORING WELL
STAFF-S	SURFACE WATER GAUGE LOCATION
	MTBE <20 ug/L
	MTBE 20 – 1,000 ug/L
	MTBE >1,000 – 10,000 ug/L
	MTBE >10,000 ug/L
	INTERCEPTOR TRENCH
	CONVEYANCE LINE AND ELECTRICAL TRENCH
	EXTRACTION SUMP

SCALE

0 150' 300'

SCALE IN FEET

TITLE

STF ALTERNATIVE 2
NE PLUME INTERCEPTOR TRENCHES

FIGURE

10-6

DESIGNED BY	W. PICKENS	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	C. PHILIPS	04/14
APPROVED BY	D. MICK	04/14
PROJECT MANAGER	D. MICK	04/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: STF ALTERNATIVE 2
NE PLUME INTERCEPTOR TRENCHES

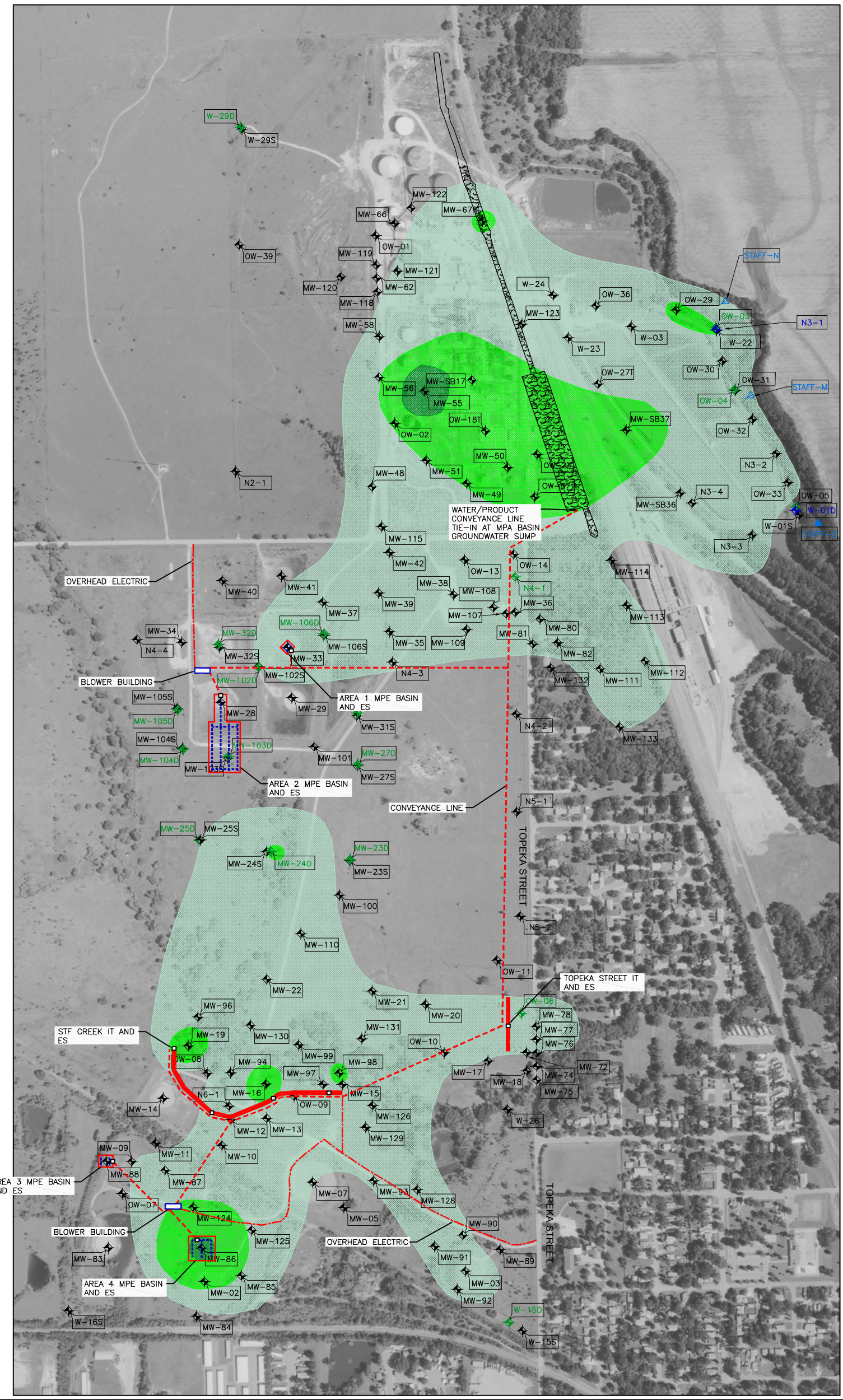
MWH

FIGURE 10-6

REVISION 1

FILE NAME EDR Fig 10-6 MTBE Conc Map.dwg

Print Date: April 22, 2014



LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
OW-06	FORT RILEY LIMESTONE MONITORING WELL
W-01D	FLORENCE LIMESTONE MONITORING WELL
STAFF-S	SURFACE WATER GAUGE LOCATION
	TPH-DRO <500 ug/L
	TPH-DRO 500 – 10,000 ug/L
	TPH-DRO >10,000 – 100,000 ug/L
	TPH-DRO >100,000 ug/L
	INTERCEPTOR TRENCH (IT)
	EXTRACTION SUMP (ES)
	MULTI-PHASE EXTRACTION (MPE)
	CONVEYANCE TRENCH/LINE

SCALE

0 300' 600'

SCALE IN FEET

TITLE: STF ALTERNATIVE 3 MPE SYSTEM

FIGURE: 10-7

DESIGNED BY	W. PICKENS	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	C. PHILIPS	04/14
APPROVED BY	D. MICK	04/14
PROJECT MANAGER	D. MICK	04/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

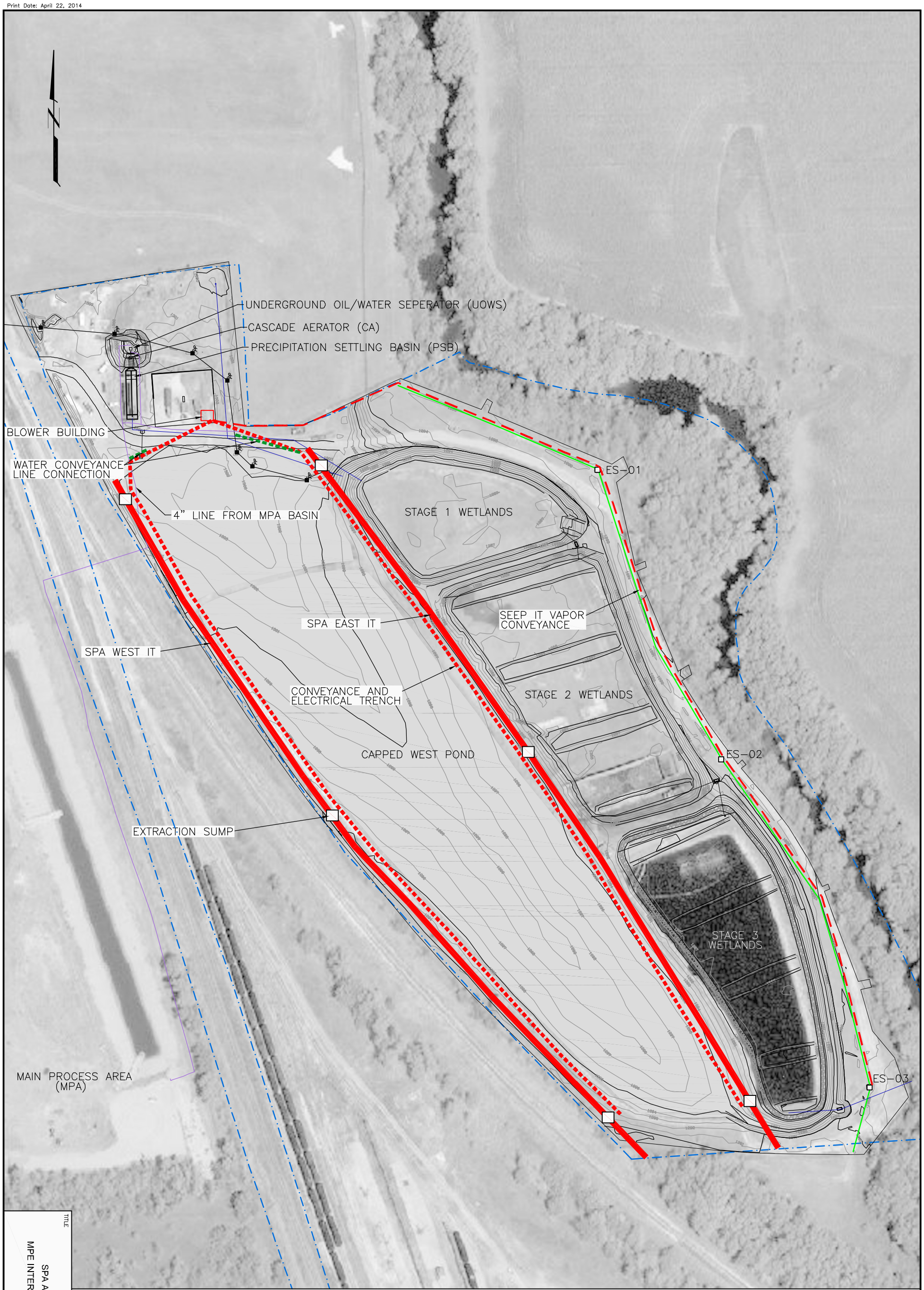
TITLE: STF ALTERNATIVE 3 MPE SYSTEM

MWH

FIGURE 10-7 REVISION 1

FILE NAME: EDR Fig 10-7 TPH-DRO Conc Map.dwg

Print Date: April 22, 2014



LEGEND

- NEW INTERCEPTOR TRENCH
- CONVEYANCE & ELECTRICAL TRENCH
- WATER CONVEYANCE LINE CONNECTION
- OVERHEAD ELECTRIC AND POWER POLE
- SEEP IT VAPOR CONVEYANCE LINE
- EXTRACTION SUMP (ES)
- STONE RIPRAP
- EXISTING INTERCEPTOR TRENCH (IT)

SCALE

0 75' 150'

SCALE IN FEET

TITLE

SPA ALTERNATIVE 3
MPE INTERCEPTOR TRENCHES

FIGURE

10-8

DESIGNED BY	M. WARNER	04/14
DRAWN BY	M. WARNER	04/14
CHECKED BY	C. PHILIPS	04/14
APPROVED BY	J. TEGROTENHUIS	04/14
PROJECT MANAGER	D. MICK	04/14
CLIENT APPROVAL	L. SUSTAITA	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: FORMER COASTAL REFINERY, EL DORADO, KS

PROJECT: CORRECTIVE ACTION STUDY

TITLE: SPA ALTERNATIVE 3
MPE INTERCEPTOR TRENCHES

MWH

FIGURE 10-8

REVISION 1

FILE NAME Current Site Plan - Pond Area.dwg

APPENDIX A

HISTORICAL AND REFERENCE DOCUMENTS COMPACT DISK

MWH

INDEX: APPENDIX A HISTORICAL AND REFERENCE DOCUMENTS COMPACT DISK

Historical Figures and Drawings
Historical Soil Boring & Well Logs
Historical Tables

Historical Reports, Work Plans and Designs

2005-10-01 El Dorado Phase III Investigation Report
2007-02-16 El Dorado Seep Trench Record As-Built Drawings
2008-07-09 El Dorado Phase III Supplemental Investigation Work Plan
2009-03-24 El Dorado Subslab Vapor Sampling Report
2009-04-02 El Dorado Off-Site Well Installation Work Plan
2009-04-06 El Dorado Pond Treatability Study Work Plan
2009-09-22 El Dorado AHA Treatability Stud y Work Plan
2009-11-24 El Dorado Phase III Investigation Report (sans Appendices)
2010-01-07 El Dorado Ponds Sediment Stabilization Treatability Study Status
2010-04-14 El Dorado MPA Grading, Sewer, and Basin Design
2010-09-03 El Dorado AHA Treatability Stud y Report
2010-09-21 El Dorado Pond Sediment Treatability Study Final Report
2011-04-25 El Dorado Final (100%) Water Treatment Design
2011-05-02 El Dorado Final (100%) Ponds & AHA Work Plan-Design
2011-06-22 El Dorado Baseline Ecological Risk Assessment - MPA and AHA
2011-07-18 El Dorado STF-Focused Risk Assessment
2011-07-27 El Dorado Addition of UOWS to Water Treatment Design
2011-08-17 El Dorado OWS Water Sample Results Letter Report
2012-02-24 El Dorado Human Health Risk Assessment
2012-03-23 El Dorado Baseline Ecological Risk Assessment - WBWR and STF
2012-06-13 El Dorado MPA Spring Mitigation System Design
2013-06-03 El Dorado IRM CCR (through Appendix A only)
2013-10-11El Dorado MPA Spring Tar Treatment System Design
2014-03-18 El Dorado Draft Soil-Waste Management Plan

KDHE Guidance Documents

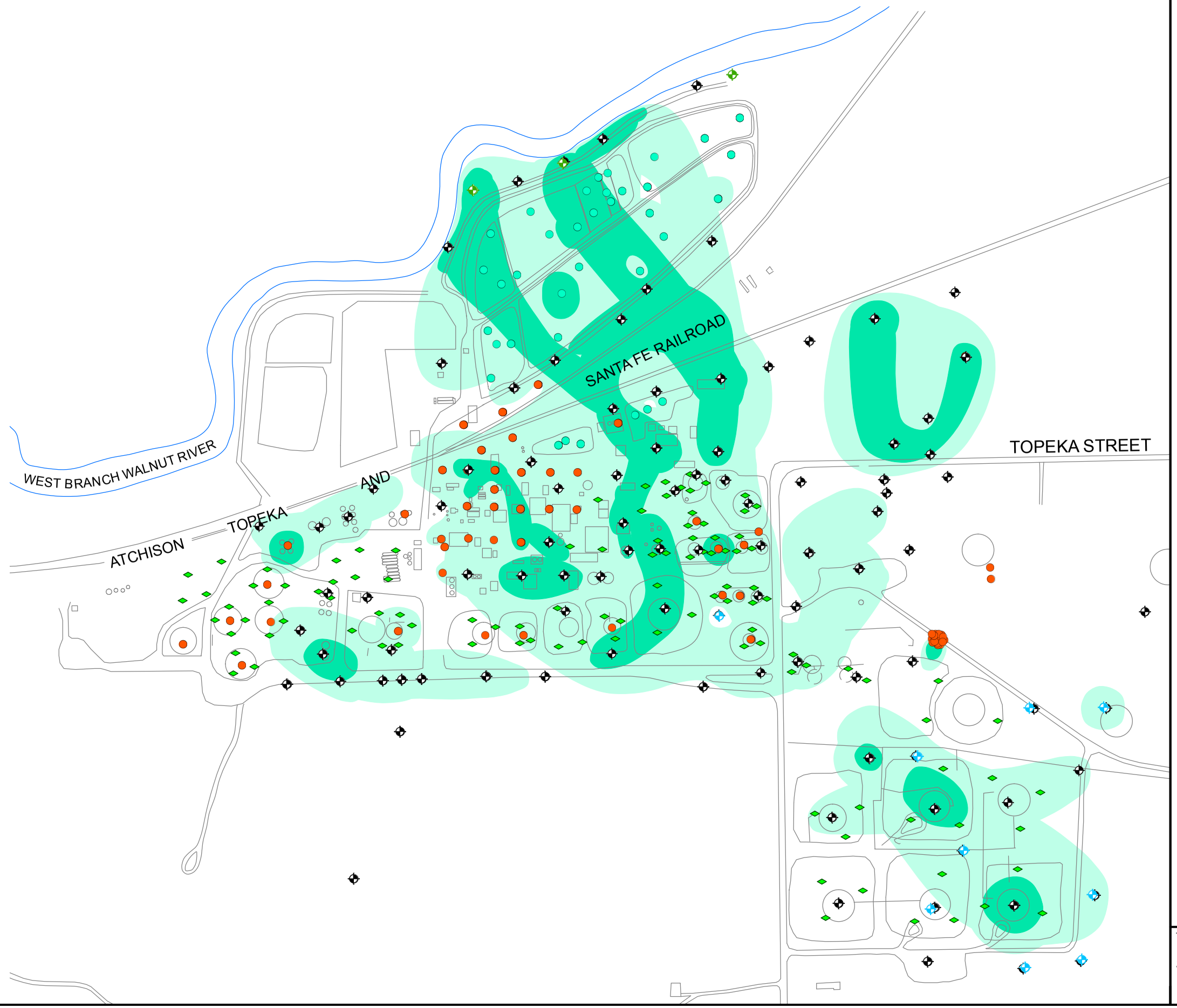
BER-ARS-045 Sediment Policy
BER-RS-005 Evaluating Future Land Use
BER-RS-015 ARARs
BER-RS-019 CAS SOW
BER-RS-020 CI and CAS SOW
BER-RS-023 CAP and CA SOW
BER-RS-024 Reclassification Plan
BER-RS-028 Consideration for Hydraulic Containment
BER-RS-033 Considerations for Remedial Standards
BER-RS-036 Site Monitoring SOW
BER-RS-041 TPH GRO and DRO

BER-RS-042 MNA (new)
BER-RS-042 MNA (old)
BER-RS-045 GW and RSK Considerations
EUC Application
RSK Manual March 2014
RSK Manual October 2010
Surface Water Quality Standards

APPENDIX B

THIRD PHASE INVESTIGATION REPORT
SELECT SOIL FIGURES

MWH



LEGEND:

- SHALLOW SOIL SAMPLE
- SOIL BORING
- POND SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- DEEP WEATHERED BEDROCK MONITORING WELL (DOYLE SHALE OR SHALLOW FORT RILEY FORMATION)
- DEEP FORT RILEY MONITORING WELL

NOTES:
WELLS AND SOIL BORINGS SHOWN WHERE PID RESULTS (PPMV) WERE OBSERVED BETWEEN 0 AND 32 FEET BELOW GROUND SURFACE (BGS).
SOIL HEADSPACE GAS CONCENTRATIONS (SHADED REGIONS) ARE OVERLAIN FOR THE EIGHT 4-FOOT INTERVALS BETWEEN 0 AND 32 FEET BGS.
PID = PHOTOIONIZATION DETECTOR

DRAWING REFERENCE(S):
1. LINE DRAWING SITE MAP BASED ON AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES. NAD 83. US FEET.

DESIGNED BY	R. Hultgren 07/09
DRAWN BY	R. Hultgren 08/09
CHECKED BY	R. Hultgren 08/09
APPROVED BY	W. Pickens 08/09
PROJECT MANAGER	D. Mick 08/09
PROJECT NO.	1914351.90010408
FILE NAME	RPT-016C_SiteSoilVOC_0-32.mxd

SOIL HEADSPACE GAS CONCENTRATIONS

- MAXIMUM PID RESULT <100 PPMV
- MAXIMUM PID RESULT 100 - 1000 PPMV
- MAXIMUM PID RESULT >1000 PPMV

N W E S

SCALE
0 400 800
SCALE IN FEET

elpaso

MWH

PROJECT LOCATION: EL DORADO, KANSAS

PROJECT: EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE: SOIL HEADSPACE GAS DATA, 0-32' COMPOSITE NORTHERN AREA

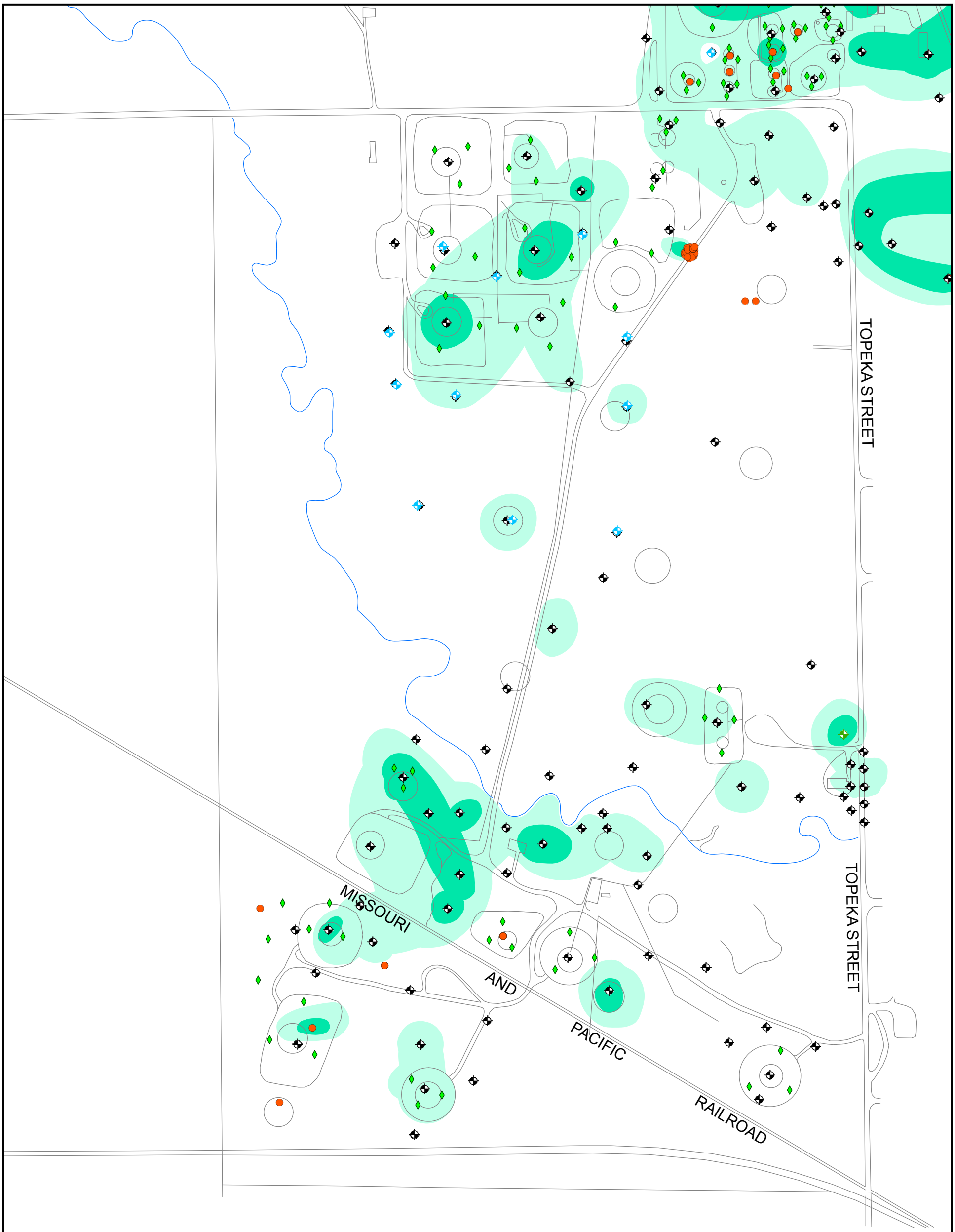
FIGURE: 37

TITLE

SOIL HEADSPACE GAS DATA, 0-32' COMPOSITE NORTHERN AREA

FIGURE

37



LEGEND:

- SHALLOW SOIL SAMPLE
- SOIL BORING
- POND SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
- DEEP WEATHERED BEDROCK MONITORING WELL (DOYLE SHALE OR SHALLOW FORT RILEY FORMATION)
- DEEP FORT RILEY MONITORING WELL

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SOIL HEADSPACE GAS CONCENTRATIONS

- MAXIMUM PID RESULT <100 PPMV
- MAXIMUM PID RESULT 100 - 1000 PPMV
- MAXIMUM PID RESULT >1000 PPMV

N
W E
S

SCALE

0 400 800

SCALE IN FEET

TITLE
SOIL HEADSPACE GAS DATA,
0-32' COMPOSITE
SOUTHERN AREA

FIGURE
38

DRAWING REFERENCE(S):
1. LINE DRAWING SITE MAP BASED ON AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

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DRAWN BY	R. Hultgren	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-016C_SiteSoilVOC_0-32.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS DATA,
0-32' COMPOSITE
SOUTHERN AREA

MWH

FIGURE
38

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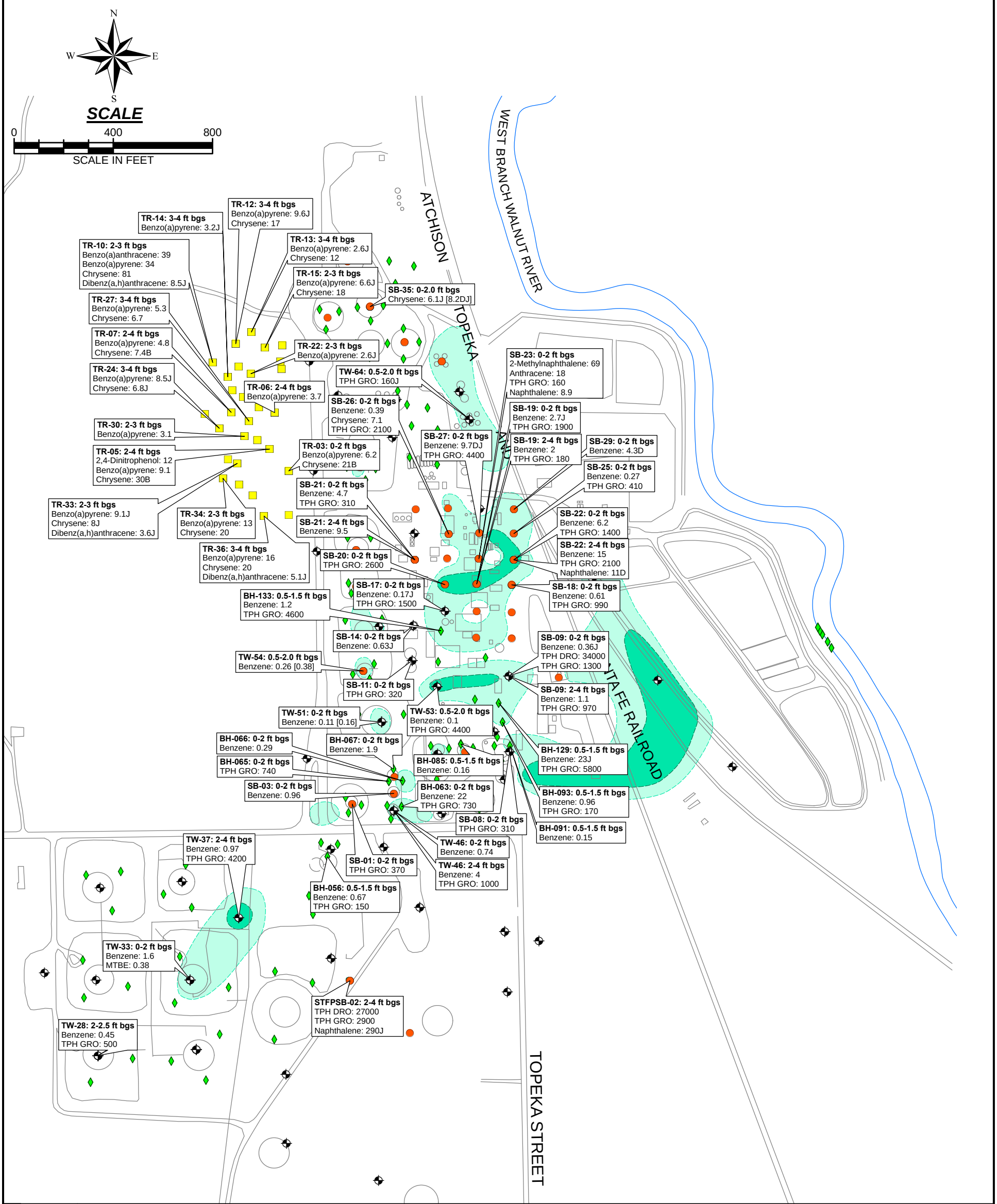

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 0-4' SAMPLING INTERVAL NORTHERN AREA

FIGURE
39

LEGEND:

- AHA BACKHOE SAMPLE
- SHALLOW SOIL SAMPLE
- SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

- MAXIMUM PID RESULT <100 PPMV
- MAXIMUM PID RESULT 100 - 1000 PPMV
- MAXIMUM PID RESULT >1000 PPMV

KANSAS TIER 2 RISK-BASED STANDARDS FOR NON-RESIDENTIAL (INDUSTRIAL) PATHWAYS:

ANALYTE	LEVEL	UNITS	PATHWAY(S)
2,4-DINITROPHENOL	2.1	mg/kg	SOIL TO GROUNDWATER
2-METHYLNAPHTHALENE	45	mg/kg	SOIL TO GROUNDWATER
ANTHRACENE	13	mg/kg	SOIL/SOIL TO GROUNDWATER
BENZENE	0.08	mg/kg	SOIL TO GROUNDWATER
BENZO(A)ANTHRACENE	26	mg/kg	SOIL
BENZO(A)PYRENE	2.6	mg/kg	SOIL
BENZO(B)FLUORANTHENE	19	mg/kg	SOIL/SOIL TO GROUNDWATER
CHLOROFORM	0.96	mg/kg	SOIL TO GROUNDWATER
CHRYSENE	6.4	mg/kg	SOIL/SOIL TO GROUNDWATER
DIBENZ(A,H)ANTHRACENE	2.6	mg/kg	SOIL
TPH DRO	15000	mg/kg	SOIL TO GROUNDWATER
ETHYLBENZENE	55	mg/kg	SOIL TO GROUNDWATER
TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
MTBE	0.09	mg/kg	SOIL TO GROUNDWATER
NAPHTHALENE	3.52	mg/kg	SOIL TO GROUNDWATER
PYRIDINE	0.05	mg/kg	SOIL TO GROUNDWATER

NOTES:
WELLS AND SOIL BORINGS LABELED WITH NAME, SAMPLING DEPTH, ANALYTE, AND CONCENTRATION IN SOIL (mg/kg).
DATA ARE ONLY SHOWN WHERE RESULTS EXCEEDED THE CORRESPONDING SCREENING LEVEL FOR THE ORGANIC ANALYTES LISTED ON THE RIGHT.
DUPLICATE RESULTS SHOWN IN BRACKETS [ ] FOR APPLICABLE ANALYTE(S) AND RESULT(S).
ft bgs = FEET BELOW GROUND SURFACE. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
B = ANALYTE FOUND IN AN ASSOCIATED BLANK AND IN THE SAMPLE. D = COMPOUND DETECTED AT A SECONDARY DILUTION FACTOR.

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DESIGNED BY	R. Hultgren	07/09
DRAWN BY	C. Pappas	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-108C_SoilHCResults_0-4.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 0-4' SAMPLING INTERVAL NORTHERN AREA

MWH

FIGURE
39

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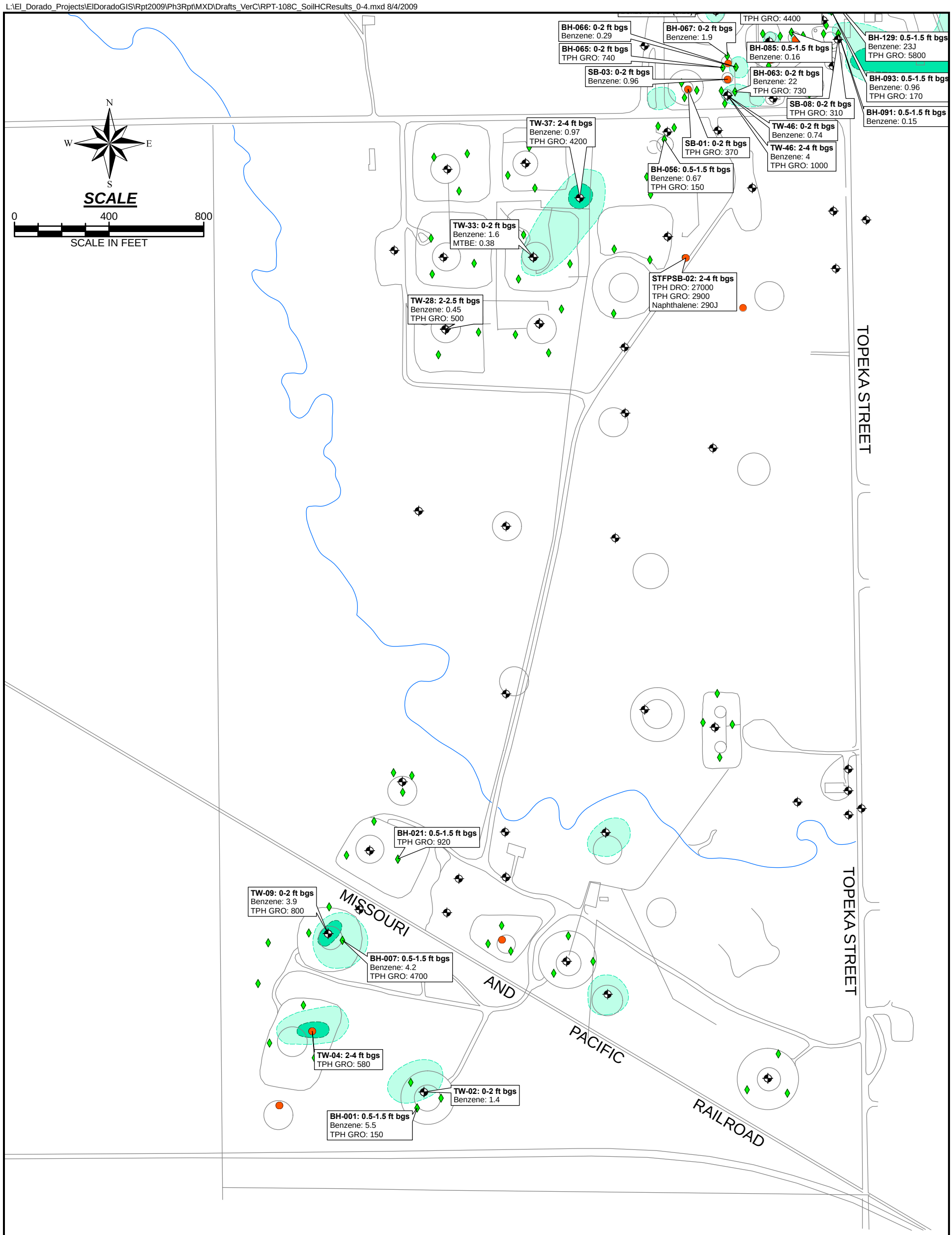

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 0-4' SAMPLING INTERVAL SOUTHERN AREA

FIGURE
40

LEGEND:

- AHA BACKHOE SAMPLE
- SHALLOW SOIL SAMPLE
- SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

- MAXIMUM PID RESULT <100 PPMV
- MAXIMUM PID RESULT 100 - 1000 PPMV
- MAXIMUM PID RESULT >1000 PPMV

KANSAS TIER 2 RISK-BASED STANDARDS FOR NON-RESIDENTIAL (INDUSTRIAL) PATHWAYS:

ANALYTE	LEVEL	UNITS	PATHWAY(S)
2,4-DINITROPHENOL	2.1	mg/kg	SOIL TO GROUNDWATER
2-METHYLNAPHTHALENE	45	mg/kg	SOIL TO GROUNDWATER
ANTHRACENE	13	mg/kg	SOIL/SOIL TO GROUNDWATER
BENZENE	0.08	mg/kg	SOIL TO GROUNDWATER
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DESIGNED BY	R. Hultgren	07/09
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APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-108C_SoilHCResults_0-4.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 0-4' SAMPLING INTERVAL SOUTHERN AREA

MWH

FIGURE
40

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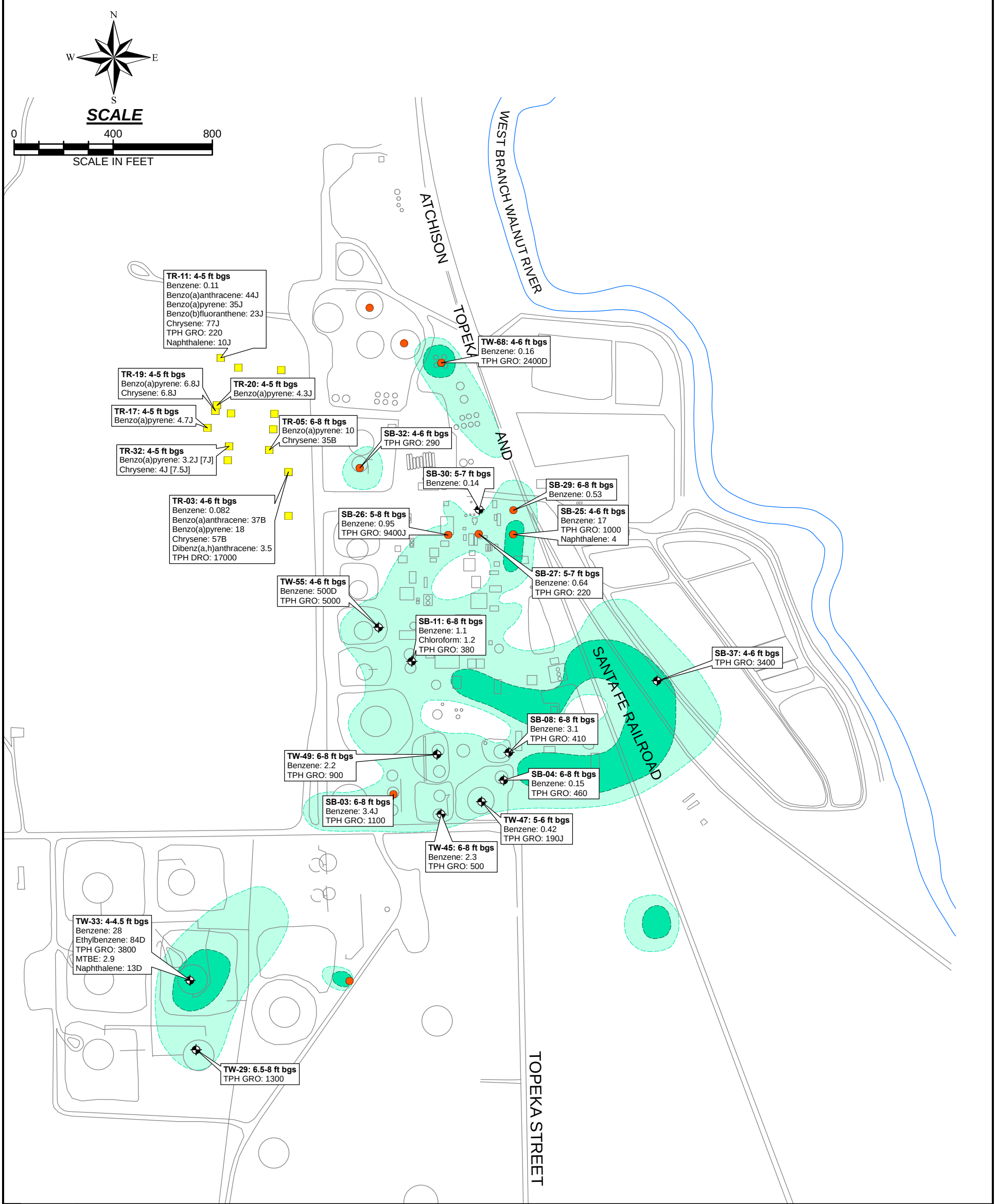

TITLE
SOIL HEADSPACE DATA AND ORGANIC ANALYTICAL DATA, 4-8' SAMPLING INTERVAL NORTHERN AREA

FIGURE
41

LEGEND:

- AHA BACKHOE SAMPLE
- SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

- MAXIMUM PID RESULT <100 PPMV
- MAXIMUM PID RESULT 100 - 1000 PPMV
- MAXIMUM PID RESULT >1000 PPMV

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TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
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DRAWN BY	R. Hultgren	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-109C_SoilHCResults_4-8.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE DATA AND ORGANIC ANALYTICAL DATA, 4-8 SAMPLING INTERVAL NORTHERN AREA

MWH

FIGURE
41

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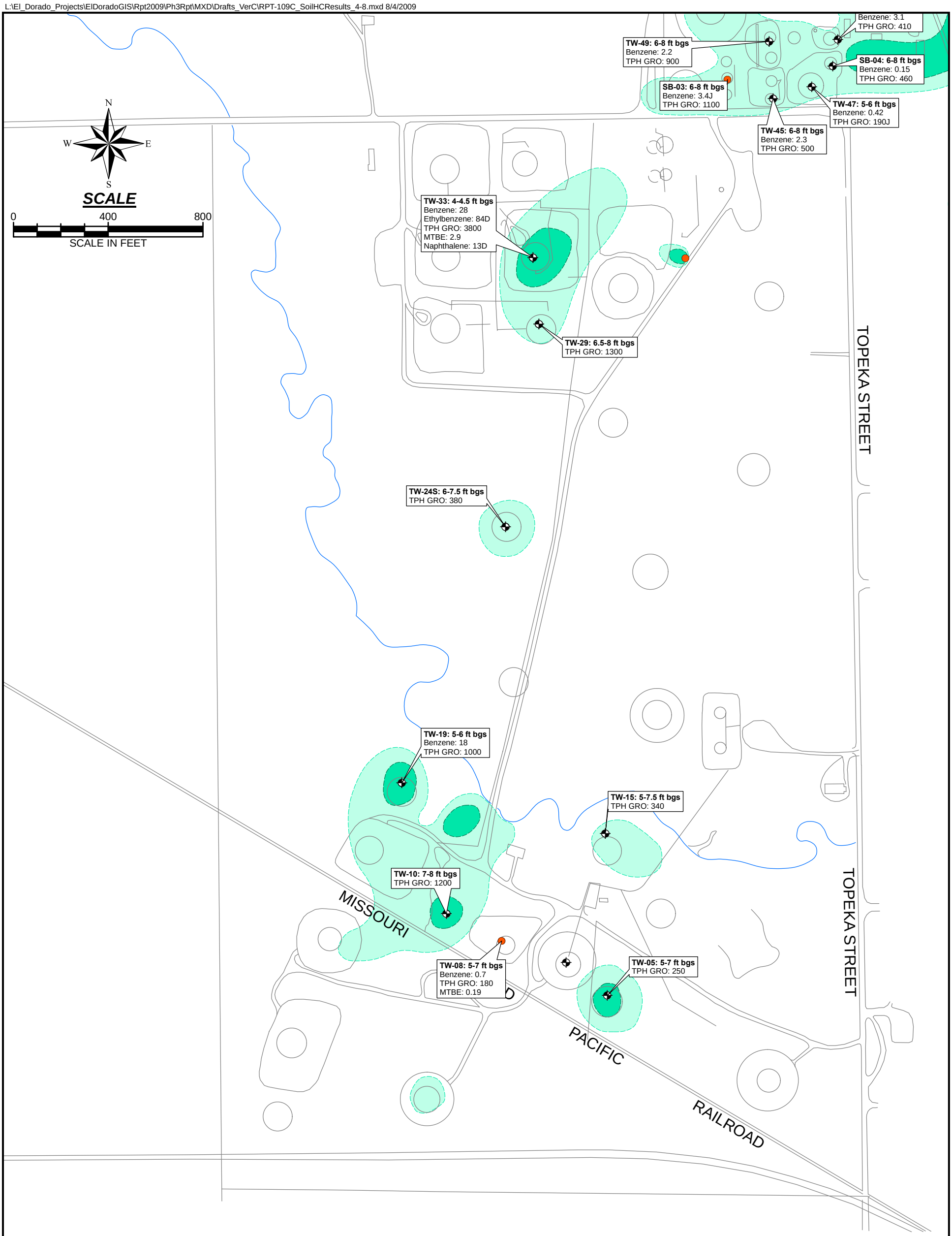

TITLE
SOIL HEADSPACE DATA AND ORGANIC ANALYTICAL DATA, 4-8' SAMPLING INTERVAL SOUTHERN AREA

FIGURE
42

LEGEND:

- AHA BACKHOE SAMPLE
- SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

- MAXIMUM PID RESULT <100 PPMV
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CHRYSENE	6.4	mg/kg	SOIL/SOIL TO GROUNDWATER
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TPH DRO	15000	mg/kg	SOIL TO GROUNDWATER
ETHYLBENZENE	55	mg/kg	SOIL TO GROUNDWATER
TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
MTBE	0.09	mg/kg	SOIL TO GROUNDWATER
NAPHTHALENE	3.52	mg/kg	SOIL TO GROUNDWATER
PYRIDINE	0.05	mg/kg	SOIL TO GROUNDWATER

NOTES:
WELLS AND SOIL BORINGS LABELED WITH NAME, SAMPLING DEPTH, ANALYTE, AND CONCENTRATION IN SOIL (mg/kg).
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DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-109C_SoilHCResults_4-8.mxd	

elpaso

PROJECT LOCATION: EL DORADO, KANSAS
PROJECT: EL PASO MERCHANT ENERGY - PETROLEUM CO.
TITLE: SOIL HEADSPACE DATA AND ORGANIC ANALYTICAL DATA, 4-8 SAMPLING INTERVAL SOUTHERN AREA

MWH

FIGURE
42

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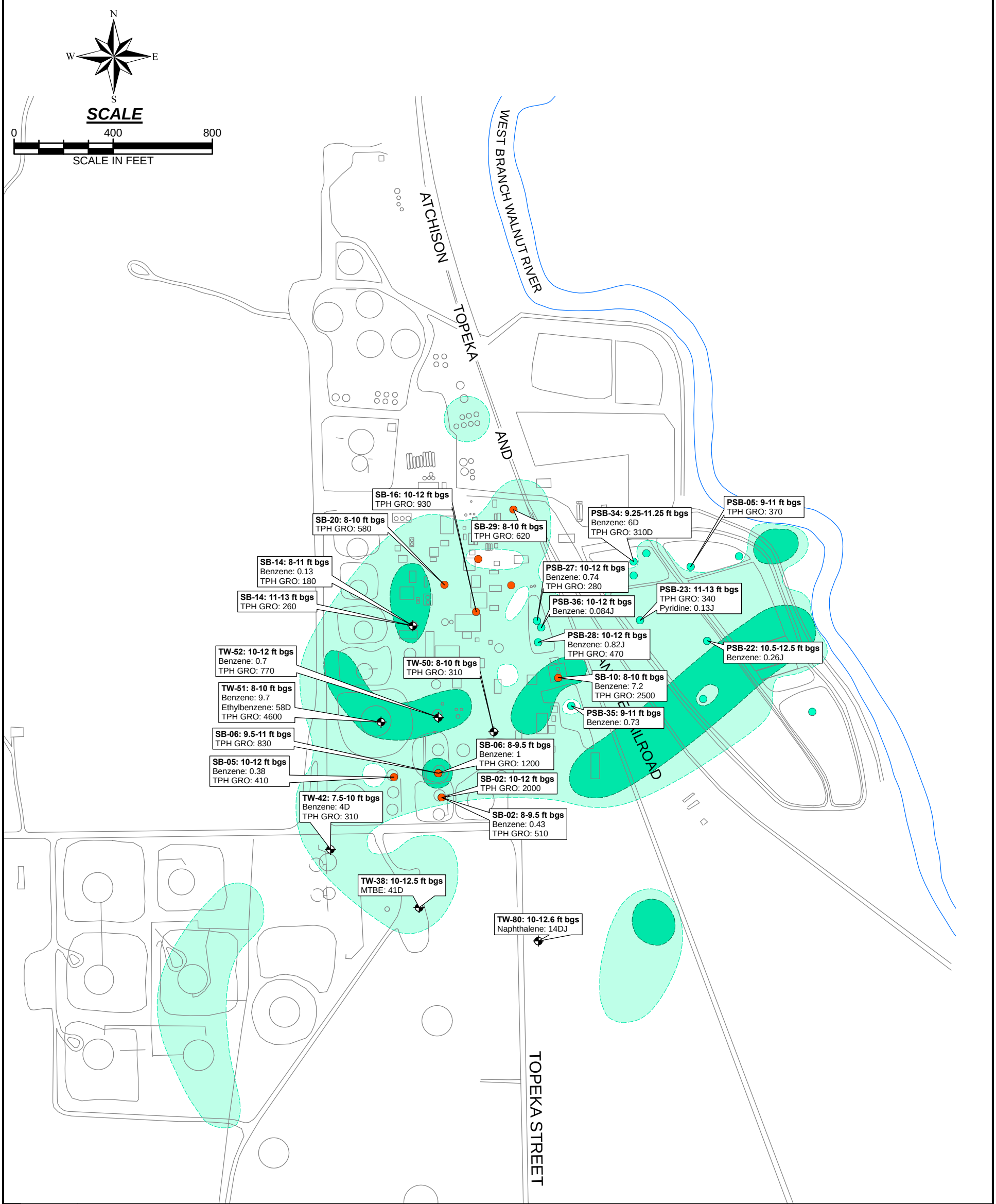

LEGEND:

- SOIL BORING
- POND SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

- MAXIMUM PID RESULT <100 PPMV
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KANSAS TIER 2 RISK-BASED STANDARDS FOR NON-RESIDENTIAL (INDUSTRIAL) PATHWAYS:

ANALYTE	LEVEL	UNITS	PATHWAY(S)
2,4-DINITROPHENOL	2.1	mg/kg	SOIL TO GROUNDWATER
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ANTHRACENE	13	mg/kg	SOIL/SOIL TO GROUNDWATER
BENZENE	0.08	mg/kg	SOIL TO GROUNDWATER
BENZO(A)ANTHRACENE	26	mg/kg	SOIL
BENZO(A)PYRENE	2.6	mg/kg	SOIL
BENZO(B)FLUORANTHENE	19	mg/kg	SOIL/SOIL TO GROUNDWATER
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TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 8-12' SAMPLING INTERVAL NORTHERN AREA

FIGURE
43

DRAWING REFERENCE(S):
1. LINE DRAWING SITE MAP BASED ON AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

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APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-110C_SoilHCResults_8-12.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

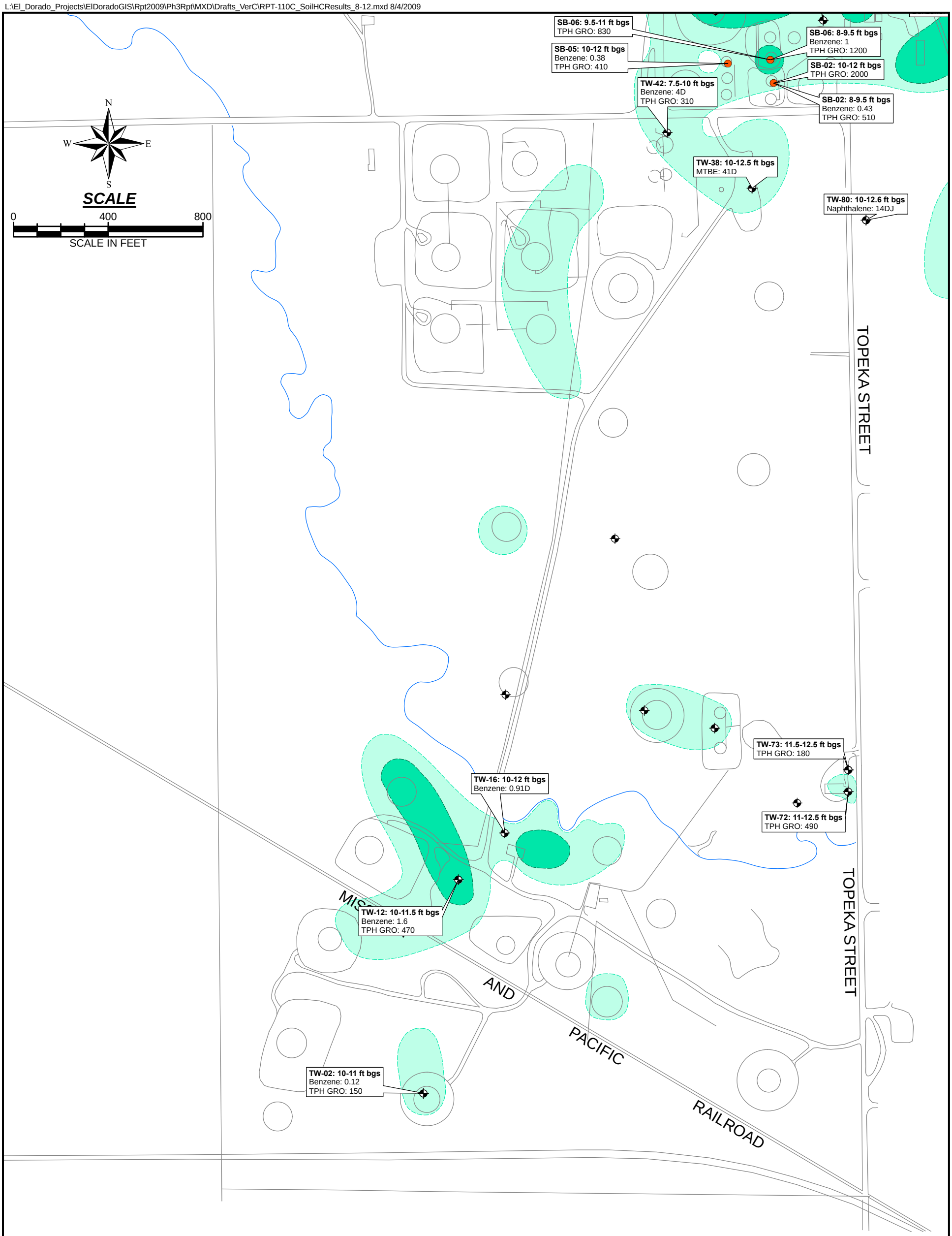
PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 8-12' SAMPLING INTERVAL NORTHERN AREA

MWH

FIGURE
43

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-110C_SoilHCResults_8-12.mxd 8/4/2009



TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 8-12' SAMPLING INTERVAL SOUTHERN AREA

FIGURE
44

LEGEND:

- SOIL BORING
- POND SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

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APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-110C_SoilHCResults_8-12.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

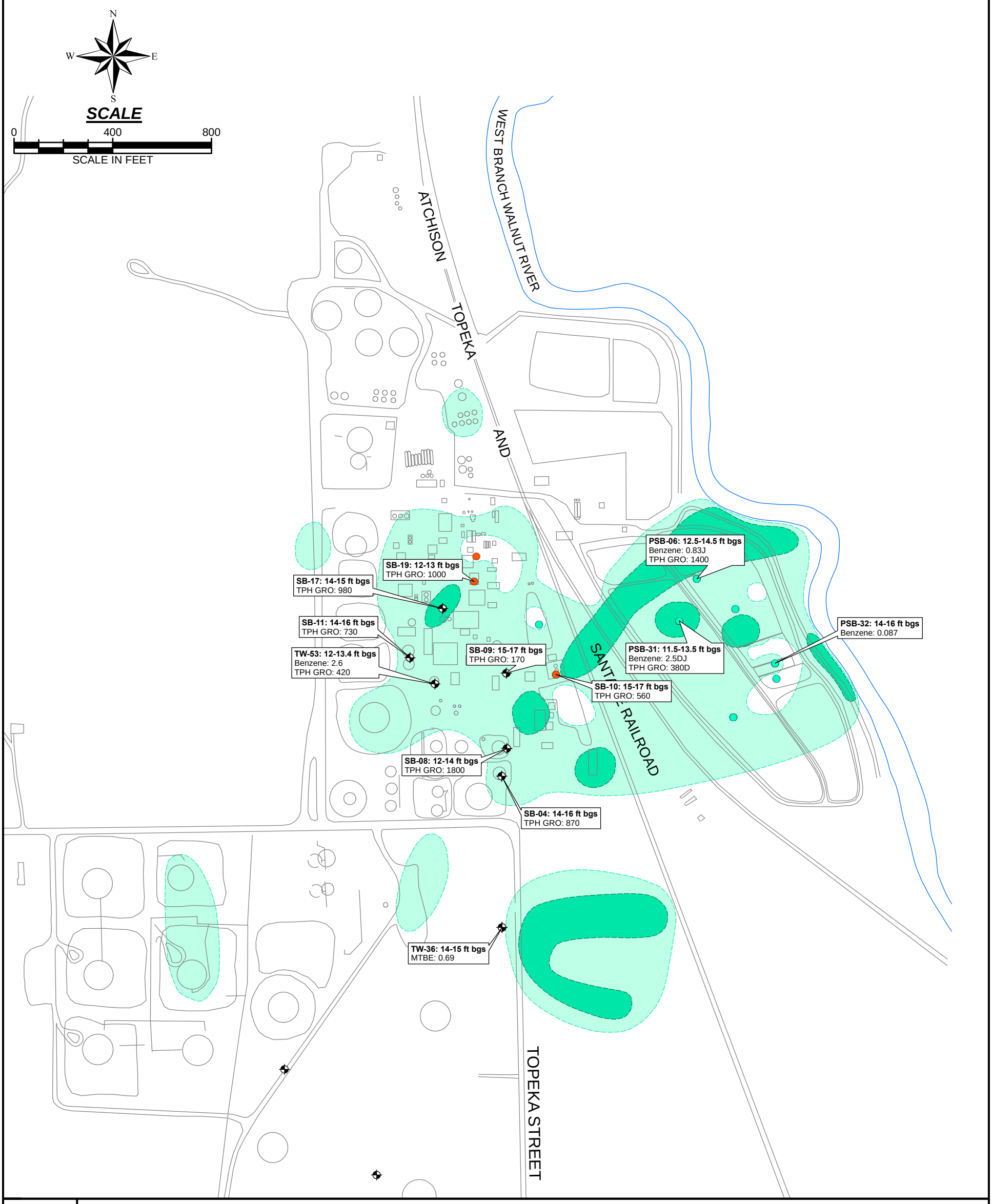
PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 8-12' SAMPLING INTERVAL SOUTHERN AREA

MWH

FIGURE
44

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-111C_SoilHCResults_12-16.mxd 8/4/2009



TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 12-16' SAMPLING INTERVAL NORTHERN AREA

FIGURE
45

LEGEND:

- SOIL BORING
- POND SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

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DRAWN BY	R. Hultgren	08/09
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PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-111C_SoilHCResults_12-16.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 12-16' SAMPLING INTERVAL NORTHERN AREA

MWH

FIGURE
45

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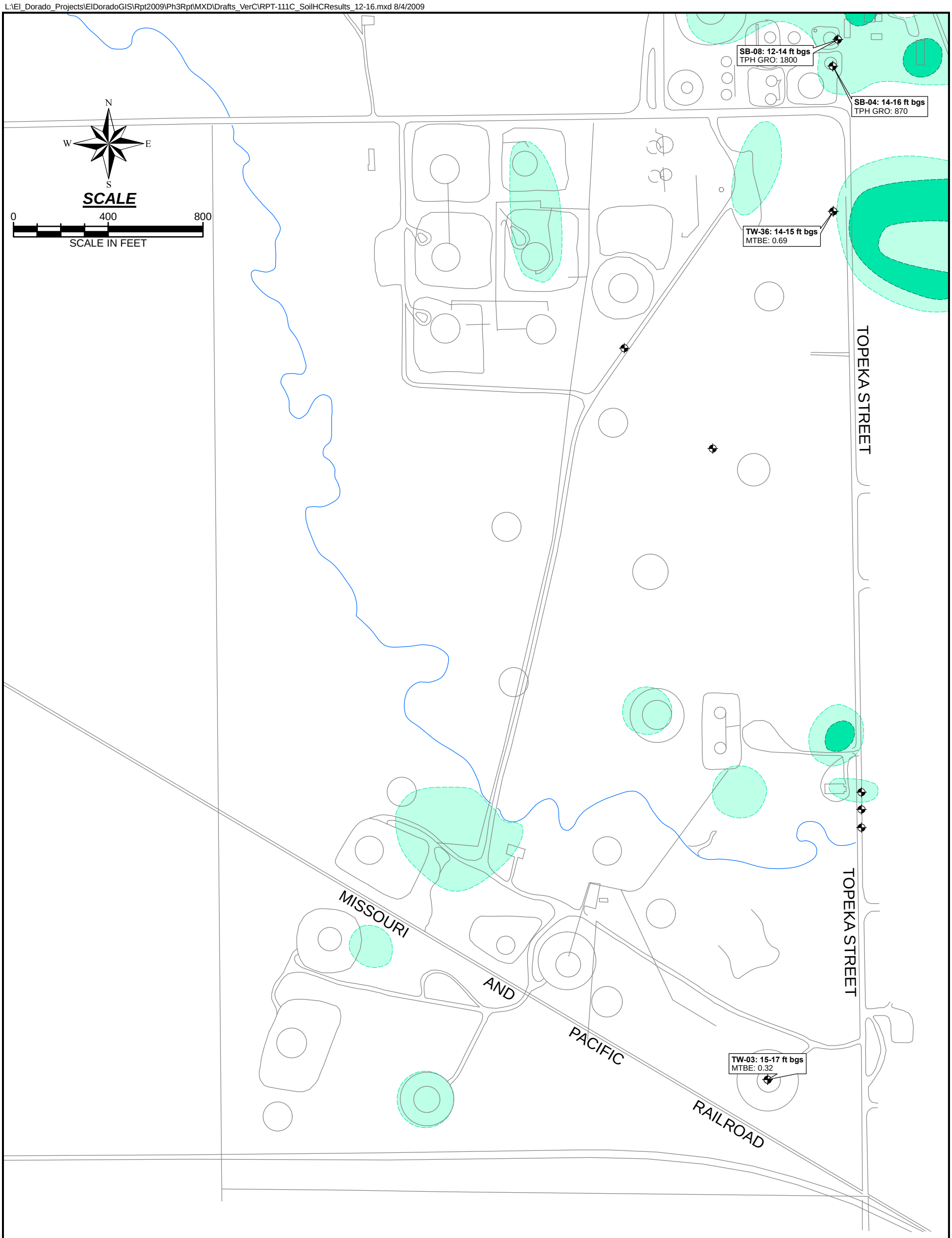

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 12-16' SAMPLING INTERVAL SOUTHERN AREA

FIGURE
46

LEGEND:

- SOIL BORING
- POND SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

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PROJECT NO.	1914351.90010408	
FILE NAME	RPT-111C_SoilHCResults_12-16.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

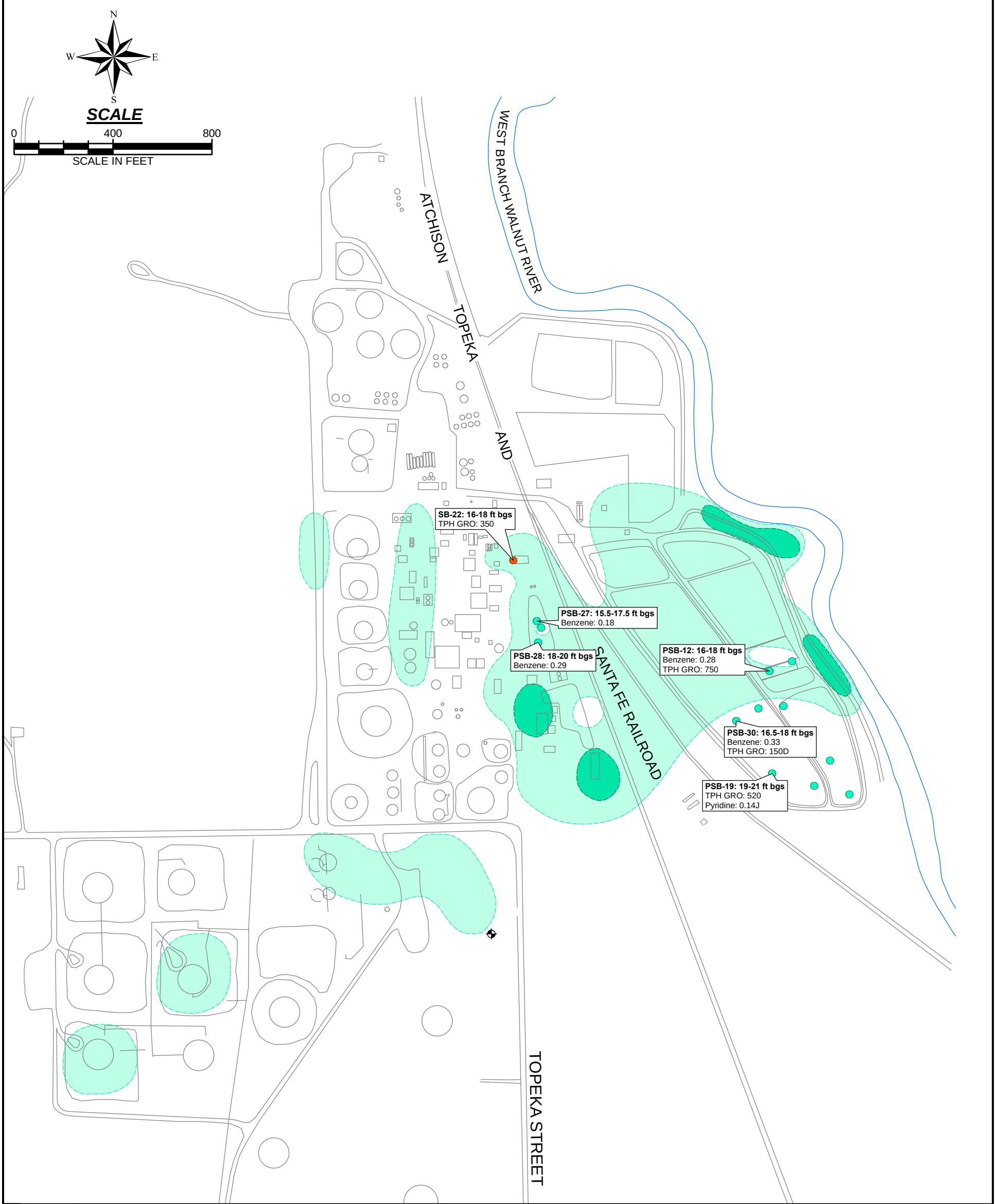
PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 12-16' SAMPLING INTERVAL SOUTHERN AREA

MWH

FIGURE
46

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-112C_SoilHCResults_16-20.mxd 8/4/2009



TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 16-20' SAMPLING INTERVAL NORTHERN AREA

FIGURE
47

LEGEND:

- SOIL BORING
- POND SOIL BORING
- SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

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PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-112C_SoilHCResults_16-20.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 16-20' SAMPLING INTERVAL NORTHERN AREA

MWH

FIGURE
47

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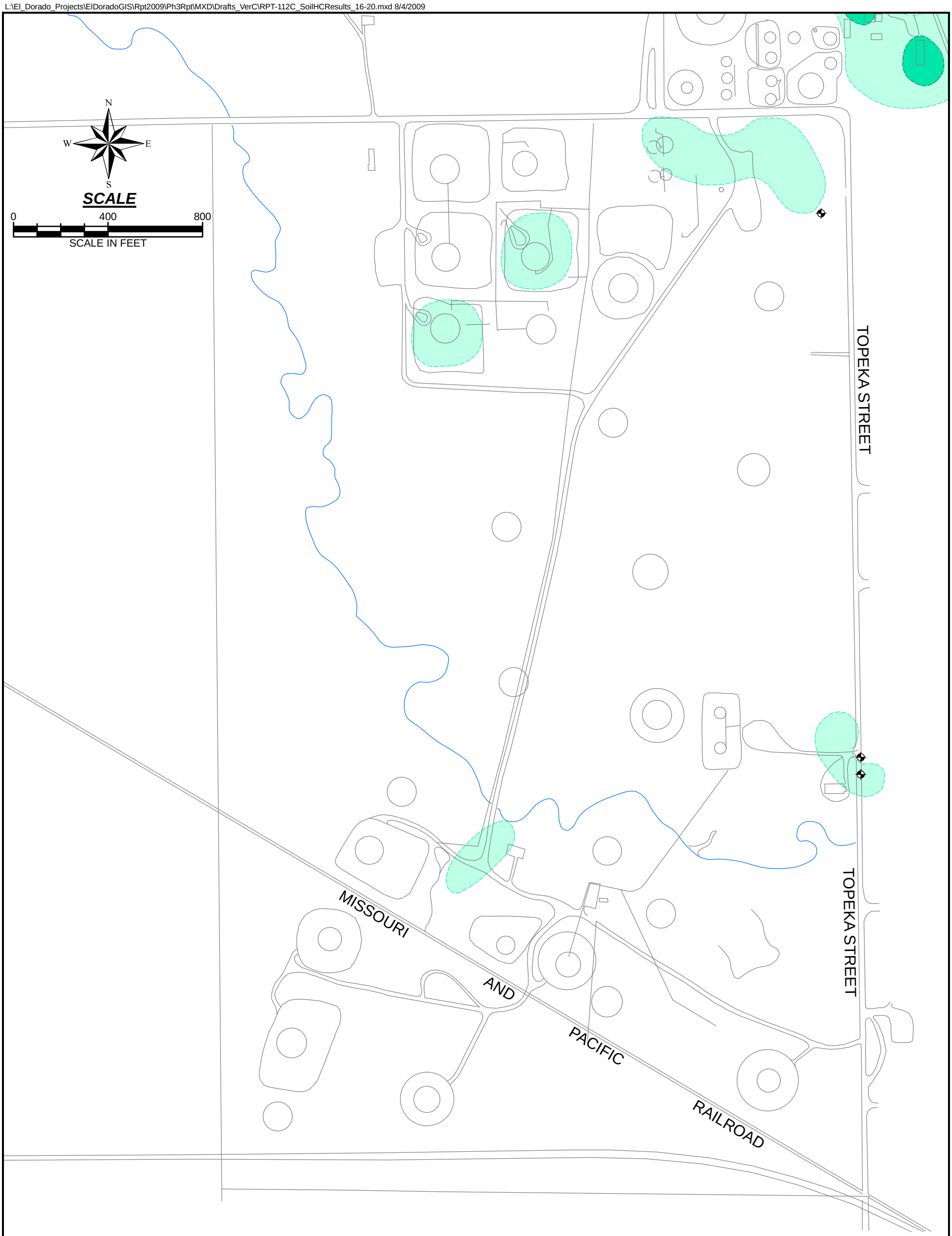

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 16-20' SAMPLING INTERVAL SOUTHERN AREA

FIGURE
48

LEGEND:

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ft bgs = FEET BELOW GROUND SURFACE. J = DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.
B = ANALYTE FOUND IN AN ASSOCIATED BLANK AND IN THE SAMPLE. D = COMPOUND DETECTED AT A SECONDARY DILUTION FACTOR.
SAMPLE DEPTHS FOR POND SOIL BORINGS (PSB) ARE REFERENCED FROM POND SURFACE WATER LEVEL.

DRAWING REFERENCE(S):
1. LINE DRAWING SITE MAP BASED ON AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-112C_SoilHCResults_16-20.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

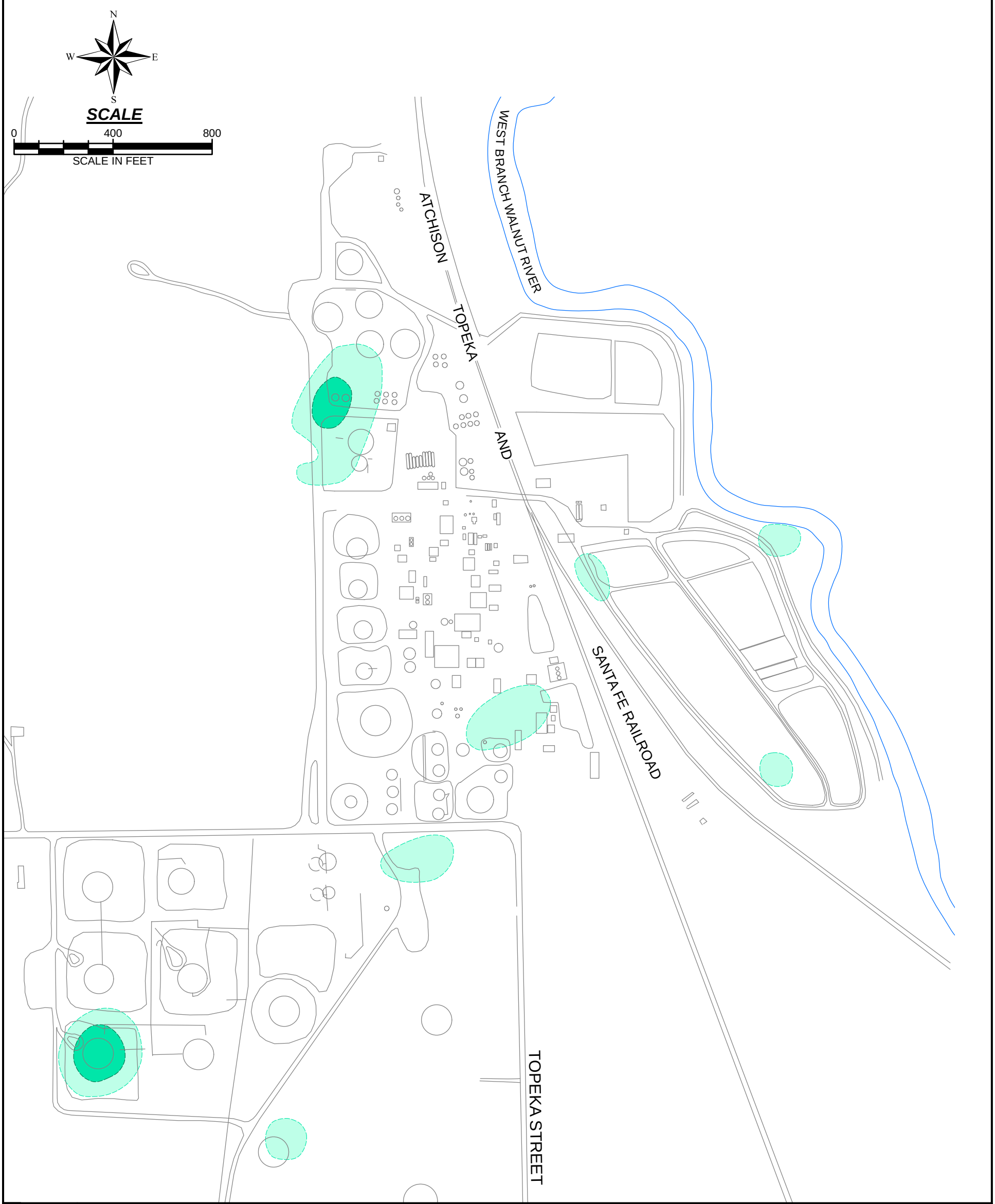
PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 16-20' SAMPLING INTERVAL SOUTHERN AREA

MWH

FIGURE
48

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-113C_SoilHCResults_20-24.mxd 8/4/2009



LEGEND:

SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

- MAXIMUM PID RESULT <100 PPMV
- MAXIMUM PID RESULT 100 - 1000 PPMV
- MAXIMUM PID RESULT >1000 PPMV

KANSAS TIER 2 RISK-BASED STANDARDS FOR NON-RESIDENTIAL (INDUSTRIAL) PATHWAYS:

ANALYTE	LEVEL	UNITS	PATHWAY(S)
2,4-DINITROPHENOL	2.1	mg/kg	SOIL TO GROUNDWATER
2-METHYLNAPHTHALENE	45	mg/kg	SOIL TO GROUNDWATER
ANTHRACENE	13	mg/kg	SOIL/SOIL TO GROUNDWATER
BENZENE	0.08	mg/kg	SOIL TO GROUNDWATER
BENZO(A)ANTHRACENE	26	mg/kg	SOIL
BENZO(A)PYRENE	2.6	mg/kg	SOIL
BENZO(B)FLUORANTHENE	19	mg/kg	SOIL/SOIL TO GROUNDWATER
CHLOROFORM	0.96	mg/kg	SOIL TO GROUNDWATER
CHRYSENE	6.4	mg/kg	SOIL/SOIL TO GROUNDWATER
DIBENZ(A,H)ANTHRACENE	2.6	mg/kg	SOIL
TPH DRO	15000	mg/kg	SOIL TO GROUNDWATER
ETHYLBENZENE	55	mg/kg	SOIL TO GROUNDWATER
TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
MTBE	0.09	mg/kg	SOIL TO GROUNDWATER
NAPHTHALENE	3.52	mg/kg	SOIL TO GROUNDWATER
PYRIDINE	0.05	mg/kg	SOIL TO GROUNDWATER

NOTES:
WELLS AND SOIL BORINGS LABELED WITH NAME, SAMPLING DEPTH, ANALYTE, AND CONCENTRATION IN SOIL (mg/kg).
DATA ARE ONLY SHOWN WHERE RESULTS EXCEEDED THE CORRESPONDING SCREENING LEVEL FOR THE ORGANIC ANALYTES LISTED ON THE RIGHT.
DUPLICATE RESULTS SHOWN IN BRACKETS [ ] FOR APPLICABLE ANALYTE(S) AND RESULT(S).
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B = ANALYTE FOUND IN AN ASSOCIATED BLANK AND IN THE SAMPLE. D = COMPOUND DETECTED AT A SECONDARY DILUTION FACTOR.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 20-24' SAMPLING INTERVAL NORTHERN AREA

FIGURE
49

DRAWING REFERENCE(S):
1. LINE DRAWING SITE MAP BASED ON AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

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DRAWN BY	R. Hultgren	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-113C_SoilHCResults_20-24.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

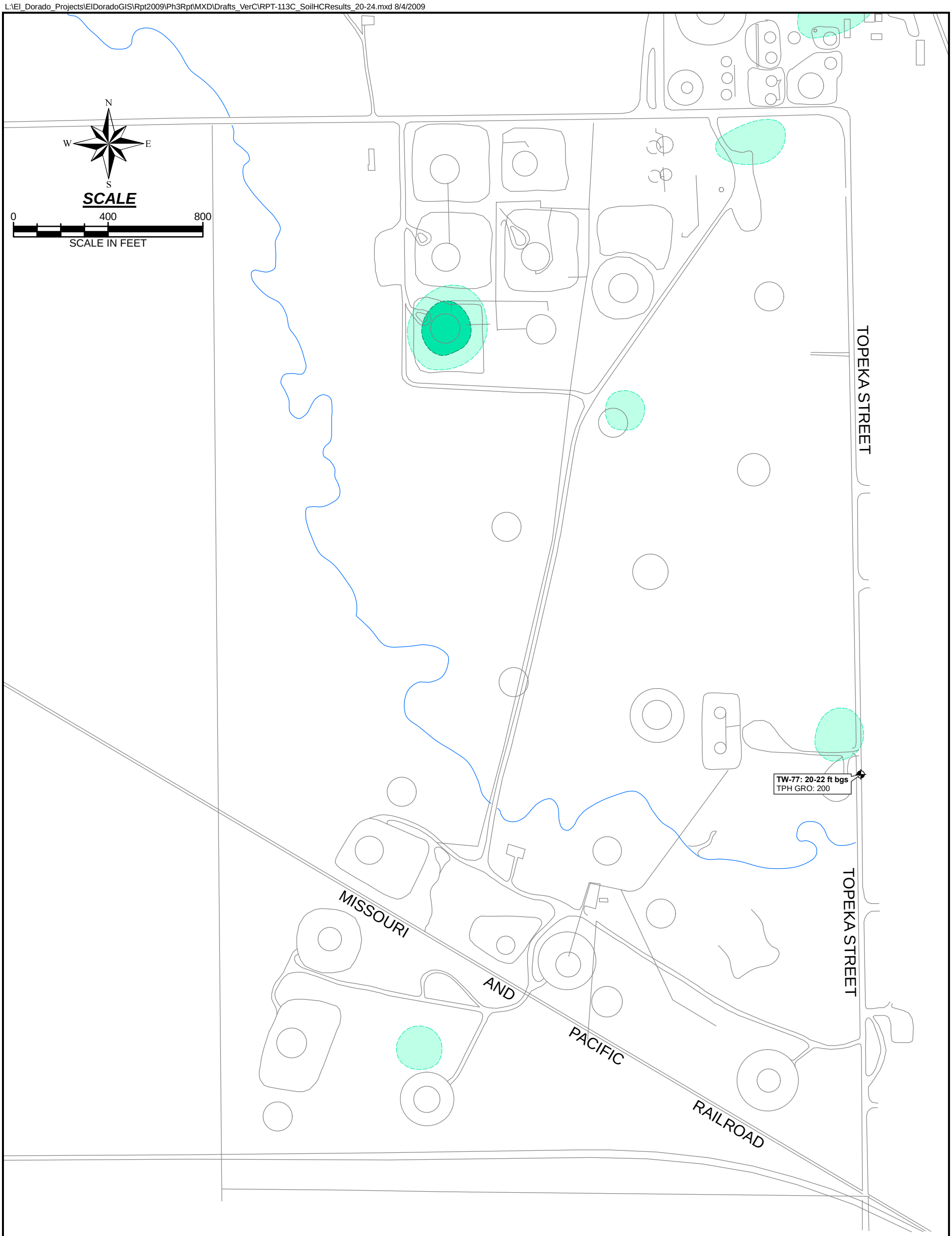
PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

MWH

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 20-24' SAMPLING INTERVAL NORTHERN AREA

FIGURE
49

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-113C_SoilHCResults_20-24.mxd 8/4/2009



TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 20-24' SAMPLING INTERVAL SOUTHERN AREA

FIGURE
50

LEGEND:

SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

- MAXIMUM PID RESULT <100 PPMV
- MAXIMUM PID RESULT 100 - 1000 PPMV
- MAXIMUM PID RESULT >1000 PPMV

KANSAS TIER 2 RISK-BASED STANDARDS FOR NON-RESIDENTIAL (INDUSTRIAL) PATHWAYS:

ANALYTE	LEVEL	UNITS	PATHWAY(S)
2,4-DINITROPHENOL	2.1	mg/kg	SOIL TO GROUNDWATER
2-METHYLNAPHTHALENE	45	mg/kg	SOIL TO GROUNDWATER
ANTHRACENE	13	mg/kg	SOIL/SOIL TO GROUNDWATER
BENZENE	0.08	mg/kg	SOIL TO GROUNDWATER
BENZO(A)ANTHRACENE	26	mg/kg	SOIL
BENZO(A)PYRENE	2.6	mg/kg	SOIL
BENZO(B)FLUORANTHENE	19	mg/kg	SOIL/SOIL TO GROUNDWATER
CHLOROFORM	0.96	mg/kg	SOIL TO GROUNDWATER
CHRYSENE	6.4	mg/kg	SOIL/SOIL TO GROUNDWATER
DIBENZ(A,H)ANTHRACENE	2.6	mg/kg	SOIL
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ETHYLBENZENE	55	mg/kg	SOIL TO GROUNDWATER
TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
MTBE	0.09	mg/kg	SOIL TO GROUNDWATER
NAPHTHALENE	3.52	mg/kg	SOIL TO GROUNDWATER
PYRIDINE	0.05	mg/kg	SOIL TO GROUNDWATER

NOTES:
WELLS AND SOIL BORINGS LABELED WITH NAME, SAMPLING DEPTH, ANALYTE, AND CONCENTRATION IN SOIL (mg/kg).
DATA ARE ONLY SHOWN WHERE RESULTS EXCEEDED THE CORRESPONDING SCREENING LEVEL FOR THE ORGANIC ANALYTES LISTED ON THE RIGHT.
DUPLICATE RESULTS SHOWN IN BRACKETS [ ] FOR APPLICABLE ANALYTE(S) AND RESULT(S).
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B = ANALYTE FOUND IN AN ASSOCIATED BLANK AND IN THE SAMPLE. D = COMPOUND DETECTED AT A SECONDARY DILUTION FACTOR.

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APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-113C_SoilHCResults_20-24.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

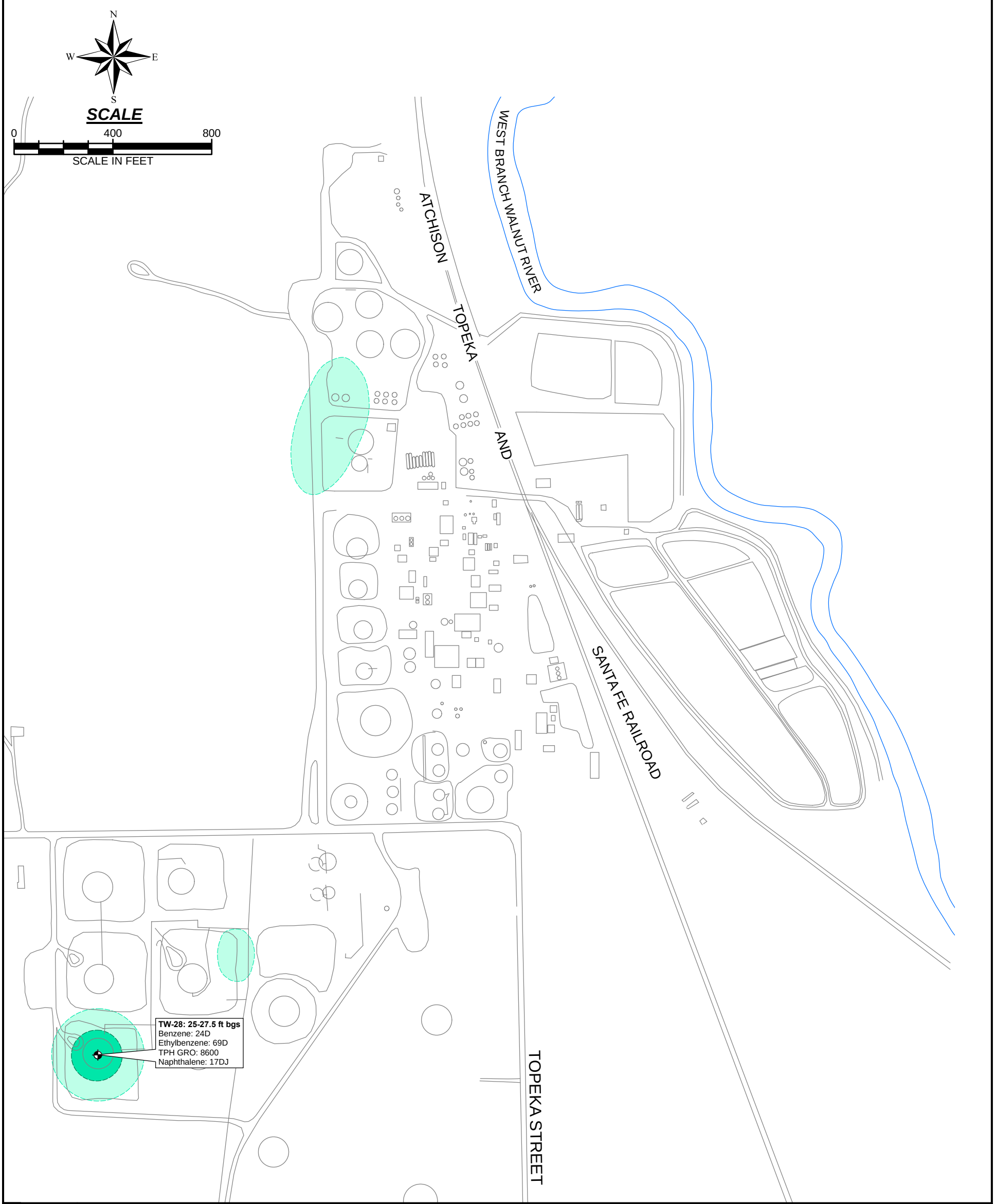
PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 20-24' SAMPLING INTERVAL SOUTHERN AREA

MWH

FIGURE
50

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-114C_SoilHCResults_24-28.mxd 8/4/2009



LEGEND:

SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

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TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 24-28' SAMPLING INTERVAL NORTHERN AREA

FIGURE
51

DRAWING REFERENCE(S):
1. LINE DRAWING SITE MAP BASED ON AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	R. Hultgren	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-114C_SoilHCResults_24-28.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

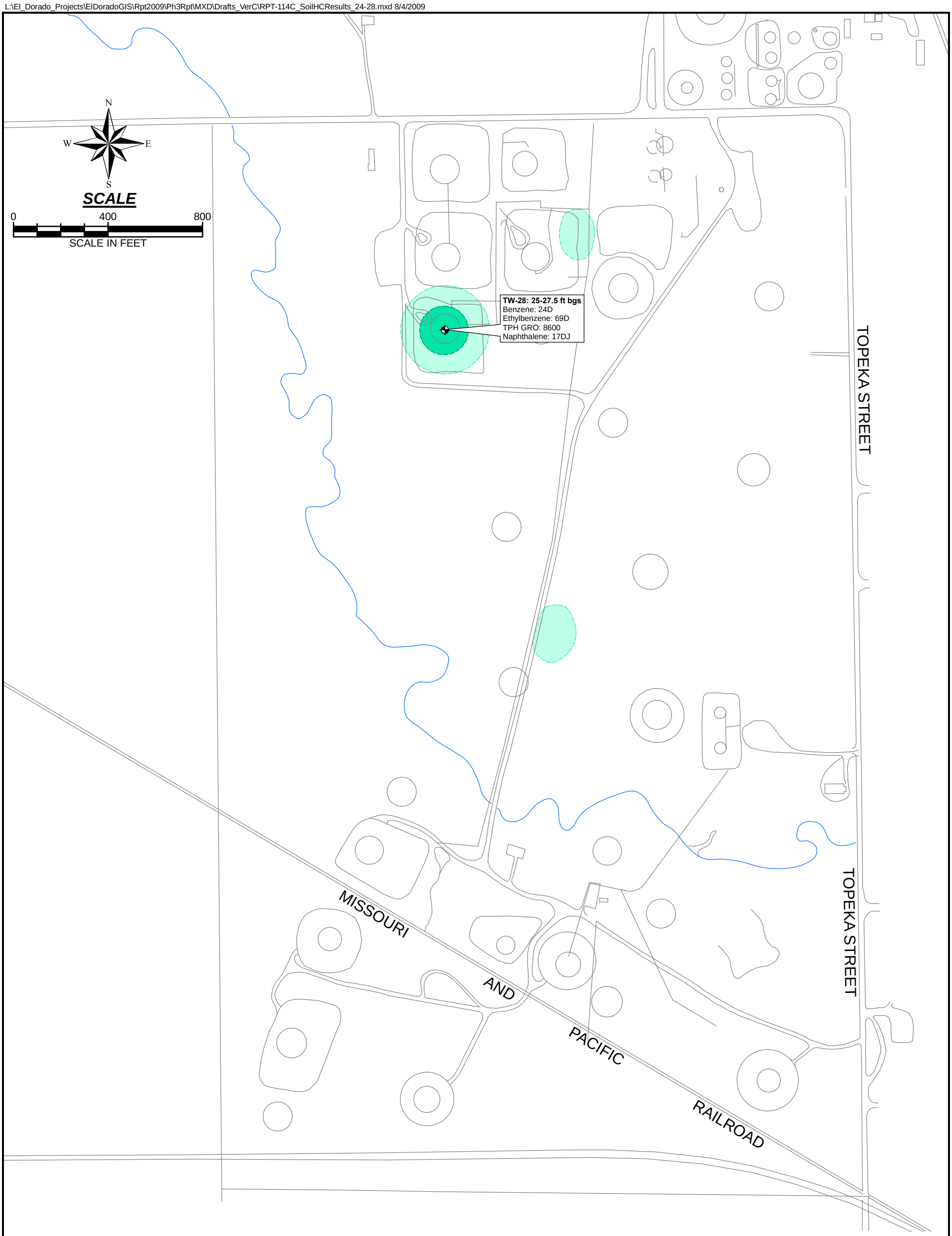
PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 24-28' SAMPLING INTERVAL NORTHERN AREA

MWH

FIGURE
51

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-114C_SoilHCResults_24-28.mxd 8/4/2009



TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 24-28' SAMPLING INTERVAL SOUTHERN AREA

FIGURE
52

LEGEND:

SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)

SOIL HEADSPACE GAS CONCENTRATIONS (MEASURED IN THE FIELD WITH A PHOTOIONIZATION DETECTOR)

- MAXIMUM PID RESULT <100 PPMV
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BENZENE	0.08	mg/kg	SOIL TO GROUNDWATER
BENZO(A)ANTHRACENE	26	mg/kg	SOIL
BENZO(A)PYRENE	2.6	mg/kg	SOIL
BENZO(B)FLUORANTHENE	19	mg/kg	SOIL/SOIL TO GROUNDWATER
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CHRYSENE	6.4	mg/kg	SOIL/SOIL TO GROUNDWATER
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ETHYLBENZENE	55	mg/kg	SOIL TO GROUNDWATER
TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
MTBE	0.09	mg/kg	SOIL TO GROUNDWATER
NAPHTHALENE	3.52	mg/kg	SOIL TO GROUNDWATER
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WELLS AND SOIL BORINGS LABELED WITH NAME, SAMPLING DEPTH, ANALYTE, AND CONCENTRATION IN SOIL (mg/kg).
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APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-114C_SoilHCResults_24-28.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

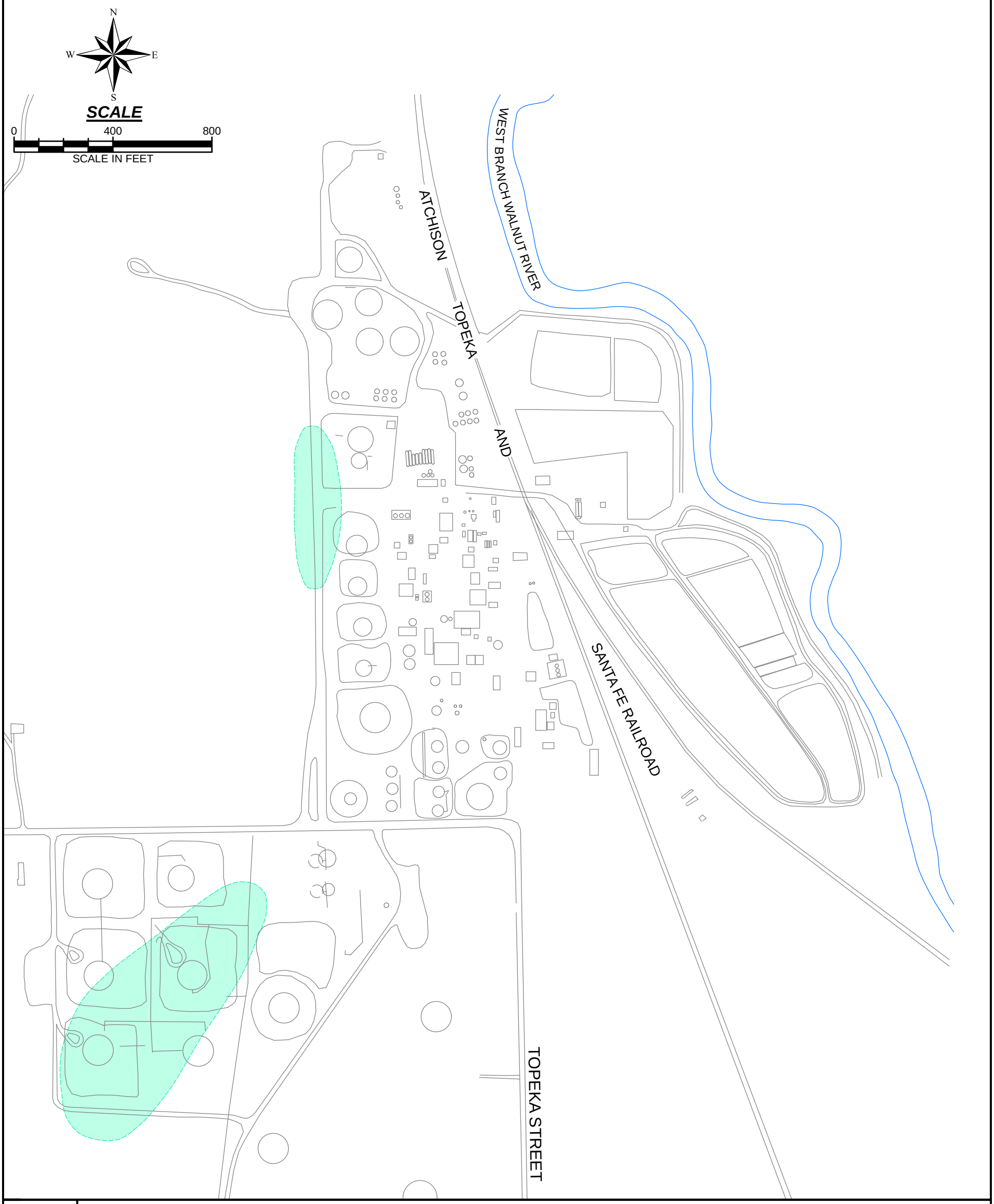
PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 24-28' SAMPLING INTERVAL SOUTHERN AREA

MWH

FIGURE
52

L:\El_Dorado_Projects\ElDoradoGIS\Rpt2009\Ph3Rpt\MXD\Drafts_VerC\RPT-115C_SoilHCResults_28-32.mxd 8/4/2009



LEGEND:

SOIL HEADSPACE GAS CONCENTRATIONS

- MAXIMUM PID RESULT <100 PPMV
- MAXIMUM PID RESULT 100 - 1000 PPMV
- MAXIMUM PID RESULT >1000 PPMV

NOTES:
NO SOIL SAMPLES WERE COLLECTED FOR LABORATORY ANALYSIS FROM THE 28-32 FEET BELOW GROUND SURFACE INTERVAL.

KANSAS TIER 2 RISK-BASED STANDARDS FOR NON-RESIDENTIAL (INDUSTRIAL) PATHWAYS:

ANALYTE	LEVEL	UNITS	PATHWAY(S)
2,4-DINITROPHENOL	2.1	mg/kg	SOIL TO GROUNDWATER
2-METHYLNAPHTHALENE	45	mg/kg	SOIL TO GROUNDWATER
ANTHRACENE	13	mg/kg	SOIL/SOIL TO GROUNDWATER
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ETHYLBENZENE	55	mg/kg	SOIL TO GROUNDWATER
TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
MTBE	0.09	mg/kg	SOIL TO GROUNDWATER
NAPHTHALENE	3.52	mg/kg	SOIL TO GROUNDWATER
PYRIDINE	0.05	mg/kg	SOIL TO GROUNDWATER

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 28-32' SAMPLING INTERVAL NORTHERN AREA

FIGURE
53

DRAWING REFERENCE(S):
1. LINE DRAWING SITE MAP BASED ON AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

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DRAWN BY	R. Hultgren	07/09
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APPROVED BY	W. Pickens	07/09
PROJECT MANAGER	D. Mick	07/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-115C_SoilHCResults_28-32.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 28-32' SAMPLING INTERVAL NORTHERN AREA

MWH

FIGURE
53

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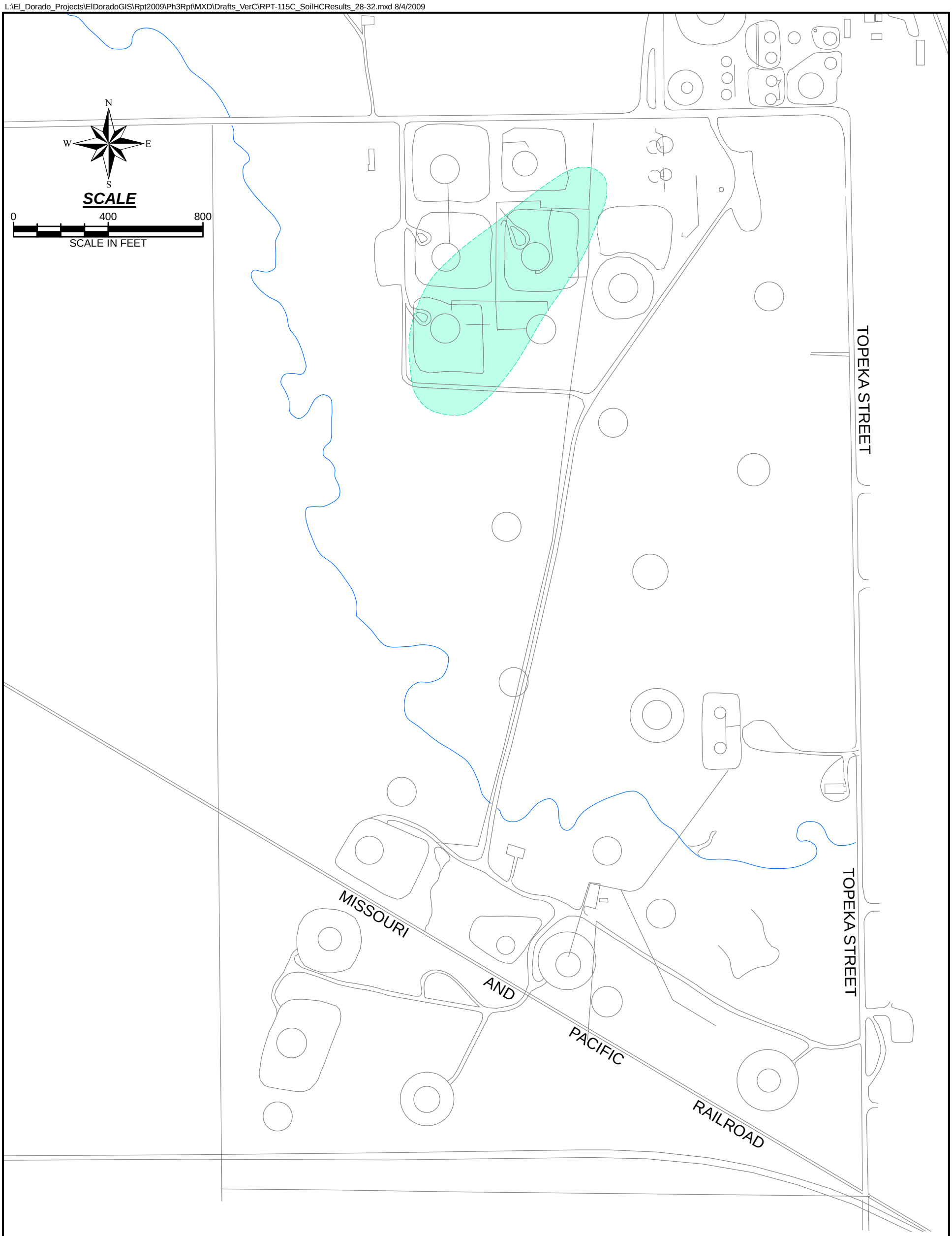

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 28-32' SAMPLING INTERVAL SOUTHERN AREA

FIGURE
54

LEGEND:

SOIL HEADSPACE GAS CONCENTRATIONS

- MAXIMUM PID RESULT <100 PPMV
- MAXIMUM PID RESULT 100 - 1000 PPMV
- MAXIMUM PID RESULT >1000 PPMV

NOTES:
NO SOIL SAMPLES WERE COLLECTED FOR LABORATORY ANALYSIS FROM THE 28-32 FEET BELOW GROUND SURFACE INTERVAL.

KANSAS TIER 2 RISK-BASED STANDARDS FOR NON-RESIDENTIAL (INDUSTRIAL) PATHWAYS:

ANALYTE	LEVEL	UNITS	PATHWAY(S)
2,4-DINITROPHENOL	2.1	mg/kg	SOIL TO GROUNDWATER
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DIBENZ(A,H)ANTHRACENE	2.6	mg/kg	SOIL
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ETHYLBENZENE	55	mg/kg	SOIL TO GROUNDWATER
TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
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PROJECT MANAGER	D. Mick	07/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-115C_SoilHCResults_28-32.mxd	

elpaso

PROJECT LOCATION
EL DORADO, KANSAS

PROJECT
EL PASO MERCHANT ENERGY - PETROLEUM CO.

TITLE
SOIL HEADSPACE GAS AND ORGANIC ANALYTICAL DATA, 28-32' SAMPLING INTERVAL SOUTHERN AREA

MWH

FIGURE
54

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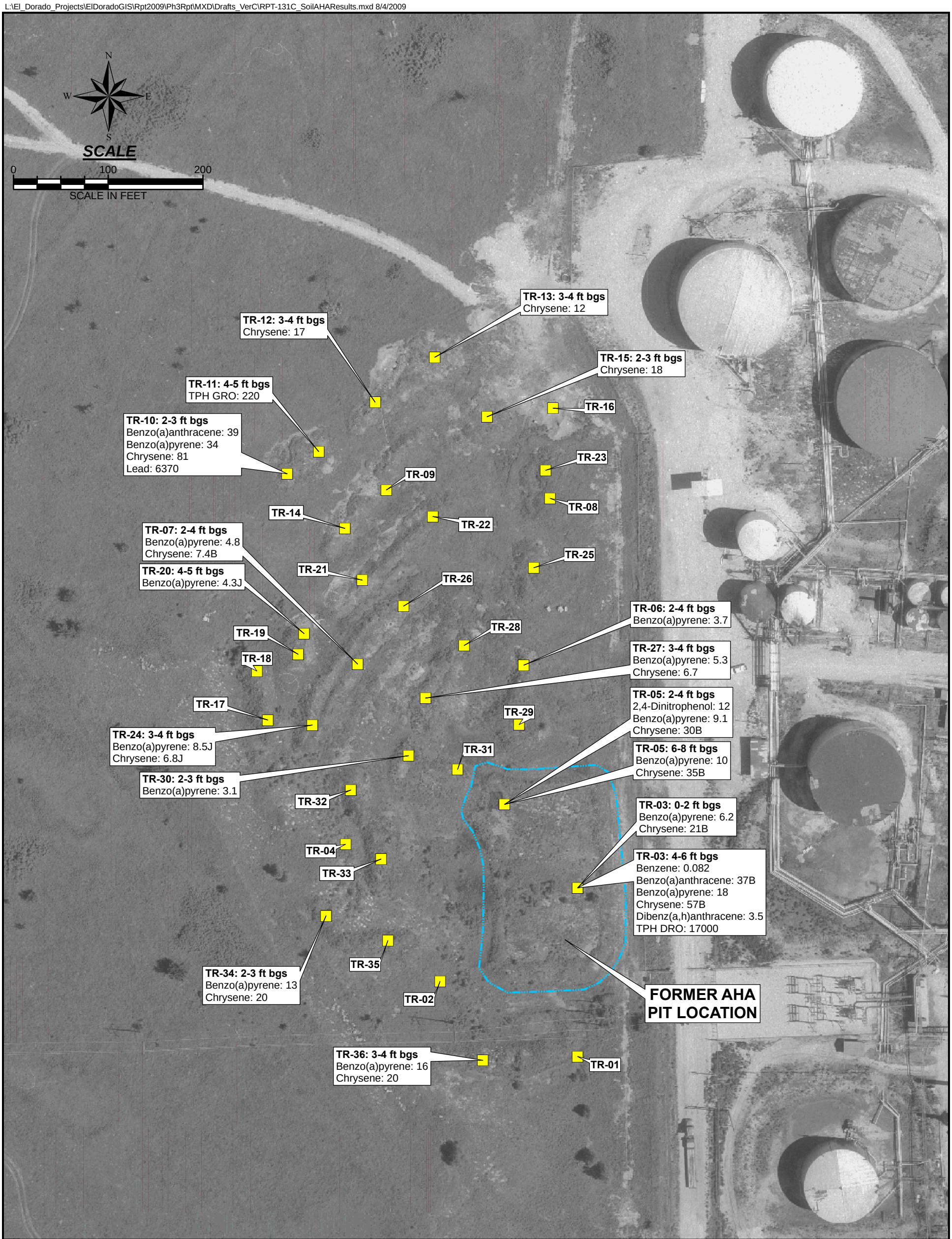

TITLE
ASPHALT HANDLING AREA
SOIL SAMPLE DATA MAP

FIGURE
55

LEGEND:

- AHA BACKHOE SAMPLE
- FORMER ASPHALT HANDLING AREA PIT LOCATION

KANSAS TIER 2 RISK-BASED STANDARDS FOR NON-RESIDENTIAL (INDUSTRIAL) PATHWAYS:

ANALYTE	LEVEL	UNITS	PATHWAY(S)
2,4-DINITROPHENOL	2.1	mg/kg	SOIL TO GROUNDWATER
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TPH GRO	150	mg/kg	SOIL TO GROUNDWATER
LEAD	1000	mg/kg	SOIL

NOTES:
SAMPLING LOCATIONS LABELED WITH NAME, SAMPLING DEPTH, ANALYTE, AND CONCENTRATION IN SOIL (mg/kg). DATA ARE ONLY SHOWN WHERE RESULTS EXCEEDED THE CORRESPONDING SCREENING LEVEL FOR AT LEAST ONE OF THE ANALYTES LISTED ON THE RIGHT.
DATA ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA ARE NOT SHOWN ON THIS FIGURE.
ft bgs = FEET BELOW GROUND SURFACE

DRAWING REFERENCE(S):
1. AERIAL PHOTOGRAPH PRODUCED BY AERO-METRIC, INC. FROM JUNE 15, 2005 AERIAL SURVEY. STATE PLANE KANSAS SOUTH COORDINATES, NAD 83, US FEET.

DESIGNED BY	R. Hultgren	07/09
DRAWN BY	C. Pappas	08/09
CHECKED BY	R. Hultgren	08/09
APPROVED BY	W. Pickens	08/09
PROJECT MANAGER	D. Mick	08/09
PROJECT NO.	1914351.90010408	
FILE NAME	RPT-131C_SoilAHAResults.mxd	

elpaso

PROJECT LOCATION: EL DORADO, KANSAS
PROJECT: EL PASO MERCHANT ENERGY - PETROLEUM CO.
TITLE: ASHPALT HANDLING AREA SOIL SAMPLE DATA MAP

MWH

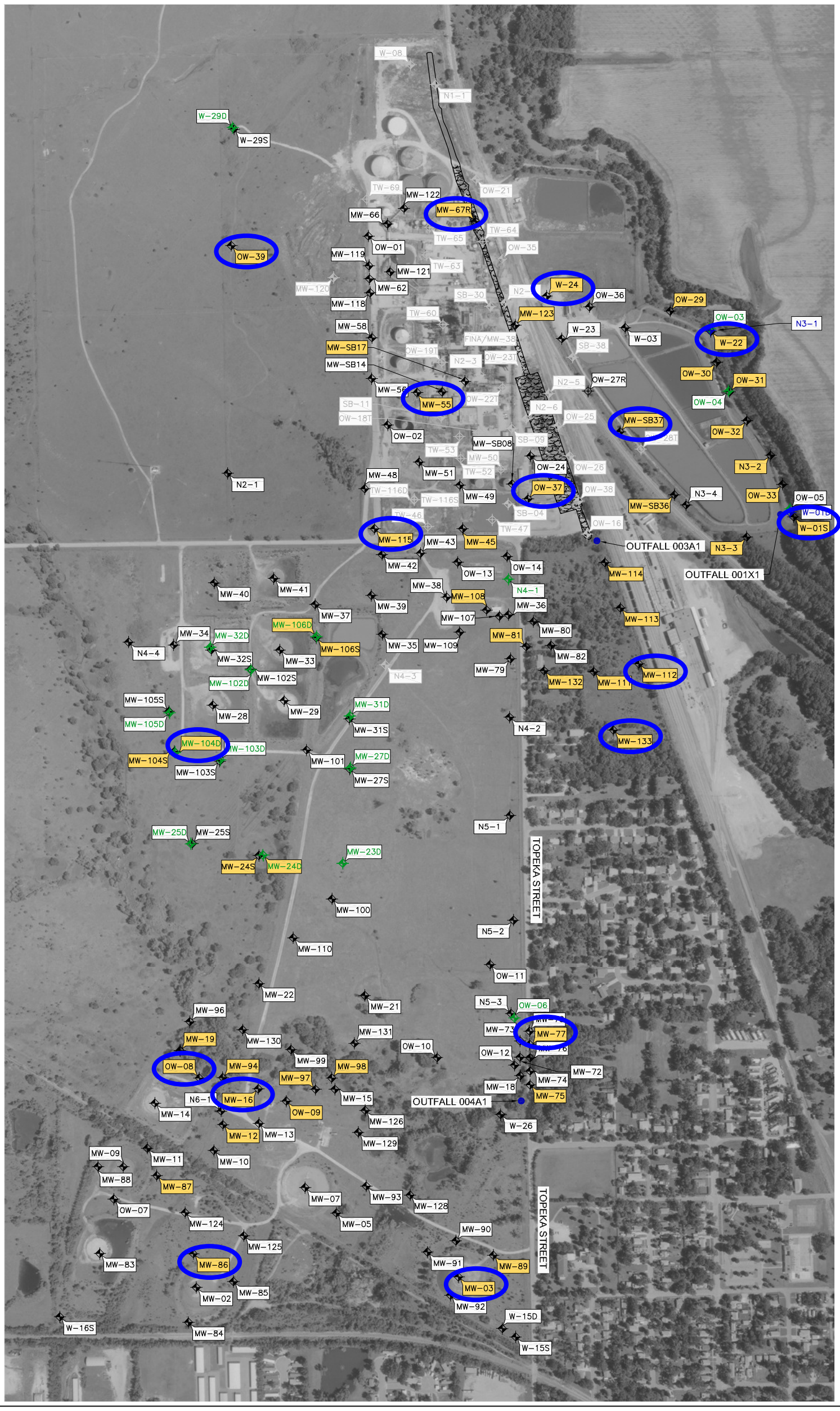
FIGURE: 55

APPENDIX C

TIME-CONCENTRATION GRAPHS

MWH

Print Date: December 13, 2012



TITLE

LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
W-01D	FLORENCE LIMESTONE MONITORING WELL
OW-25	ABANDONED WELL
OW-06	FORT RILEY LIMESTONE MONITORING WELL
MW-03	WELL IN MONITORING PROGRAM
TW-52	ABANDONED TEMPORARY MONITORING WELL
	A WELL FOR WHICH A TIME CONCENTRATION GRAPH IS PROVIDED IN THIS APPENDIX
	OUTFALL LOCATION

SCALE

0 300' 600'

SCALE IN FEET

FIGURE

DESIGNED BY	M. WARNER	12/12
DRAWN BY	M. WARNER	12/12
CHECKED BY	C. PHILIPS	12/12
APPROVED BY	J. GARNSEY	12/12
PROJECT MANAGER	J. GARNSEY	12/12
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: EL DORADO REFINERY, EL DORADO, KS

PROJECT: EL PASO MERCHANT ENERGY - PETROLEUM CO

TITLE: MONITORING WELL NETWORK

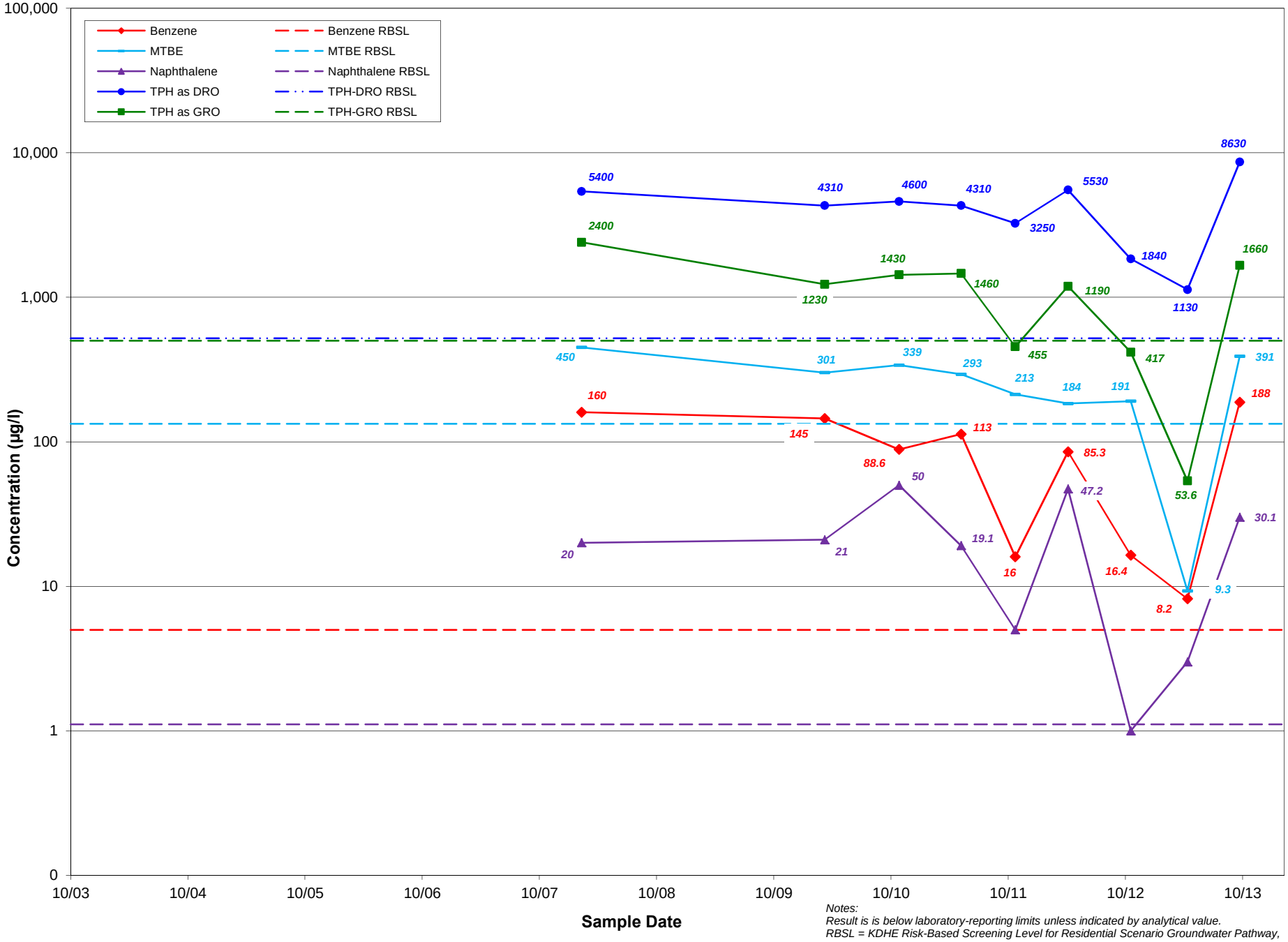
MWH

FIGURE

REVISION 1

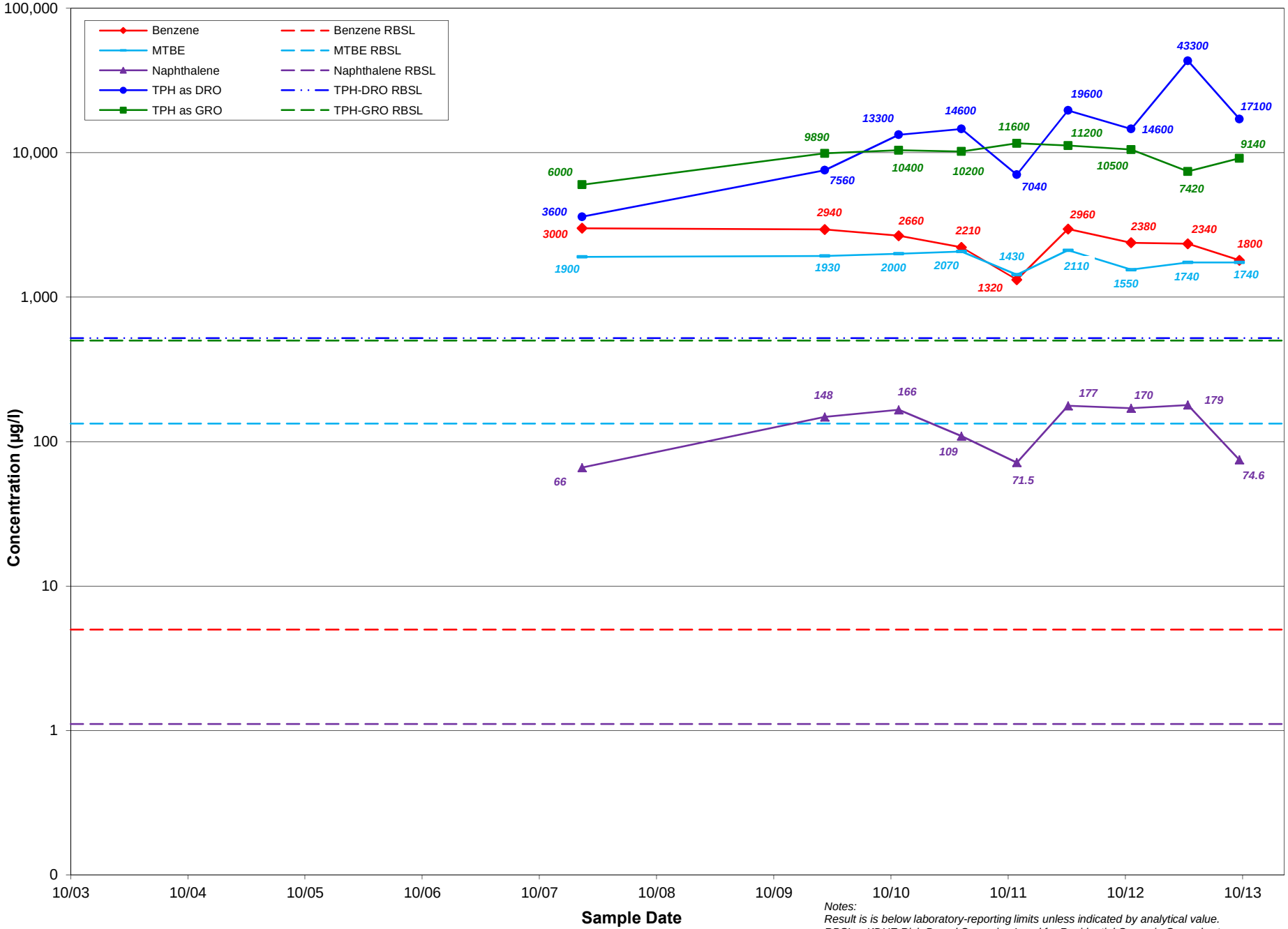
FILE NAME: El Dorado Monitoring Well Network.dwg

Historical Dissolved-Phase Concentrations: MW-03
Former Coastal Refinery, El Dorado, Kansas



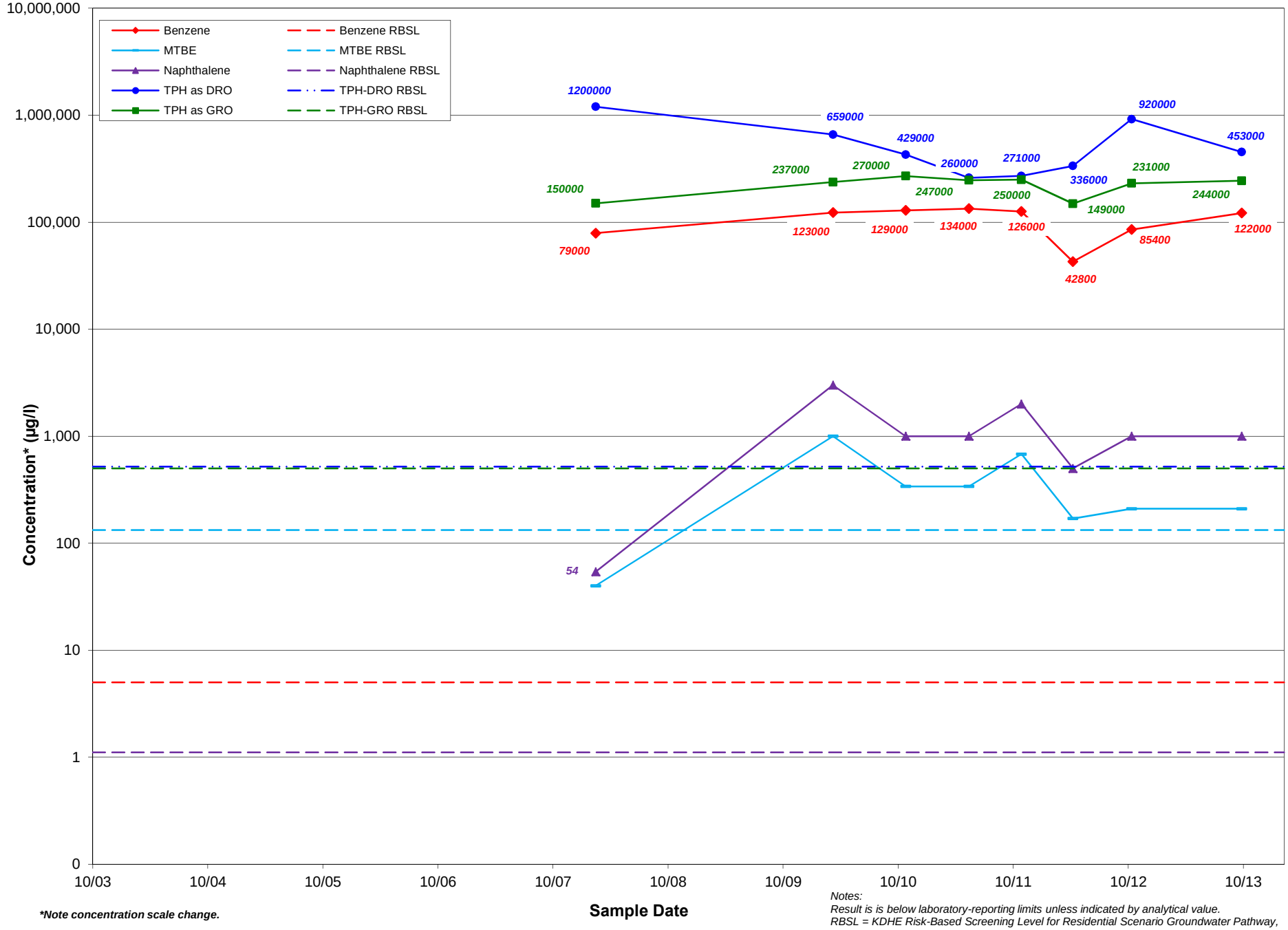
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: MW-16
Former Coastal Refinery, El Dorado, Kansas



Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

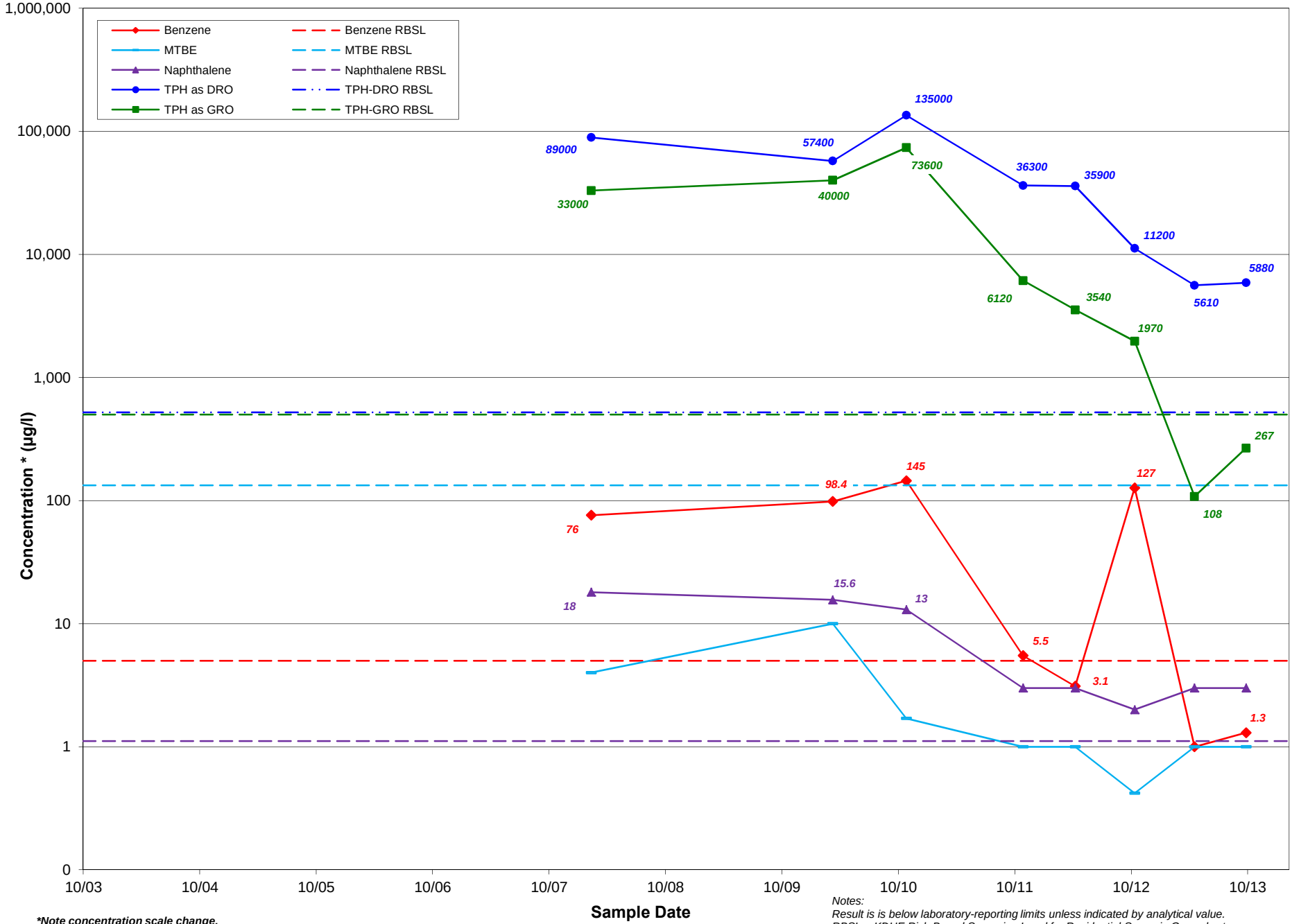
Historical Dissolved-Phase Concentrations: MW-55
Former Coastal Refinery, El Dorado, Kansas



***Note concentration scale change.**

Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

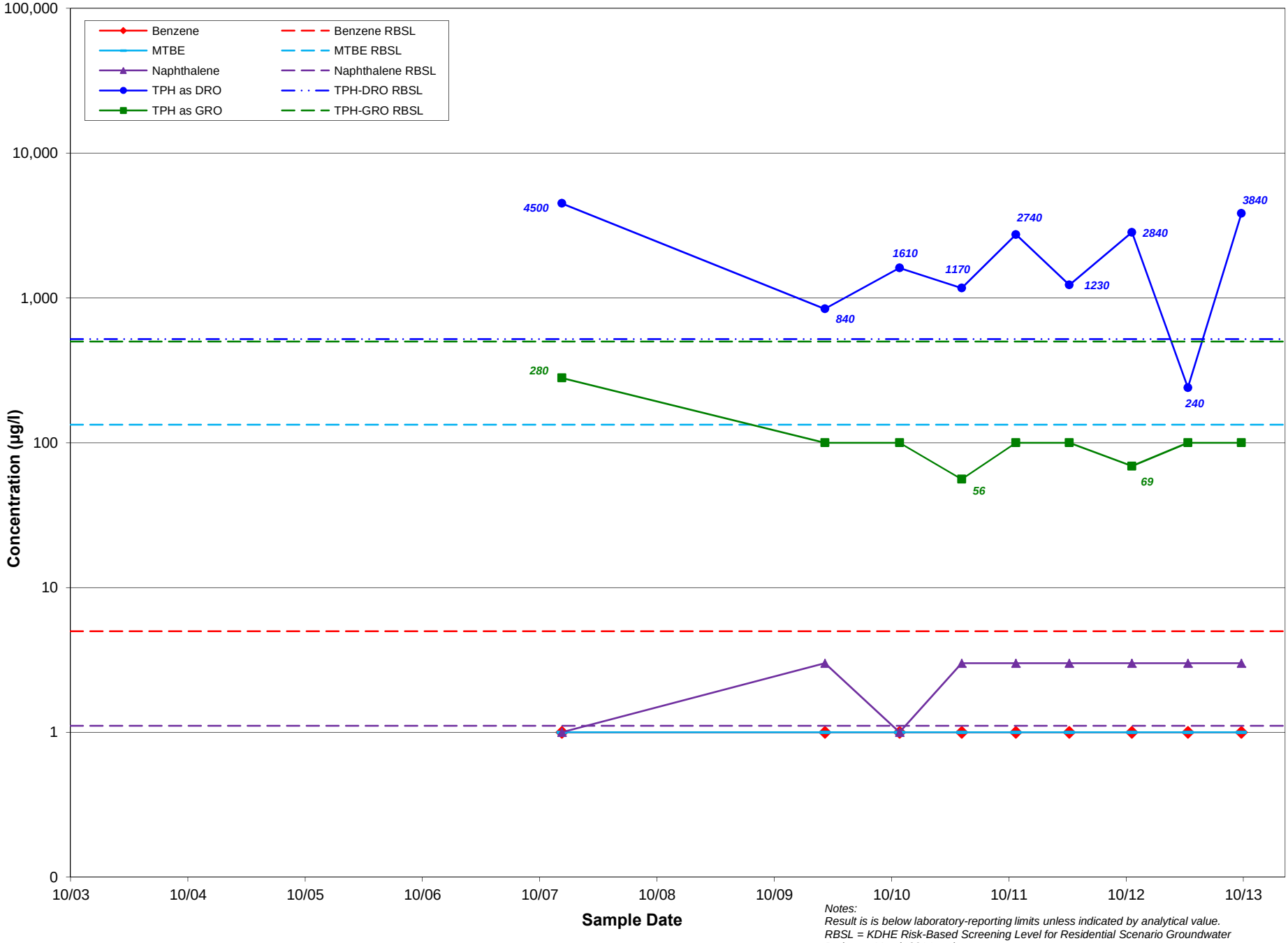
Historical Dissolved-Phase Concentrations: MW-67/67R
Former Coastal Refinery, El Dorado, Kansas



***Note concentration scale change.**

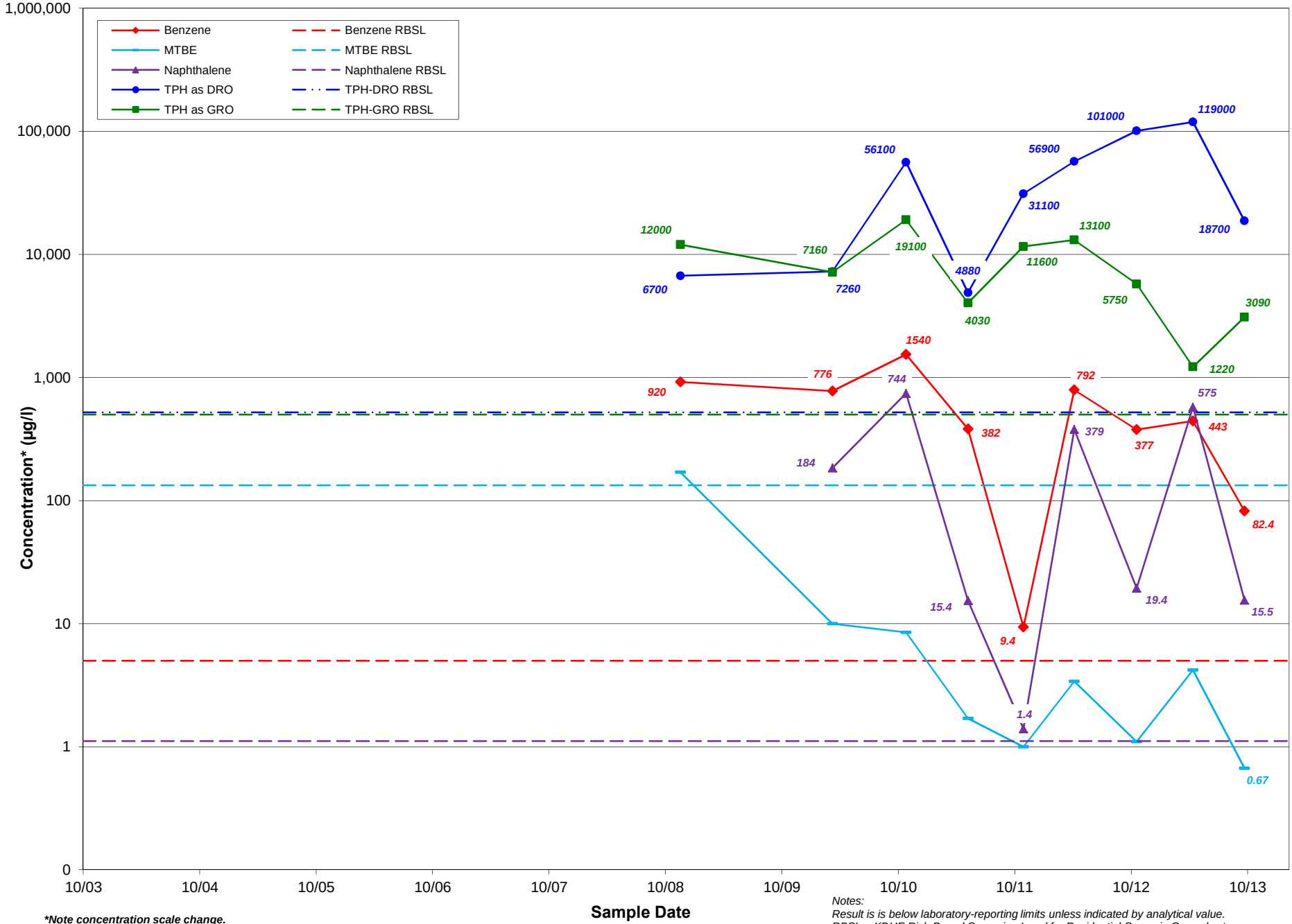
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: MW-77
Former Coastal Refinery, El Dorado, Kansas



Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

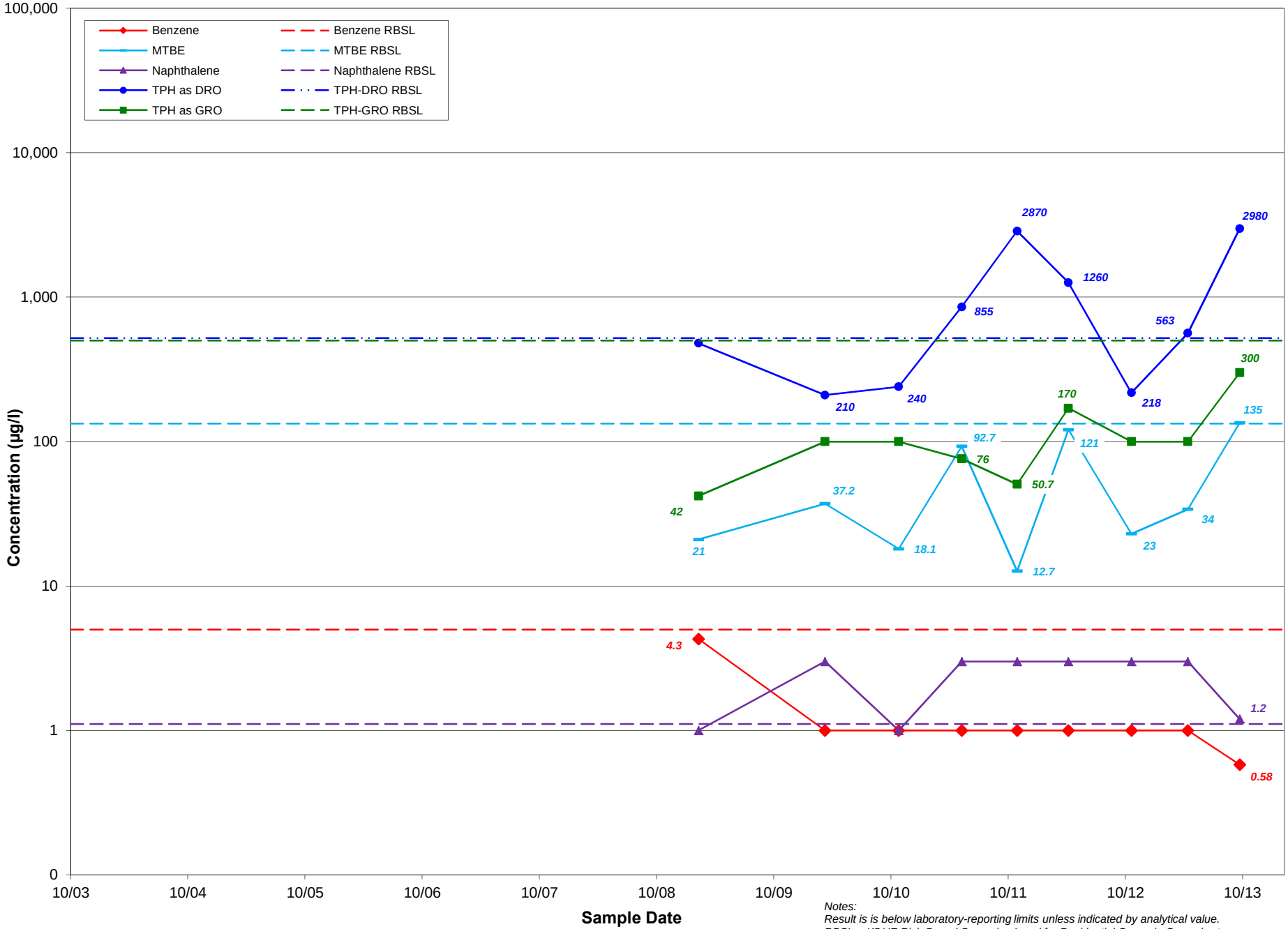
Historical Dissolved-Phase Concentrations: MW-86
Former Coastal Refinery, El Dorado, Kansas



***Note concentration scale change.**

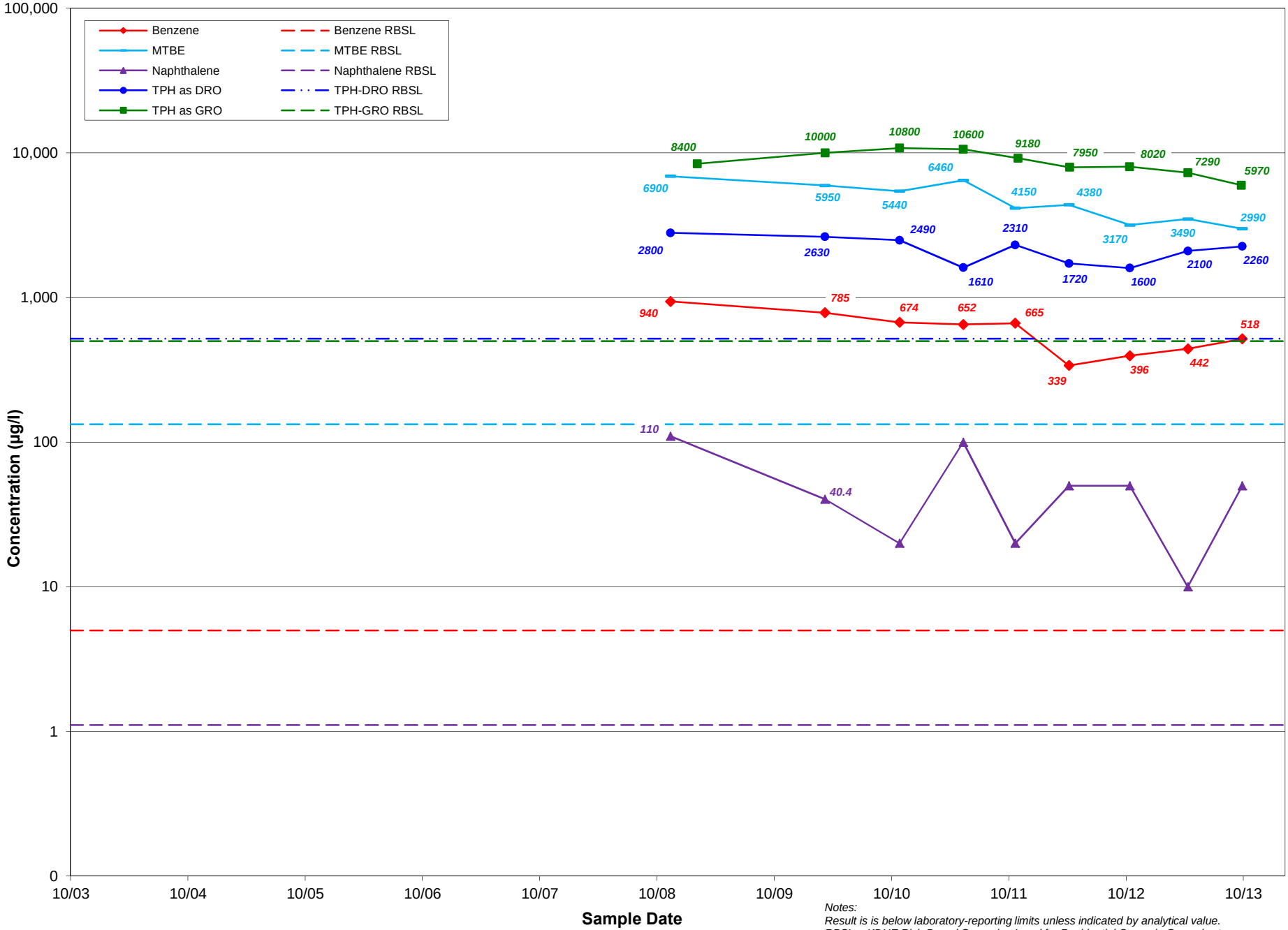
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: MW-104D
Former Coastal Refinery, El Dorado, Kansas



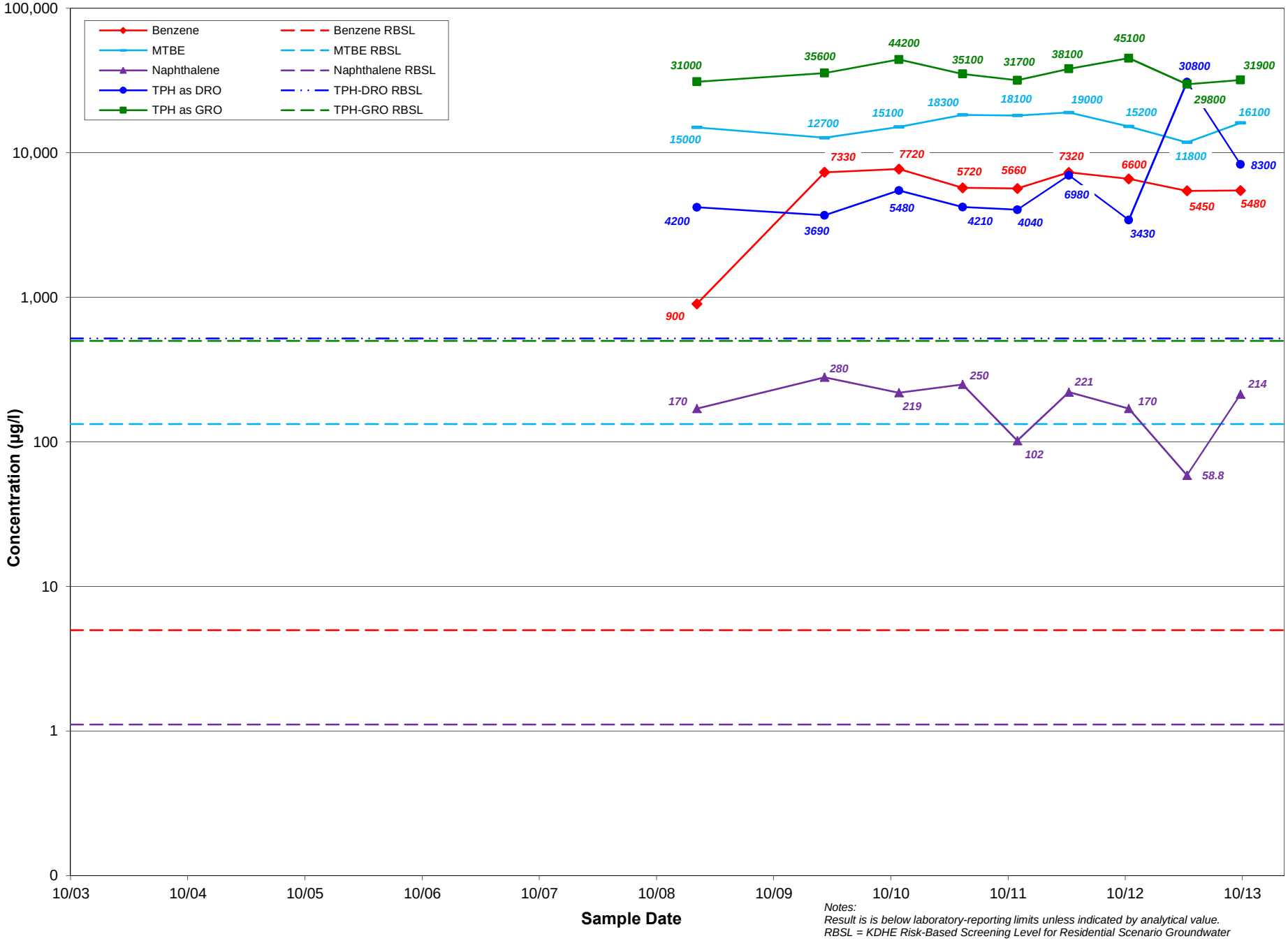
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: MW-112
Former Coastal Refinery, El Dorado, Kansas



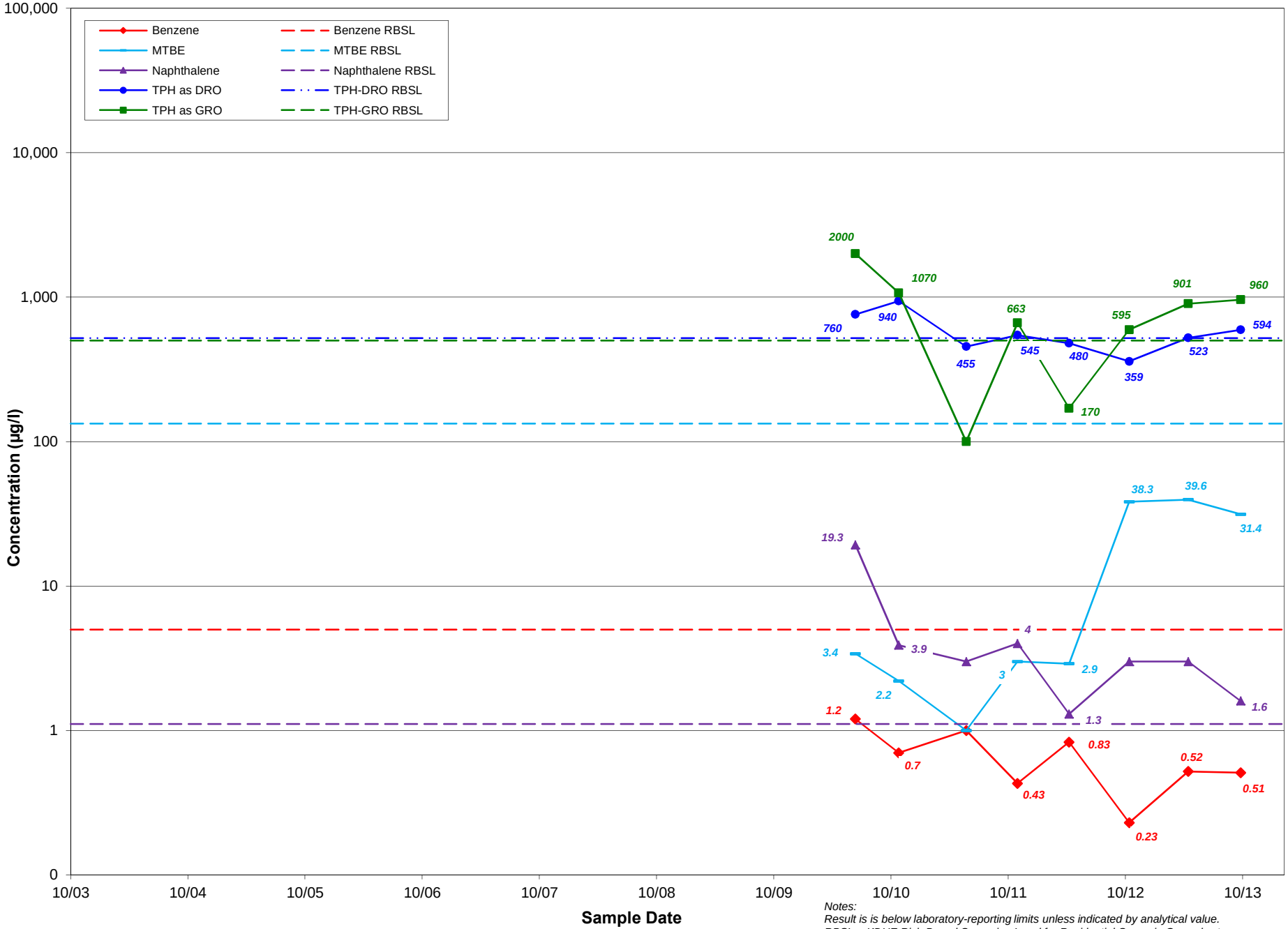
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: MW-115
Former Coastal Refinery, El Dorado, Kansas



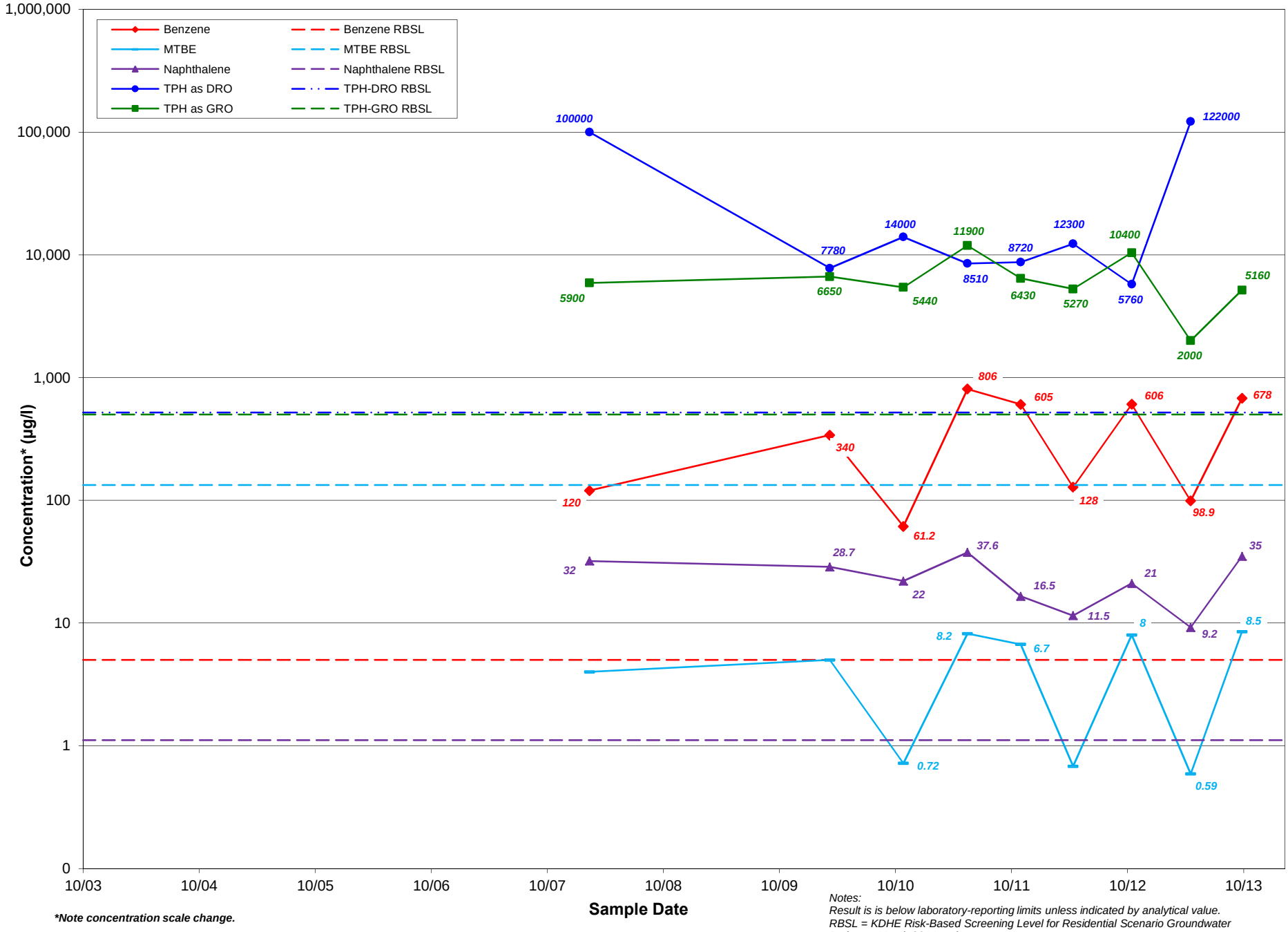
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: MW-133
Former Coastal Refinery, El Dorado, Kansas



Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

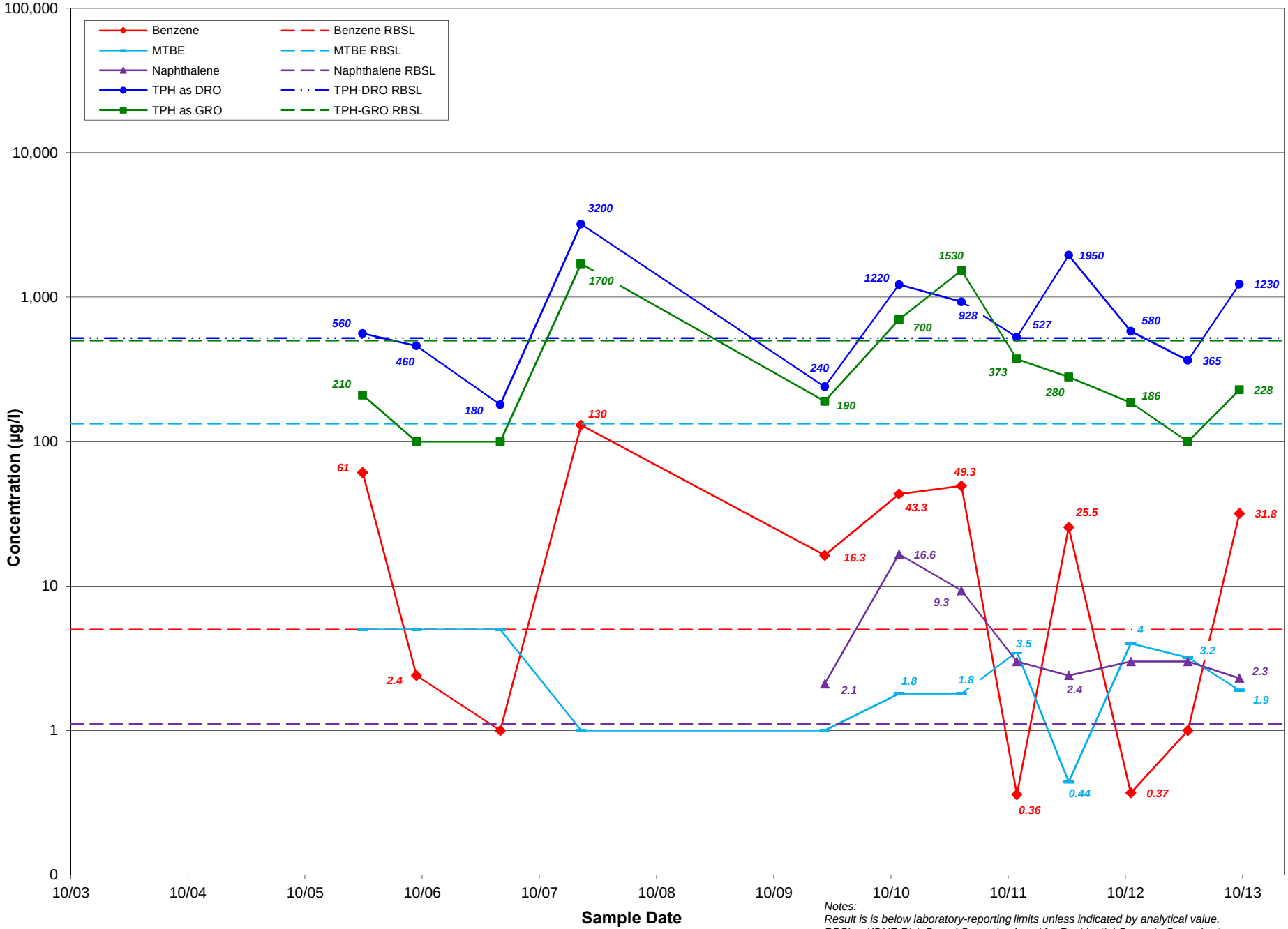
Historical Dissolved-Phase Concentrations: MW-SB37
Former Coastal Refinery, El Dorado, Kansas



**Note concentration scale change.*

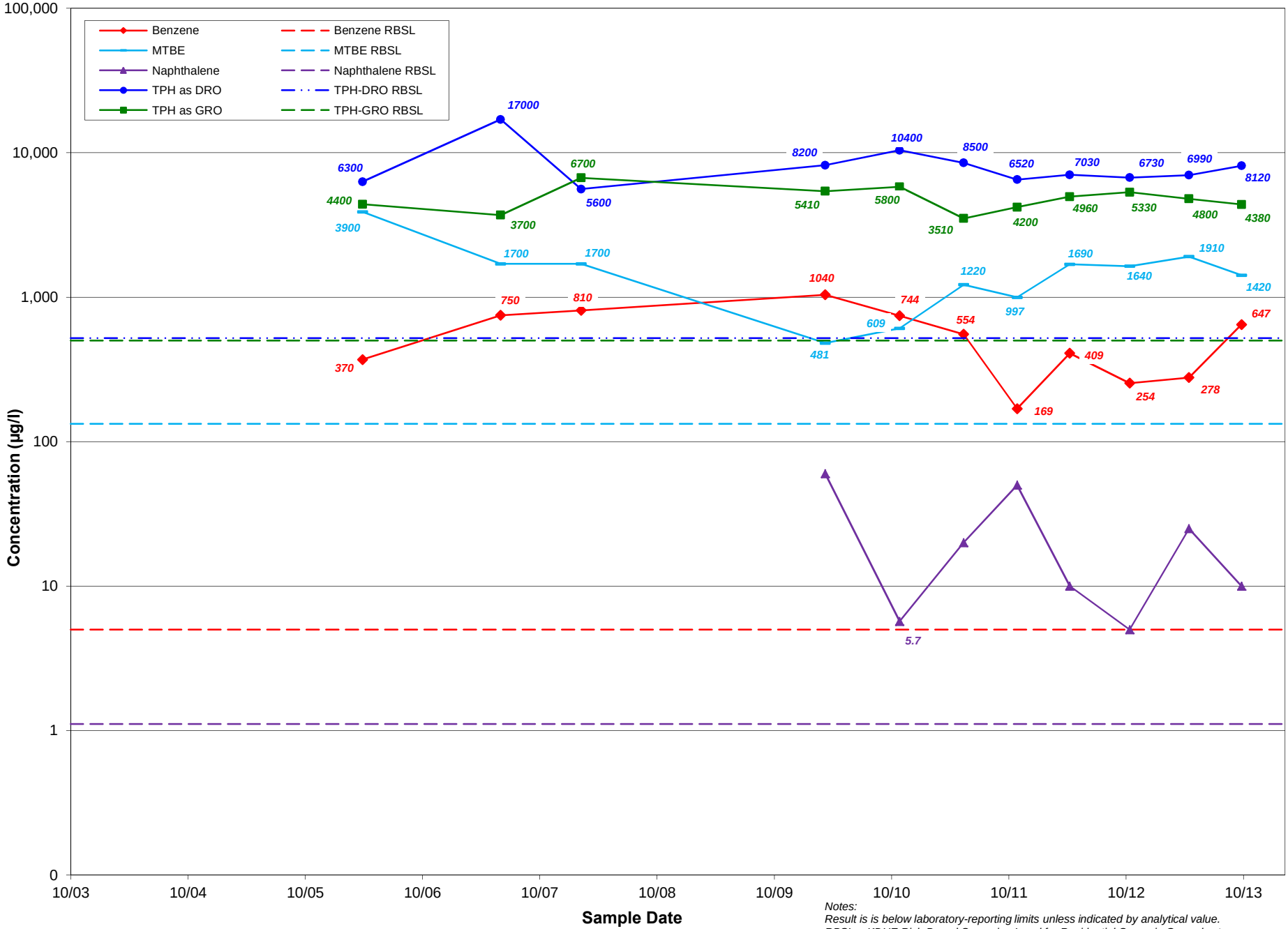
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: OW-08
Former Coastal Refinery, El Dorado, Kansas



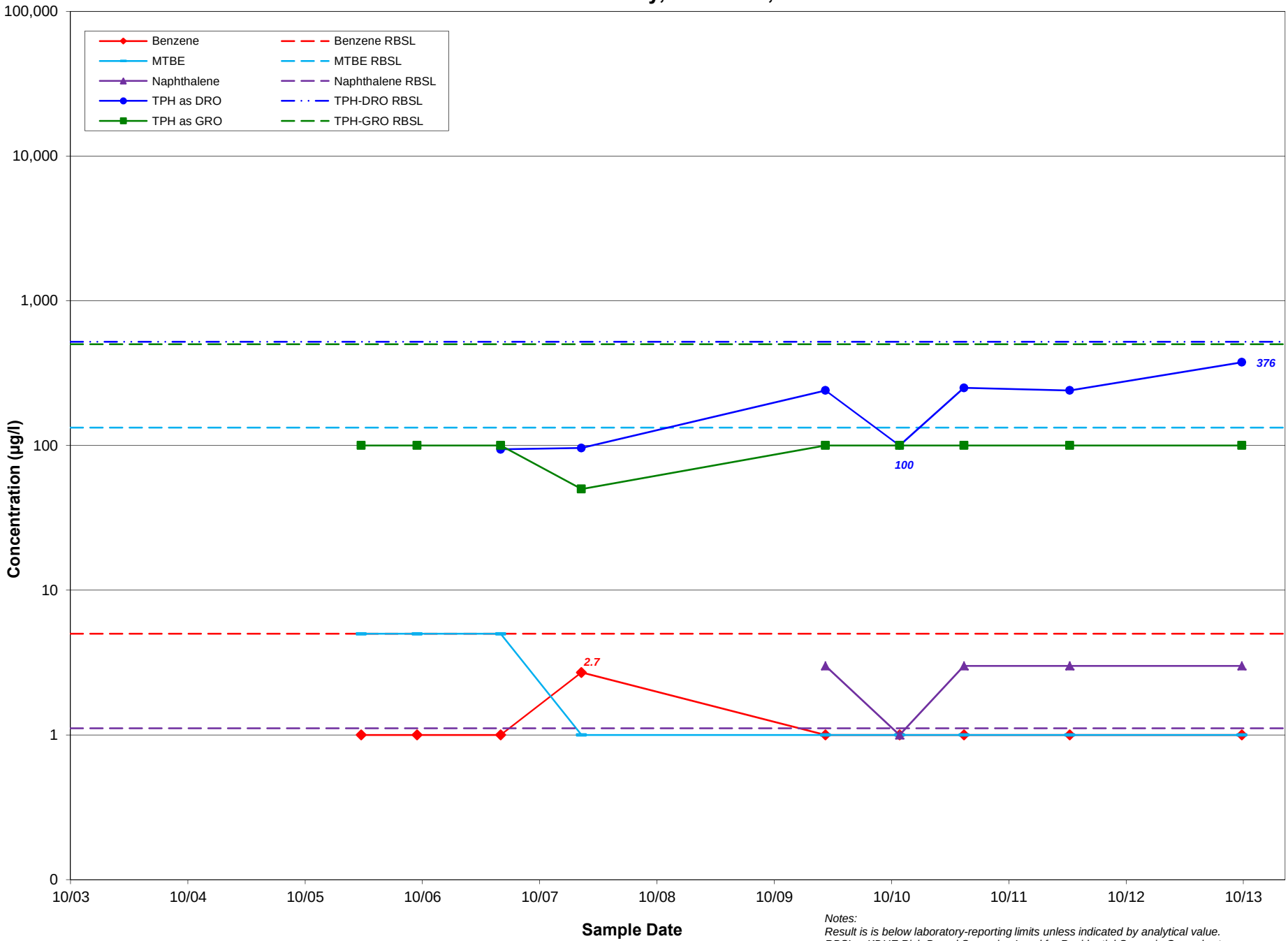
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: OW-37
Former Coastal Refinery, El Dorado, Kansas



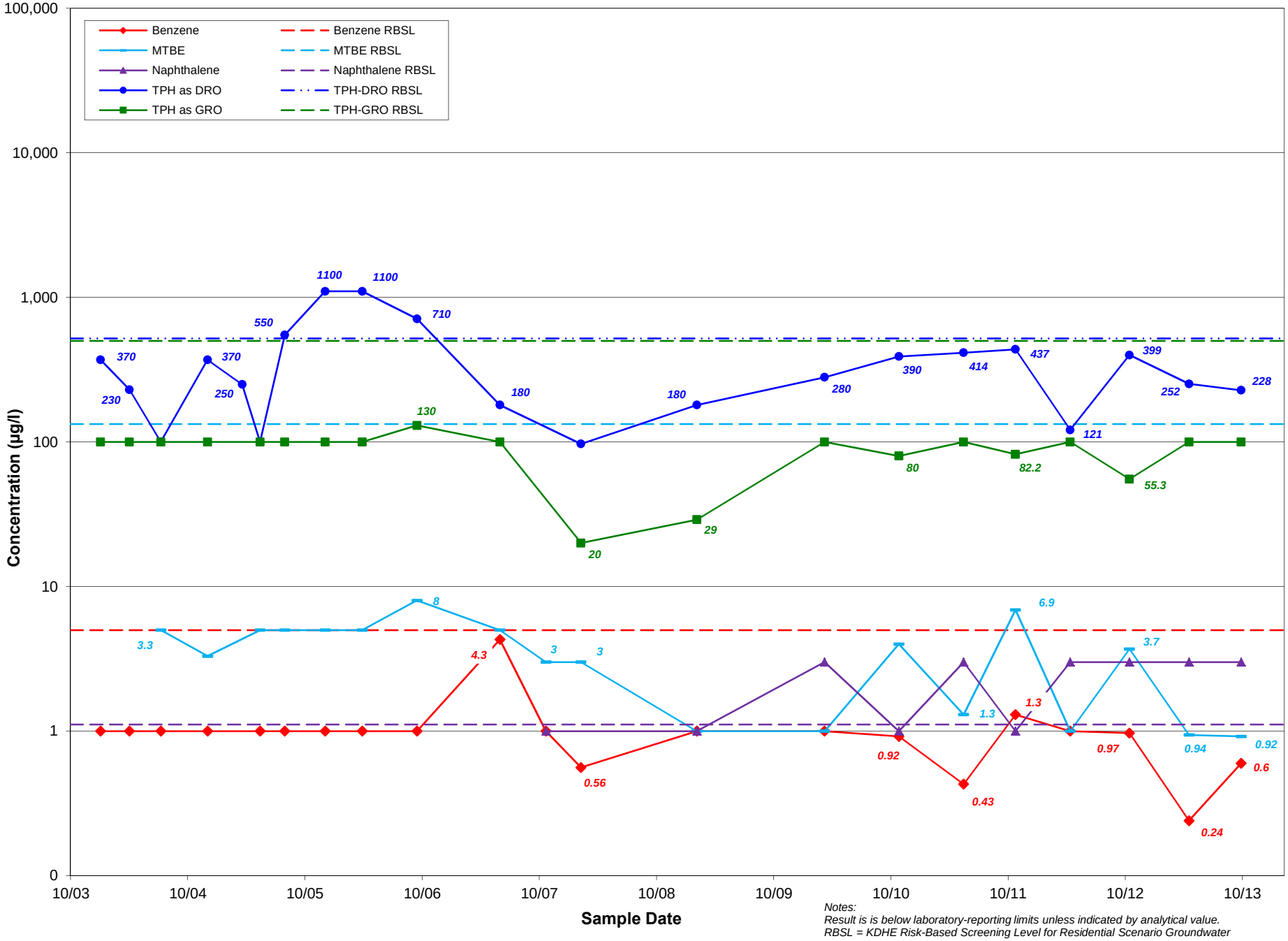
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: OW-39
Former Coastal Refinery, El Dorado, Kansas



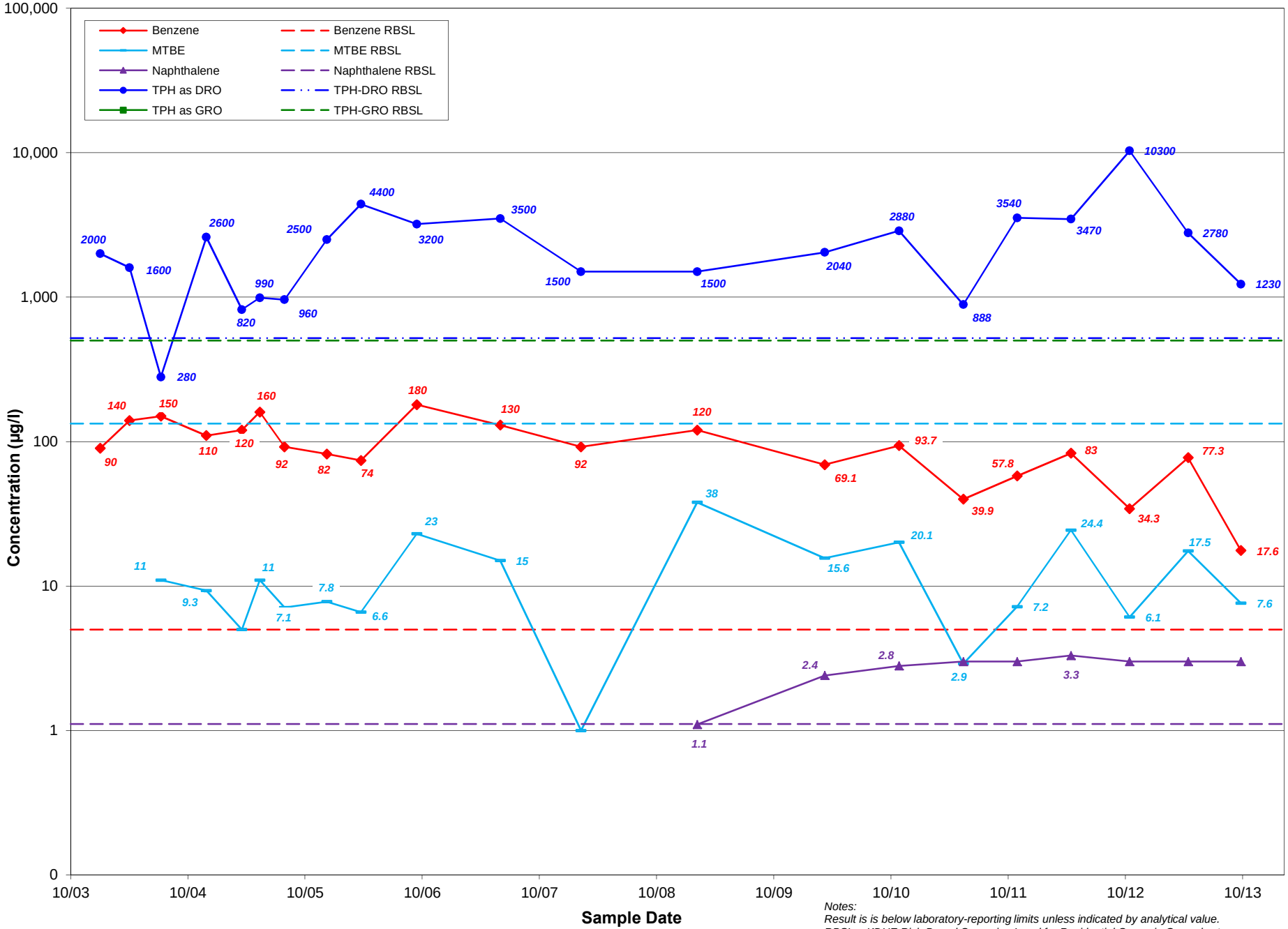
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: W-01S
Former Coastal Refinery, El Dorado, Kansas



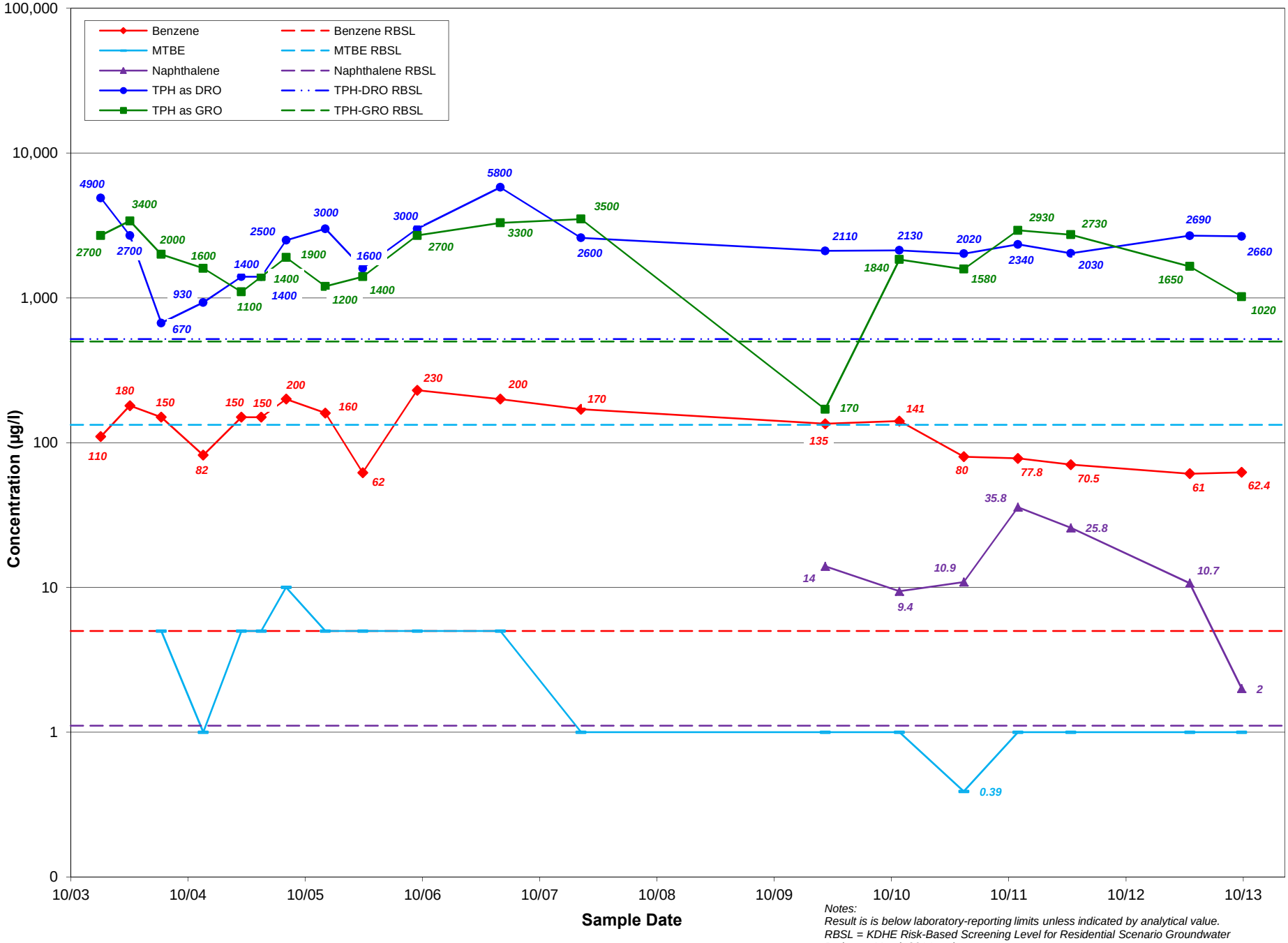
Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: W-22
Former Coastal Refinery, El Dorado, Kansas



Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

Historical Dissolved-Phase Concentrations: W-24
Former Coastal Refinery, El Dorado, Kansas



Notes:
Result is is below laboratory-reporting limits unless indicated by analytical value.
RBSL = KDHE Risk-Based Screening Level for Residential Scenario Groundwater Pathway, March 2014 update.

APPENDIX D

COST SUPPORT TABLES AND SKETCHES

MWH

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
REMEDY COMPONENTS ALREADY COMPLETED AS PART OF INTERIM REMEDIAL MEASURE (IRM) - SECTION 10.1					
Costs include associated costs such as travel, shipping, project management, reporting, etc. unless they are separately line-itemized.					
1 - Seep Interceptor Trench					
Design, Oversight, Reporting	1	lump	$ 200,000	$ 200,000	
1,600 foot-long Trench	1	lump	$ 790,000	$ 790,000	*Excavate, backfill, sumps, pumps*
Extracted Water Conveyance Line	1	lump	$ 80,000	$ 80,000	*To oil-water separator*
O&M	8	Years	$ 60,000	$ 480,000	*Costs included under GTS (Task #9)*
Water Treatment	0	lump	$ -	$ -	*Costs included under GTS (Task #9)*
			Total	**$ 1,550,000**	
MPA Portion			80%	**$ 1,240,000**	*Most of impacts are related to the MPA*
AHA Portion			5%	**$ 80,000**	*Some AHA-impacted water may get there*
STF Portion			5%	**$ 80,000**	*Part of the North STF MTBE may enter*
SPA Portion			10%	**$ 160,000**	*Some impacts may be from Pond Sediments*
			100%		
2 - MPA Demolition and Grading					
Designs, Oversight, Sampling, Misc	1	lump	$ 250,000	$ 250,000	
Structures	1	lump	$ 5,100,000	$ 5,100,000	*Process equipment, buildings*
Waste Management/Disposal	1	lump	$ 2,400,000	$ 2,400,000	*Product in piping, buried waste, etc.*
Concrete Removal (crushing under wetlands)	1	lump	$ 400,000	$ 400,000	*Above-grade, slabs, and upper 2 feet*
Sewers and Piping	1	lump	$ 300,000	$ 300,000	*Storm and process sewer. Fire water line*
Grading	1	lump	$ 300,000	$ 300,000	*Storm and process sewer. Fire water line*
			Total	**$ 8,750,000**	
MPA Portion			80%	**$ 7,000,000**	*Former process equipment, piping, etc.*
AHA Portion			0%	**$ -**	*None*
STF Portion			10%	**$ 880,000**	*Piping, ASTs*
SPA Portion			10%	**$ 880,000**	*Pond Structures, OWS Clean-out*
			100%		
3 - MPA Landfarming					
Work Plan, Sampling, Closure, Reporting	1	lump	$ 100,000	$ 100,000	
Landfarm Upper 8-inch of Soil	6	events	$ 2,000	$ 12,000	*Part of clean soil separation barrier*
Landfarm all MPA Basin Soil	6	events	$ 2,000	$ 12,000	*Including all disking, sampling, reporting*
Erosion Control, Post-Landfarm Seeding	1	lump	$60,000	$ 60,000	
			Total	**$ 184,000**	
MPA Portion			100%	**$ 184,000**	*All soil and reasons for completing are MPA*
AHA Portion			0%	**$ -**	
STF Portion			0%	**$ -**	
SPA Portion			0%	**$ -**	
			100%		
4 - Lead Impacted Soil					
Work Plan, Sampling, Reporting	1	lump	$ 50,000	$ 50,000	
Consolidate MPA Soils to South Side	1	lump	$ 100,000	$ 100,000	*3,000 cubic yards*
Cover with Landfarm Soil	0	lump	$ -	$ -	*No cost - included in Task 3*
			Total	**$ 150,000**	
MPA Portion			100%	**$ 150,000**	*All metals-impacted soil was from the MPA*
AHA Portion			0%	**$ -**	*None*
STF Portion			0%	**$ -**	*None*
SPA Portion			0%	**$ -**	*None*
			100%		

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
5 - MPA Channel IT and Basin IT					
Design, Oversight, Reporting	1	lump	$ 170,000	$ 170,000	
Pond Sediment Transport to West Ponds	1	lump	$ 80,000	$ 80,000	*Cost for stabilization and capping elsewhere*
Excavation and Landfarming	1	lump	$ 180,000	$ 180,000	*LNAPL-impacted area and soil*
Buried UST removal/disposal	1	lump	$ 20,000	$ 20,000	*Two process tanks*
Basin IT, Liner, and Sump	1	lump	$ 100,000	$ 100,000	*LNAPL and Groundwater recovery*
Stormwater Sump	1	lump	$ 40,000	$ 40,000	*Runoff control during IRM work/landfarming*
Surface Water Channel (MPA Channel)	1	lump	$ 80,000	$ 80,000	*Including liner for perched water seeps*
O&M Costs to Date	5	years	$ 16,000	$ 80,000	*Future costs are addressed elsewhere*
			Total	**$ 750,000**	
MPA Portion			85%	**$ 640,000**	*Primarily and MPA remedial measure*
AHA Portion			10%	**$ 80,000**	*Captures any plume from AHA*
STF Portion			5%	**$ 40,000**	*Also captures part of STF MTBE plume*
SPA Portion			0%	**$ -**	
			100%		
6 - MPA Spring System					
Design, Oversight, Reporting	1	lump	$ 70,000	$ 70,000	
Interceptor Trench, Sump, Conveyance	1	lump	$ 90,000	$ 90,000	*Completed in 2012*
Underground Oil-Water Separator	1	lump	$ 80,000	$ 80,000	*Completed in 2014*
Carbon Filter Polishing Treatment	1	lump	$ 60,000	$ 60,000	*Completed in 2014*
O&M Costs to Date	4	years	$ 16,000	$ 64,000	*Future costs are addressed elsewhere*
			Total	**$ 364,000**	
MPA Portion			100%	**$ 360,000**	*AHA Pit is source of asphaltic tar;*
AHA Portion			0%	**$ -**	*however, system/risk within MPA*
STF Portion			0%	**$ -**	
SPA Portion			0%	**$ -**	
			100%		
7 - AHA Pit and Piles					
Design, Oversight, Reporting	1	lump	$ 180,000	$ 180,000	
Excavate and Transport Piles to West Ponds	1	lump	$ 290,000	$ 290,000	*Stabilization/capping costs listed elsewhere*
Excavate & Transport Pit Material to Ponds	1	lump	$ 330,000	$ 330,000	*Stabilization/capping costs listed elsewhere*
Backfill AHA Pit	1	lump	$ 110,000	$ 110,000	
Grade, Erosion Control, Seed	1	lump	$ 40,000	$ 40,000	
			Total	**$ 950,000**	
MPA Portion			0%	**$ -**	
AHA Portion			100%	**$ 950,000**	*All for AHA clean-closure*
STF Portion			0%	**$ -**	
SPA Portion			0%	**$ -**	
			100%		
8 - Waste Stabilization & Capping					
Design, Oversight, Reporting	1	lump	$ 430,000	$ 430,000	
Dewatering and Water Treatment During	1	lump	$ 110,000	$ 110,000	*Curtain, Aeration Piping, O&M, etc.*
Disposed Off-Site during Demolition	1	lump	$ 40,000	$ 40,000	*Product in lines, sludge, tank bottoms, etc.*
East, Marley, and Spray Pond Sed & MPA	1	lump	$ 510,000	$ 510,000	*Excavation and transport*
AHA Piles and Pit	1	lump	$ 580,000	$ 580,000	*Excavation and transport*
Stabilize all Waste in West Ponds	1	lump	$ 3,500,000	$ 3,500,000	*Cement and fly ash*
Cap Fill, Grading, Cap, Seeding	1	lump	$ 400,000	$ 400,000	*Berm earth fill, grade, cap, condition, seed*
			Total	**$ 5,600,000**	
MPA Portion			10%	**$ 560,000**	*Waste from earthwork & Marley/Spray Pond*
AHA Portion			25%	**$ 1,400,000**	*AHA asphaltic material from Pit and Piles*
STF Portion			0%	**$ -**	*None*
SPA Portion			65%	**$ 3,600,000**	*Pond sediments*
			100%		

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
9 - Groundwater Treatment System (GTS)					
Initial Eval, Design, OS, Reporting, O&M Man.	1	lump	$ 300,000	$ 300,000	
Wetlands - Excavation, Plantings, Structures	1	lump	$ 650,000	$ 650,000	*Located in former east stormwater pond area*
Crushing of MPA Concrete - Riprap, Stage 1	1	lump	$ 510,000	$ 510,000	*Recycled Crushed Concrete (RCC)*
UOWS, Clean and Convert API OWS	1	lump	$ 150,000	$ 150,000	*Pre-treatment - LNAPL and Mineral removal*
O&M Costs To Date	8	years	$ 68,000	$ 544,000	*Future costs are addressed elsewhere*
			Total	**$ 2,200,000**	
MPA Portion			65%	**$ 1,400,000**	*Most of impacts are related to the MPA*
AHA Portion			5%	**$ 110,000**	*Some AHA-impacted water may enter in IT*
STF Portion			20%	**$ 440,000**	*Part of the North STF MTBE plume*
SPA Portion			10%	**$ 220,000**	*Some impacts may be from Pond Sediments*
			100%		
REMEDY COMPONENTS SHARED AMONG MULTIPLE AOCS - SECTION 10.2					
A) Existing IT Continued Operation		Seep IT, Channel IT, and Basin IT			
Design					
Already Complete	1	lump	$ -	$ -	*Part of IRM Work*
			Subtotal	$ -	
Construction					
Already Complete	1	lump	$ -	$ -	*Part of IRM Work*
			Subtotal	$ -	
Total Capital Cost			**Subtotal**	**$ -**	
MPA Portion			65%	**$ -**	
AHA Portion			5%	**$ -**	
STF Portion			20%	**$ -**	
SPA Portion			10%	**$ -**	
			100%		
O&M					
Seep IT: Checks, cleaning, meters, PM, etc.	1	Annual	$ 60,000	$ 60,000	*Based on Recent O&M Costs*
MPA Basin and Channel IT	1	Annual	$ 20,000	$ 20,000	*Based on Recent O&M Costs*
			Subtotal	**$ 80,000**	*Annually*
MPA Portion			65%	**$ 52,000**	*Most of impacts are related to the MPA*
AHA Portion			5%	**$ 4,000**	*Some AHA-impacted water may enter in IT*
STF Portion			20%	**$ 16,000**	*Part of the North STF MTBE plume*
SPA Portion			10%	**$ 8,000**	*Some impacts may be from Pond Sediments*
			100%		
B) Groundwater Treatment System O&M					
Plan Modifications					
Combined O&M Plan Update	1	lump	$ 15,000	$ 15,000	
	1	lump	$ -	$ -	
			Subtotal	**$ 15,000**	
MPA Portion			65%	**$ 9,750**	
AHA Portion			5%	**$ 750**	
STF Portion			20%	**$ 3,000**	
SPA Portion			10%	**$ 1,500**	
			100%		
O&M					
Escrow for Wetlands clean-out, replant	1	Annual	$ 5,000	$ 5,000	*Estimate*
NPDES Sampling, Checks, Cleaning, etc.	1	Annual	$ 70,000	$ 70,000	*Based on Recent O&M Costs*
			Subtotal	**$ 75,000**	
MPA Portion			65%	**$ 48,750**	*Most of impacts are related to the MPA*
AHA Portion			5%	**$ 3,750**	*Some AHA-impacted water may enter in IT*
STF Portion			20%	**$ 15,000**	*Part of the North STF MTBE plume*
SPA Portion			10%	**$ 7,500**	*Some impacts may be from Pond Sediments*
			100%		

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
C) LNAPL/Product Skimming					
Notes					
Costs are for monthly product recovery per area from wells known to contain product. Groundwater monitoring costs are separate.					
Additional MPA product recovery is included as part of the MPA Spring, MPA Basin IT, and Seep IT groundwater/product extraction O&M.					
Initial Capital Costs					*Beyond existing infrastructure investments*
Sorbent Socks	8	each	$ 10	$ 80	*Consumable - in monthly costs*
Selective Oil Skimmers (SOS) w/ Canisters	4	each	$ 800	$ 3,200	*Web quote*
SOS with Pneumatic Pump and Drum	2	each	$ 3,000	$ 6,000	*Web quote*
Procurement, Installation	1	lump	$ 1,000	$ 1,000	*Select, order, assemble, install*
			Subtotal	**$ 10,280**	
MPA Portion			20%	**$ 2,056**	
AHA Portion			0%	**$ -**	
STF Portion			80%	**$ 8,224**	
SPA Portion			0%	**$ -**	
			100%		
Ongoing/O&M Costs					
Equipment Rental	1	lump	$ 100	$ 100	*Interface probe, bailers, and/or pumps*
Mobilization	1	lump	$ 250	$ 250	*Gather equipment, drive to sites, etc.*
Consumables - gloves sorbent socks	1	each	$ 100	$ 100	
Skim Product and Empty Skimmers	2	hrs	$ 70	$ 140	
Waste Management - Disposal	1	lump	$ 100	$ 100	*Transfer to UOWS, Combined disposal*
Data Entry/Reporting	4	hrs	$ 120	$ 480	*Escrowed for semi-annual reports*
Management	2	lump	$ 120	$ 240	*PM, coordination, invoicing, etc.*
			Per Event	$ 1,410	*Monthly*
			Per Year	**$ 16,920**	
MPA Portion			20%	**$ 3,384**	*Per Year*
AHA Portion			0%	**$ -**	
STF Portion			80%	**$ 13,536**	*Per Year*
SPA Portion			0%	**$ -**	
			100%		
D) LTM					
Initial Capital Costs					
Revise Monitoring Plan	1	lump	$ 5,000	$ 5,000	*Modest changes to existing plan*
Quality Assurance Project Plan (QAPP)	0	lump	$ -	$ -	*Already existing - minor modifications*
Standard Operating Procedures (SOPs)	0	lump	$ -	$ -	*Already existing - for monitoring*
Equipment	0	lump	$ -	$ -	*Already own or rent*
			Subtotal	**$ 5,000**	
MPA Portion			23%	**$ 1,163**	*10 of 43 locations (wells+MPA Spring)*
AHA Portion			0%	**$ -**	*0 of 43 locations (wells+MPA Spring)*
STF Portion			58%	**$ 2,907**	*25 of 43 locations (wells+MPA Spring)*
SPA Portion			19%	**$ 930**	*8 of 43 locations (wells+MPA Spring)*
			100%		
Annual Sampling (Equivalent of Annual O&M)					
Prep, Sampling, Reporting	1	lump	$ 30,000	$ 30,000	*Based on 1/2 of recent semi-annual costs*
Laboratory - GW	1	lump	$ 5,000	$ 5,000	*Based on 1/2 of recent semi-annual costs*
			Subtotal	**$ 35,000**	
MPA Portion			23%	**$ 8,140**	*10 of 43 locations (wells+MPA Spring)*
AHA Portion			0%	**$ -**	*0 of 43 locations (wells+MPA Spring)*
STF Portion			58%	**$ 20,349**	*25 of 43 locations (wells+MPA Spring)*
SPA Portion			19%	**$ 6,512**	*8 of 43 locations (wells+MPA Spring)*
			100%		

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
E) MNA and NSZD					
Work Plans, QAPP, Set-up					
MNA Work Plan	1	lump	$ 15,000	$ 15,000	
NSZD Work Plan	1	lump	$ 10,000	$ 10,000	*Included within MNA Work Plan*
Quality Assurance Project Plan (QAPP)	1	lump	$ 8,000	$ 8,000	*Revisions to Existing QAPP for MNA param*
Standard Operating Procedures (SOPs)	0	lump	$ -	$ -	*Already have required field sampling SOPs*
Set-up Initial Figures, Statically Calcs, etc.	1	lump	$ 15,000	$ 15,000	*Spreadsheet, analysis, and text for the report*
			Subtotal	**$ 48,000**	
MPA Portion			40%	**$ 19,200**	
AHA Portion			0%	**$ -**	
STF Portion			40%	**$ 19,200**	
SPA Portion			20%	**$ 9,600**	
			100%		
MNA Each Event					*Additional Costs Beyond LTM & Annual Rpt*
Preparation and Mobilization	4	hrs	$ 120	$ 480	
Field Labor	9.5	hrs	$ 90	$ 855	*Extra sample/shipment time (0.5hr/well)*
Laboratory - GW	19	wells	$ 200	$ 3,800	*Additional parameters beyond LTM list*
Report - Analysis and Text for SIX areas	1	lump	$ 10,000	$ 10,000	*Routine (after initial set-up) evaluation*
Project Management	16	hrs	$ 140	$ 2,240	*Job setup, invoicing, PM, QA, etc.*
			Subtotal	**$ 17,375**	
MPA Portion			40%	**$ 6,950**	
AHA Portion			10%	**$ 1,738**	
STF Portion			30%	**$ 5,213**	
SPA Portion			20%	**$ 3,475**	
			100%		
NSZD Each Event					
Preparation and Mobilization	24	hrs	$ 120	$ 2,880	*Different equipment, new procedures*
Field Labor	12	each	$ 720	$ 8,640	*Install and retrieve carbon traps*
Field Equipment/Components	12	each	$ 300	$ 3,600	
Carbon Traps	12	each	$ 1,000	$ 12,000	*Includes total carbon analysis*
Carbon13 analysis	12	each	$ 400	$ 4,800	
Report	1	lump	$ 10,000	$ 10,000	*Section within LTM & O&M Report*
Project Management	24	hrs	$ 140	$ 3,360	
			Subtotal	**$ 45,280**	
MPA Portion			50%	**$ 22,640**	
AHA Portion			0%	**$ -**	
STF Portion			50%	**$ 22,640**	
SPA Portion			0%	**$ -**	
			100%		
F) EUCs and SWMP					
Up-Front Documents and Fees					
Prepare Soil-Waste Management Plan	1	lump	$ 15,000	$ 15,000	
Environmental Use Controls Support Info	1	lump	$ 15,000	$ 15,000	*Survey, descriptions, maps*
Payment to Obtain Deed Restrictions	0	each	$ -	$ -	*None - All property owned by EPME-PC*
KDHE Management Fee	1	each	$ 5,000	$ 5,000	*First Long-Term Care Agreement payment*
			Total	**$ 35,000**	
MPA Portion			40%	**$ 14,000**	
AHA Portion			10%	**$ 3,500**	
STF Portion			20%	**$ 7,000**	
SPA Portion			30%	**$ 10,500**	
			100%		
Annual Costs					
Annual Inspection (including mobilization)	6	hrs	$ 120	$ 720	*All Site AOCs. Includes Water Well Survey*
Annual Report Status Update	1	each	$ 5,000	$ 5,000	*Included within annual O&M report*
Escrow for Required Action/Oversight	1	each	$ 4,000	$ 4,000	*Future excavation, development, issue, etc.*
KDHE Management Fee	1	each	$ 5,000	$ 5,000	*Long-Term Care Agreement*
			Total	**$ 14,720**	
MPA Portion			40%	**$ 5,888**	
AHA Portion			10%	**$ 1,472**	
STF Portion			20%	**$ 2,944**	
SPA Portion			30%	**$ 4,416**	
			100%		

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
G) Close-Out of Shared Components					
Confirmation Soil and GW Sampling					
Work Plan	1	lump	$ 15,000	$ 15,000	*Soil sampling locations/analysis, wells*
Mobilization	1	lump	$ 3,000	$ 3,000	*Direct push rig/crew*
Direct Push Soil Sampling	8	days	$ 4,000	$ 32,000	*Assume 10 points per day*
Soil Sampling Field Labor	8	days	$ 1,050	$ 8,400	*10 hour days plus equipment/vehicle*
Groundwater Sampling Field Labor	173	each	$ 135	$ 23,355	*1.5 hours per well, Sample all Site wells*
Laboratory - GW	173	each	$ 200	$ 34,600	*Sample all Site wells*
Laboratory - Soil	80	each	$ 150	$ 12,000	*Full VOC and SVOC scan*
Report	1	lump	$ 20,000	$ 20,000	*All reviews and revisions*
Management	40	hrs	$ 140	$ 5,600	
			Subtotal	**$ 153,955**	
MPA Portion			40%	**$ 61,582**	
AHA Portion			0%	**$ -**	
STF Portion			40%	**$ 61,582**	
SPA Portion			20%	**$ 30,791**	
			100%		
Well Abandonment & System Removal					
Work Plan/KDHE Approval	1	lump	$ 10,000	$ 10,000	
Mobilization	1	lump	$ 5,000	$ 5,000	*Drill rig and crew*
Well Abandonment	173	each	$ 1,000	$ 173,000	
Well Abandonment Forms	173	each	$ 200	$ 34,600	
Field Labor	173	each	$ 230	$ 39,790	*2 hrs per well plus equipment/vehicle*
Disposal	173	each	$50	$ 8,650	*Well casing, pad, cover, etc.*
Earthwork	173	each	$50	$ 8,650	*Repair/seeding of well area*
Remove MPA Spring System	1	lump	$ 15,000	$ 15,000	
Remove GTS UOWS and PSB	1	lump	$ 20,000	$ 20,000	
Remove Wetlands	0	lump	$ -	$ -	*Assumes wetlands left in place/natural*
Remove STF Systems	1	lump	$ 15,000	$ 15,000	*Abandon trenches and extraction sumps*
Management	1	lump	$ 20,000	$ 20,000	*Consultant and construction firm*
			Subtotal	**$ 349,690**	
MPA Portion			40%	**$ 139,876**	
AHA Portion			0%	**$ -**	
STF Portion			40%	**$ 139,876**	
SPA Portion			20%	**$ 69,938**	
			100%		
MAIN PROCESS AREA (MPA)-ONLY COSTS FOR ALTERNATIVES 2 OR 3					
MPA Spring System Continued Operation					
Design					
Already Complete		lump	$ -	$ -	*Part of IRM Work*
			Subtotal	$ -	
Construction					
Already Complete		lump	$ -	$ -	*Part of IRM Work*
			Subtotal	$ -	
Total Capital Cost			**Subtotal**	**$ -**	
O&M					*Over 30 Year Life-Time*
Monthly Inspection, Sample, Maintain, Notes	24	hr	$ 80	$ 1,920	*1 hr/mth while on-site for other O&M activities*
Cleaning of UOWS Coalescing Filters	0.3	each	$ 5,000	$ 1,500	*9 Events Total: Annual at 1st, none by end*
GAC/Media Replacement (set of 3)	0.1	each	$ 5,000	$ 500	*3 Sets Total: Years 2, 4, & 6 only (then none)*
Tar Disposal	0.2	each	$ 10,000	$ 2,000	*6 Events Total: Annual at 1st, none by end*
Miscellaneous Repair Escrow	1	lump	$ 500	$ 500	*Annual Average Cost*
Project Management	1	lump	$ 800	$ 800	
			Subtotal	**$ 7,220**	*Annual Average Cost*

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
Phytoremediation					
Scope					
Area to plant	1,548,000	sf			*Excludes substation, pond, road, power lines*
Area Allowance for Each Tree	900	sf			*Poplar tree canopy at 30', squared*
Total Trees	1,720	Trees			*Based on grid, field application may vary*
Tree Mix					
Hybrid Poplar		50%	0		*Fast growing, common*
Willow		20%	0		*Fast growing, common*
Red Oak		10%	0		*Slow growing, large canopy when mature*
Swamp White Oak		10%	0		*Slow growing, good in wet area of site*
Maple		10%	0		*Medium growing, large canopy, variety*
Total		100%	0		
Design					
Predesign: Soil conditions, layout	1	lump	$ 30,000	$ 30,000	
Draft, Draft Final, Final	1	lump	$ 10,000	$ 10,000	
O&M Plan	1	lump	$ 15,000	$ 15,000	
			Subtotal	$ 55,000	
Construction					
Mobilization, Work Plans, Permits, etc.	1	lump	$18,000	$ 18,000	*Contractor - H&S Plans, SOPs, etc.*
Fertilizer/Soil Preparation	1	lump	$7,500	$ 7,500	*Fertilizer, molasses*
Contractor Field Management/Reporting	1	lump	$9,500	$ 9,500	
Shallow (30") Planting Poplars/Willows	0	trees	$ 27	$ -	*30" Trench Planting*
Supply and Planting Oaks/Maples	0	trees	$ 125	$ -	*More expensive tree, not cuttings*
Understory Planting	36	acres	$ 450	$ 16,200	
Post Installation Service	3	years	$ 25,000	$ 75,000	*Tree inspection, mapping reporting*
			Subtotal	$ 126,200	
Total Capital Cost			**Subtotal**	**$ 181,200**	
O&M					
Storm Damage Clearing	1	lump	$ 10,000	$ 10,000	*Scope will vary year to year*
Pesticide/Herbicide/Fertilizer Application	1	lump	$ 5,000	$ 5,000	*Based on site observations*
Replanting allowance (1% of all trees)	17	lump	$ 150	$ 2,550	*Remove old, plant new, small quantity*
Mowing (twice per year)	72	acres	$ 100	$ 7,200	
Management	1	lump	$ 4,000	$ 4,000	
Total Annual O&M Cost			**Subtotal**	**$ 28,750**	*Annually*
Excavate and Landfarm All Impacted Soil and Landfill Impacted Rock					
Work Plan					
Draft, Draft Final, Final Design	1	lump	$ 150,000	$ 150,000	
			Subtotal	$ 150,000	
Construction					
Preconstruction					
Mobilization, Work Plans, Permits, etc.	4	each	$ 150,000	$ 600,000	*4 years of excavation and landfarm stages*
Plans and Permits	1	each	$ 25,000	$ 25,000	
Fence	0	foot	$ 28	$ -	*Use existing fence (else 6,300 ft of new)*
			Subtotal	$ 625,000	

Note: For convenience all volumes are listed in bank cubic yards (bcy - the in-situ volume) even when actual volume is load/loose cubic yards (lcy).

Volume Calculations					
Total Exc Volume (competent rock to final)	856,675	bcy	-	-	*See CADD total Volume Sheet*
Soil/Debris Volume (weathered rock to final)	568,424	bcy			*See CADD total Volume Sheet*
Weathered/Excavatable Rock	288,251	bcy			*Total minus Soil/Debris Volume*
Debris (Concrete, pipes, etc.)	816	bcy			*1/4 of 3,265 bcy removed during IRM*
Soil Volume	567,608	bcy			*Soil/Debris Volume minus Debris Volume*
Soil Excavation	567,608	bcy		-	Total from above - Scores of source areas
Clean Soil	187,311	bcy	33%	Estimate	*Stockpile in AHA*
Non-Hazardous Soil	374,621	bcy	66%	Estimate	*Landfarm in STF*
Hazardous Soil/Waste	5,676	bcy	1%	Estimate	*Hazardous Waste Landfill*

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
Weathered Rock Excavation	288,251	bcy		-	Total from above - Primary LNAPL smear zone
Non-Hazardous Waste (Special Waste)	288,251	bcy	100%	Estimate	*Non Hazardous Waste Landfill*
Hazardous Waste	0	bcy	0%	Estimate	*Hazardous Waste Landfill*
Debris Excavation	816	bcy			Total from above - Refinery piping, footings
Non-Hazardous Waste (Special Waste)	816	bcy	100%	Estimate	*Non Hazardous Waste Landfill*
Hazardous Waste	0	bcy	0%	Estimate	*Hazardous Waste Landfill*
Excavation					
Soil Excavation	567,608	bcy	$ 1.50	$ 851,412	*means 31 23 16.43*
Weathered Rock Excavation	288,251	bcy	$ 4.50	$ 1,297,130	*triple cost per bcy that of soil*
Debris Excavation and Processing	816	bcy	$ 75	$ 61,219	*Special handling*
Soil Screening	12	month	$ 10,000	$ 120,000	*Remove rock/small debris - landfarm prep*
Survey	39	acre	$ 410	$ 15,990	
Dewatering	280	day	$ 500	$ 140,000	
Water Treatment	0	gal	$ -	$ -	*Use existing wetland-based system (GTS)*
Oversight, Documentation	1	lump	15%	$ 372,862	
			Subtotal	$ 2,858,612	
Non-Hazardous Soil Treatment					
Clean Stock Pile Load/Transportation	187,311	bcy	$ 8.00	$ 1,498,484	*Means G1030 145 7400/7600*
Landfarm Load/Transportation	374,621	bcy	$ 8.00	$ 2,996,969	*4 years screening/reporting. MWH Proposal*
Landfarm Spread - Full STF Area 6" deep	374,621	bcy	$ 0.50	$ 187,311	*1 lift per year for 4 years*
Landfarming	374,621	bcy	$ 3.59	$ 1,344,890	*Monthly disking, PID screening, sampling*
			Subtotal	$ 6,027,654	
Non-Hazardous Rock Disposal					
Debris Transportation	816	bcy	$ 35	$ 28,569	*Vendor quote*
Debris Landfill (Special Waste)	816	bcy	$ 67	$ 54,689	*Topeka KS landfill disposal rates*
Weathered Rock Transportation	288,251	bcy	$ 35	$ 10,088,785	*Vendor quote*
Weathered Rock (Special Waste)	288,251	bcy	$ 67	$ 19,312,817	*Topeka KS landfill disposal rates*
			Subtotal	$ 29,484,860	
Hazardous Waste Disposal					
Debris Transportation	0	bcy	$ 100	$ -	
Debris Landfill	0	bcy	$ 250	$ -	
Soil Transportation	5,676	bcy	$ 100	$ 567,608	
Soil Landfill	5,676	bcy	$ 250	$ 1,419,019	
Weathered Rock Transportation	0	bcy	$ 100	$ -	
Weathered Rock	0	bcy	$ 250	$ -	
			Subtotal	$ 1,986,627	
Backfill					
Total Backfill to Restore To Existing Grade	856,675	bcy			
Assumed Minimum Volume Required	599,673	bcy	70%		*Stormwater to Basin/Pond then to Ditch*
Excavate/Load Clean Stockpiled Soil	187,311	bcy	$ 6.00	$ 1,123,863	*Load and 1/2 mile trip*
Excavate Clean Landfarm Soil	374,621	bcy	$ 4.36	$ 1,633,348	*Scrap: Means 31 23 16.43 - 6200*
Load/Haul Clean Landfarm Soil	374,621	bcy	$ 8.00	$ 2,996,969	*Load and couple mile trip*
Excavate STF Borrow Pit/Swale Soil	37,741	bcy	$ 4.36	$ 164,550	*Scrap: Means 31 23 16.43 - 6200*
Load/Haul STF Borrow Pit/Swale Soil	37,741	bcy	$ 8.00	$ 301,927	*Load and couple mile trip*
Place/Spread Fill	599,673	bcy	$ 5.94	$ 3,562,055	*Means 31 23 23.14 - 5420*
Compact Fill	599,673	bcy	$ 1.53	$ 917,499	*Means 31 23 23.24 - 5421*
Oversight	1	lump	10%	$ 1,070,021	
			Subtotal	$ 9,782,712	
Restoration					
Seeding - MPA and STF	300	acre	$ 1,428	$ 428,400	*MWH Proposal*
Road Construction - MPA	815	foot	$ 67.80	$ 55,257	*MWH Proposal*
Final Survey - MPA	300	acre	$ 410	$ 123,000	
Oversight, As-Built Drawings	1	lump	10%	$ 60,666	
			Subtotal	$ 667,323	
Reporting					
Construction Completion Report (CCR)	1	lump	$ 75,000	$ 75,000	
			Subtotal	$ 75,000	
Total Capital Cost			**Subtotal**	**$ 53,645,307**	
O&M					
Mobilization	0	lump	$ -	$ -	
Management	0	lump	$ -	$ -	
				$ -	*Monthly*
Total Annual O&M Cost			**Subtotal**	**$ -**	*Annually*

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
Replacement MPA Spring Collection/Treatment System					
Design					
Modifications to Existing Designs	1	lump	$ 15,000	$ 15,000	*Similar, but elevations would be different*
O&M Plan		lump		$ -	*No changes required*
			Subtotal	$ 15,000	
Construction					
Interceptor Trench, Sump, Conveyance	1	lump	$ 90,000	$ 90,000	*All New*
Underground Oil-Water Separator	1	lump	$ 40,000	$ 40,000	*Reinstallation of Existing Equipment*
Carbon Filter Polishing Treatment	1	lump	$ 30,000	$ 30,000	*Reinstallation of Existing Equipment*
Oversight, As-Built Drawings	1	lump	$ 10,000	$ 10,000	
			Subtotal	$ 170,000	
Total Capital Cost			**Subtotal**	**$ 185,000**	
O&M					*Same Costs As Prior Estimate*
Monthly Inspection, Sample, Maintain, Notes	24	hr	$ 80	$ 1,920	*1 hr/mth while on-site for other O&M activities*
Cleaning of UOWS Coalescing Filters	0	each	$ 5,000	$ 1,500	*9 Events Total: Annual at 1st, none by end*
GAC/Media Replacement (set of 3)	0	each	$ 5,000	$ 500	*3 Sets Total: Years 2, 4, & 6 only (then none)*
Tar Disposal	0	each	$ 10,000	$ 2,000	*6 Events Total: Annual at 1st, none by end*
Miscellaneous Repair Escrow	1	lump	$ 500	$ 500	*Annual Average Cost*
Project Management	1	lump	$ 800	$ 800	
			Subtotal	**$ 7,220**	*Annually*
ASPHALT HANDLING AREA (AHA)-ONLY COSTS FOR ALTERNATIVES 2 OR 3					
IT Along East Side of AHA and West Side of MPA					
Design					
Draft, Draft Final, Final Design	1	lump	$ 50,000	$ 50,000	*Reviews, comments, revisions*
O&M Plan	1	lump	$ 5,000	$ 5,000	*Minor update to existing ITs plan*
			Subtotal	$ 55,000	
Construction					
Preconstruction					
Bid Support	1	lump	$ 8,000	$ 8,000	*Contractor selection*
Mobilization, Work Plans, Permits, etc.	1	lump	$ 20,000	$ 20,000	*Contractor - H&S Plans, SOPs, etc.*
Survey for As-Builts, Wells, Etc.	1	lump	$ 1,500	$ 1,500	
			Subtotal	$ 21,500	
AHA Interceptor Trenches (ITs)					
East Trench - With Gravel, Bottom	200	ft	$ 40	$ 8,000	Relatively shallow, assumes stabile sidewalls
West Trench - With Gravel, Bottom	200	ft	$ 60	$ 12,000	*West trench is deeper - old quarry location*
Recovery Sumps (10' into fractured rock)	2	each	$ 100,000	$ 200,000	*Sump/well, pump, vault, panel, controls*
Conveyance Trenching	2,000	ft	$ 17	$ 34,000	*To MPA Basin area existing conveyance*
1" PVC Electrical Conduit and # 8 Wire	2,000	ft	$ 8	$ 16,000	
2" Water Conveyance Line	2,000	ft	$ 14	$ 28,000	
Effluent Connection to Treatment System	1	Lump	$ 3,000	$ 3,000	
Electrical Power Drop 480V 3 phase	0	Lump	$ 5,000	$ -	*Existing Panel at MPA Basin*
Pressure Test	1	Lump	$ 2,000	$ 2,000	
Oversight	1	Lump	10%	$ 30,300	
			Subtotal	$ 333,300	
Extracted Water/Product Treatment					
Groundwater Treatment System (GTS)	0	each	$ -	$ -	*Existing System sufficient - No added cost*
			Subtotal	$ -	*O&M costs itemized below*
As-Builts (Provided By Contractor)					
As-Built Review	1	lump	$ 5,000	$ 5,000	
			Subtotal	$ 5,000	
Reporting					
Construction Completion Report (CCR)	1	lump	$ 15,000	$ 15,000	
			Subtotal	$ 15,000	
Total Capital Cost			**Subtotal**	**$ 437,800**	
O&M					
Mobilization	0	lump	$ 200	$ -	*Included in monthly Site visit*
IT-related O&M	2	each	$ 500	$ 1,000	*Flow meters, pumps, cleaning, parameters*
GTS-related O&M (water treatment)	1	lump	$ 300	$ 300	*Nominal additional GTS/Wetland O&M cost*
Reporting - escrow for annual report	1	lump	$ 300	$ 300	*AHA IT operation/performance discussion*
Project Management	1	lump	$ 200	$ 200	
				$ 1,800	*Monthly*
Total Annual O&M Cost			**Subtotal**	**$ 21,600**	*Annually*

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
SOUTH TANK FARM (STF)-ONLY COSTS FOR ALTERNATIVES 2 OR 3					
Excavate, Stabilize, and Dispose of Waste					
Work Plan and Design					
Investigation Work Plan	1	lump	$ 3,000	$ 3,000	
Predesign: Waste Characterization	1	lump	$ 5,000	$ 5,000	
Stabilization Mix Design	0	lump	$ -	$ -	*Assumes AHA mix design is comparable*
Work Plan/Design	1	lump	$ 8,000	$ 8,000	
O&M Plan	1	lump	$ -	$ -	
			Subtotal	$ 16,000	
Construction					
Preconstruction					
Mobilization, Work Plans, Permits, etc.	1	lump	$ 20,000	$ 20,000	*Contractor - H&S Plans, SOPs, etc.*
Utility Locates	1	lump	$ 600	$ 600	
			Subtotal	$ 20,600	
Excavation					
Total Excavation Volume	400	yd^3	-		*Estimated 40' by 50' by 5'*
Soil Excavation/Load	400	yd^3	$ 6	$ 2,400	*means 31 23 16.43 + load*
Transportation	400	yd^3	$ 35	$ 14,000	*MWH Proposal*
Landfill Fees (Special Waste)	400	yd^3	$ 69	$ 27,600	*Topeka KS landfill disposal rates*
Oversight	1	lump	10%	$ 4,400	*Documentation, reporting, etc.*
			Subtotal	$ 48,400	
Backfill					
Soil Stabilization	400	yd^3	$ 85	$ 34,000	Based on similar past work, vol-adjusted
Fill Transportation	400	yd^3	$ 8	$ 3,200	
Soil Backfill	400	yd^3	$ 6	$ 2,400	*Means 31 23 23.14 - 5420*
Compaction	400	yd^3	$ 1.50	$ 600	*Means 31 23 23.24 - 5421*
Oversight	1	lump	10%	$ 4,020	*Documentation, reporting, etc.*
			Subtotal	$ 44,220	
Restoration					
Fine Grading, Seeding	1	Lump	$ 2,000	$ 2,000	
			Subtotal	$ 2,000	
Reporting					
Construction Completion Report (CCR)	1	lump	$ 8,000	$ 8,000	
			Subtotal	$ 8,000	
Total Capital Cost			**Subtotal**	**$ 139,220**	
O&M					
Management	0	lump	$ -	$ -	*In addition to existing OM&M plan*
				$ -	*Monthly*
Total Annual O&M Cost			**Subtotal**	**$ -**	*Annually*
NE Plumes Interceptor Trench					
Design					
Pre-Design (Soil Classification) and Design	1	lump	$ 75,000	$ 75,000	
O&M Plan	1	lump	$ 8,000	$ 8,000	
			Subtotal	$ 83,000	
Construction					
Preconstruction					
Bid Support	1	lump	$ 4,000	$ 4,000	
Locates, Coordination	1	lump	$ 1,000	$ 1,000	
Mobilization, Work Plans, Permits, etc.	1	lump	$ 30,000	$ 30,000	*Contractor - H&S Plans, SOPs, etc.*
			Subtotal	$ 35,000	

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
Interceptor Trenches					
Clearing/Grubbing - Prep	1	lump	$ 30,000	$ 30,000	
Trench - With Gravel, Bottom	1,050	ft	$ 90	$ 94,500	*Assumes average depth to fractured rock 15'*
Recovery Sumps (10' into fractured rock)	3	each	$ 100,000	$ 300,000	*Sump/well, pump, vault, panel, controls*
Conveyance Trenching	1,300	ft	$ 30	$ 39,000	*To MPA Basin groundwater conveyance*
1" PVC Electrical Conduit and # 8 Wire	1,300	ft	$ 8	$ 10,400	*Power from existing MPA Basin panel*
2" Water Conveyance Line	1,300	ft	$ 14	$ 18,200	
Conveyance Line Cleanouts	4	each	$ 800	$ 3,467	*300 foot spacing*
Effluent Connection to Treatment System	1	Lump	$ 3,000	$ 3,000	
Pressure Test	1	Lump	$ 2,000	$ 2,000	
Survey for As-Builts, Wells, Etc.	1	Lump	$ 2,000	$ 2,000	
Oversight	1	Lump	10%	$ 37,807	
			Subtotal	$ 540,373	
Water Treatment					
Processed Through Existing System	0	each	$ -	$ -	*Existing System sufficient - No added cost*
			Subtotal	$ -	*O&M costs itemized below*
As-Builts Review (As-Builts Provided By Contractor)					
Report Review	1	lump	$ 10,000	$ 10,000	
			Subtotal	$ 10,000	
Reporting					
Construction Completion Report (CCR)	1	lump	$ 15,000	$ 15,000	
			Subtotal	$ 15,000	
Total Capital Cost			**Subtotal**	**$ 683,373**	
O&M					
Mobilization	0	lump	$ 200	$ -	*Included in monthly Site visit*
IT-related O&M	3	lump	$ 500	$ 1,500	*Flow meters, pumps, cleaning, parameters*
GTS-related O&M (water treatment)	1	lump	$ 300	$ 300	*Nominal additional GTS/Wetland O&M cost*
Reporting - escrow for annual report	1	lump	$ 300	$ 300	*AHA IT operation/performance discussion*
Project Management	1	lump	$ 300	$ 300	
				$ 2,400	*Monthly*
Total Annual O&M Cost			**Subtotal**	**$ 28,800**	*Annually*
STF Creek Surface Water Sampling					
Work Plan					
Revision of/Update to Past Plan	1	lump	$ 5,000	$ 5,000	
			Subtotal	$ 5,000	
Construction					
None	1	lump		$ -	
			Subtotal	$ -	
Total Capital Cost			**Subtotal**	**$ 5,000**	
O&M					
Preparation, Drive	3	hr	$ 90	$ 270	
Sampling Labor/Time	6	hr	$ 90	$ 540	*3 locations, shipping, chain of custody*
Laboratory Analysis	3	each	$ 200	$ 600	*VOCs with MTBE, TPH-GRO, TPH-DRO*
Evaluation and Report Text	12	hrs	$ 120	$ 1,440	*Included in Annual O&M and Monitoring Rpt*
Project Management	6	hrs	$ 140	$ 840	
				$ 3,690	*Quarterly*
Total Annual O&M Cost			**Subtotal**	**$ 14,760**	*Annual Cost*
STF Creek Interceptor Trench					
Design					
Pre-Design (Soil Classification) and Design	1	lump	$ 75,000	$ 75,000	
O&M Plan	1	lump	$ 8,000	$ 8,000	
			Subtotal	$ 83,000	
Construction					
Preconstruction					
Bid Support	1	lump	$ 6,000	$ 6,000	
Locates, Coordination	1	lump	$ 1,000	$ 1,000	
Mobilization, Work Plans, Permits, etc.	1	lump	$ 20,000	$ 20,000	*Contractor - H&S Plans, SOPs, etc.*
			Subtotal	$ 27,000	

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
Interceptor Trenches					
Prep: Clearing/Grubbing /Grading	1	lump	$ 60,000	$ 60,000	
Trench - With Gravel, Bottom	1,200	ft	$ 110	$ 132,000	*Assumes average depth 15', Bioslurry*
Recovery Sumps (10' into fractured rock)	4	each	$ 100,000	$ 400,000	*Sump/well, pump, vault, panel, controls*
Conveyance Trenching	5,250	ft	$ 20	$ 105,000	*To MPA Basin groundwater conveyance*
1" PVC Electrical Conduit and # 8 Wire	2,545	ft	$ 8	$ 20,360	
2" Water Conveyance Line	5,250	ft	$ 14	$ 73,500	
Conveyance Line Cleanouts	18	each	$ 800	$ 14,000	*300 foot spacing*
Effluent Connection to Treatment System	1	Lump	$ 3,000	$ 3,000	
Electrical Power Drop 480V 3 phase	1,550	foot	$ 13	$ 20,150	*Overhead electric based on prior MPA cost*
Pressure Test	1	Lump	$ 5,000	$ 5,000	
Survey for As-Builts, Wells, Etc.	1	lump	$ 2,500	$ 2,500	
Oversight	1	Lump	10%	$ 77,301	
			Subtotal	$ 912,811	
Water Treatment					
Processed Through Existing System	0	each	$ -	$ -	*Existing System sufficient - No added cost*
			Subtotal	$ -	*O&M costs itemized below*
As-Builts Review (As-Builts Provided By Contractor)					
Report Review	1	lump	$ 10,000	$ 10,000	
			Subtotal	$ 10,000	
Reporting					
Construction Completion Report (CCR)	1	lump	$ 20,000	$ 20,000	
			Subtotal	$ 20,000	
Total Capital Cost			**Subtotal**	**$ 1,052,811**	
O&M					
Mobilization	0	lump	$ 200	$ -	*Included in monthly Site visit*
IT-related O&M	4	lump	$ 500	$ 2,000	*Flow meters, pumps, cleaning, parameters*
GTS-related O&M (water treatment)	1	lump	$ 400	$ 400	*Nominal additional GTS/Wetland O&M cost*
Reporting - escrow for annual report	1	lump	$ 300	$ 300	*AHA IT operation/performance discussion*
Project Management	1	lump	$ 300	$ 300	
				$ 3,000	*Monthly*
Total Annual O&M Cost			**Subtotal**	**$ 36,000**	*Annually*
SE Topeka St Interceptor Trench					
Design					
Pre-Design (Soil Classification) and Design	1	lump	$ 25,000	$ 25,000	
O&M Plan	1	lump	$ 2,500	$ 2,500	*assumes plan will be combined with Creek IT Pla*
			Subtotal	$ 27,500	
Construction					
Preconstruction					
Bid Support	1	lump	$ 4,000	$ 4,000	
Locates, Coordination	1	lump	$ 1,000	$ 1,000	
Mobilization, Work Plans, Permits, etc.	1	lump	$ 20,000	$ 20,000	*Contractor - H&S Plans, SOPs, etc.*
			Subtotal	$ 25,000	
Interceptor Trenches					
Trench - With Gravel, Bottom	300	ft	$ 90	$ 27,000	*Assumes average depth to fractured rock 16'*
Recovery Sumps (10' into fractured rock)	1	each	$ 100,000	$ 100,000	Recovery Sumps (10' into fractured rock)
Conveyance Trenching	50	ft	$ 17	$ 850	*Trenching cost is included in STF Creek IT*
1" PVC Electrical Conduit and # 8 Wire	100	ft	$ 8	$ 800	
2" Water Conveyance Line	50	ft	$ 14	$ 700	*Most of conveyance there for STF Creek IT*
Cleanouts	1	each	$ 800	$ 800	
Effluent Connection to Treatment System	0	Lump	$ 3,000	$ -	*Paid for in STF Creek IT Conveyance*
Electrical Power Drop 230V 3 phase	200	foot	$ 13	$ 2,600	*Overhead electric based on prior MPA cost*
Pressure Test	1	Lump	$ 1,000	$ 1,000	
Survey for As-Builts, Wells, Etc.	1	lump	$ 1,500	$ 1,500	
Oversight	1	Lump	10%	$ 13,375	
			Subtotal	$ 148,625	
Water Treatment					
Processed Through Existing System	0	each	$ -	$ -	*Existing System sufficient - No added cost*
			Subtotal	$ -	*O&M costs itemized below*
As-Builts Review (As-Builts Provided By Contractor)					
Report Review	1	lump	$ 5,000	$ 5,000	
			Subtotal	$ 5,000	

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
Reporting					
Construction Completion Report (CCR)	1	lump	$ 10,000	$ 10,000	
			Subtotal	$ 10,000	
Total Capital Cost			**Subtotal**	**$ 216,125**	
O&M					
Mobilization	0	lump	$ 200	$ -	*Included in monthly Site visit*
IT-related O&M	1	lump	$ 500	$ 500	*Flow meters, pumps, cleaning, parameters*
GTS-related O&M (water treatment)	1	lump	$ 300	$ 300	*Nominal additional GTS/Wetland O&M cost*
Reporting - escrow for annual report	1	lump	$ 300	$ 300	*AHA IT operation/performance discussion*
Project Management	1	lump	$ 300	$ 300	
				$ 1,400	*Monthly*
Total Annual O&M Cost			**Subtotal**	**$ 16,800**	*Annually*
Spot Excavate Source Area Soil					
Work Plan					
Design/Work Plan	1	lump	$ 15,000	$ 15,000	
			Subtotal	**$ 15,000**	
Inputs and Calculations					
Total Excavation Area	88,681	sf			
Average Depth	8.0	ft			*Estimated from boring logs*
Area 1	2,112	bcy			*See Figure*
Area 2	16,817	bcy			*See Figure*
Area 3	1,282	bcy			*See Figure*
Area 4	6,065	bcy			*See Figure*
Total Excavation Volume	26,276	bcy			
Construction					
Preconstruction					
Bid Support	1	lump	$ 4,000	$ 4,000	
Locates, Coordination	1	lump	$ 1,000	$ 1,000	
Mobilization, Work Plans, Permits, etc.	1	lump	$ 20,000	$ 20,000	*Contractor - H&S Plans, SOPs, etc.*
			Subtotal	**$ 25,000**	
Excavation					
Soil Excavation/Load	400	bcy	$ 6	$ 2,400	*means 31 23 16.43 + load*
Survey	2.0	acre	$ 450	$ 916	
Dewatering	75	day	$ 500	$ 37,500	
Water Treatment	1	lump	$ 5,000	$ 5,000	*Existing system can treat. Conveyance allow.*
Oversight	1	lump	10%	$ 4,342	
			Subtotal	**$ 50,158**	
Landfarming					
Landfarm Transportation	26,276	bcy	$ 8.00	$ 210,207	*Periodic checks and reporting for 3 years*
Spread soil 6-inches deep	26,276	bcy	$ 0.50	$ 13,138	*Utilize part of STF*
Landfarming	26,276	bcy	$ 3.59	$ 94,330	*Monthly disking, PID screening, sampling*
Oversight	1	lump	10%	$ 27,350	
			Subtotal	**$ 345,025**	
Backfill					
CPEP Pipe 4 inch with filter sock	900	ft	$ 3	$ 2,700	*For dewatering and MPE system*
Conductor Casing	4	each	$ 1,500	$ 6,000	*For dewatering sump installation*
Gravel Fill	6,569	lcy	$ 28.50	$ 187,215	*Well gravel from Wichita. Included Delivery costs*
Soil Backfill	19,707	lcy	$ 5.94	$ 117,059	*Means 31 23 23.14 - 5420 . High clay content*
Compaction	19,707	lcy	$ 1.53	$ 30,152	*Means 31 23 23.24 - 5421. Highly compacted*
Oversight	1	lump	10%	$ 34,313	
			Subtotal	**$ 377,438**	
Restoration					
Seeding	2	acre	$ 1,428	$ 2,856	*MWH Proposal*
Final Survey	2	acre	$ 410	$ 820	
Oversight, As-Built Drawings	1	lump	17%	$ 625	
			Subtotal	**$ 4,301**	
Reporting					
Construction Completion Report (CCR)	1	lump	$ 30,000	$ 30,000	
			Subtotal	**$ 30,000**	
Total Capital Cost			**Subtotal**	**$ 846,922**	

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
O&M					
Mobilization	0	lump	$ -	$ -	
Management	0	lump	$ -	$ -	
				$ -	*Monthly*
Total Annual O&M Cost			**Subtotal**	**$ -**	*Annually*
MPE From Excavation Galleries					
Design					
Draft, Draft Final, Final Design	1	lump	$ 50,000	$ 50,000	
O&M Plan	1	lump	$ 20,000	$ 20,000	
			Subtotal	$ 70,000	
Construction					
Preconstruction					
Mobilization, Work Plans, Permits, etc.	1	lump	$ 50,000	$ 50,000	*Driller and Contractor*
Bid Support	1	lump	$ 10,000	$ 10,000	
Utility Locates	1	lump	$ 3,000	$ 3,000	
			Subtotal	$ 63,000	
MPE System Installation					
Recovery Sumps (10' into fractured rock)	4	each	$ 100,000	$ 400,000	Recovery Sumps (10' into fractured rock)
Conveyance Trenching	3,030	ft	$ 17	$ 51,510	
1" PVC Electrical Conduit and # 8 Wire	1,500	ft	$ 8	$ 12,000	
2" Vacuum Extraction Line	1,500	ft	$ 14	$ 21,000	
2" Water Conveyance Line	3,030	ft	$ 14	$ 42,420	*To MPA Basin groundwater conveyance*
Water Effluent Tie Ins	2	each	$ 5,000	$ 10,000	*via STF conveyance line*
Blower & Aeration Pipe for Wetland Stage 3	1	lump	$ 25,000	$ 25,000	*GTS upgrade to support additional flow*
Survey for As-Builts, Wells, Etc.	1	lump	$ 40,000	$ 40,000	
Oversight	1	Lump	10%	$ 53,693	
			Subtotal	$ 655,623	
Equipment Buildings (2)					
Building	2	each	$ 15,000	$ 30,000	*Insulation, vents, lighting, noise abatement*
Cost for XP Building	2	each	$ 5,000	$ 10,000	*For SVE equipment (control panel outside*
SVE header	2	each	$ 4,000	$ 8,000	*Flower meters, valves, sample taps, etc.*
Rotary Lobe Blower w/ XP Motor 550 SCFM	2	each	$ 8,000	$ 16,000	*includes shipping, installation, etc.*
Moisture Separator	2	each	$ 3,000	$ 6,000	
Silencer	2	each	$ 2,600	$ 5,200	
Control Panel,RemoteTelemetry	2	each	$ 20,000	$ 40,000	
Electrical Power Drop 230V 3 phase	1,800	foot	$ 13	$ 23,400	
Initial Test-Out-Prove-Out	1	each	$ 6,000	$ 6,000	
			Subtotal	$ 144,600	
Water Treatment					
Assumes None Required	0	each	$ -	$ -	*Existing System sufficient - No added cost*
			Subtotal	$ -	*O&M costs itemized below*
Vapor Treatment					
Assumes None Required	0	each	$ -	$ -	*Operate to remain below deminimus conc.*
			Subtotal	$ -	
As-Builts Review (As-Builts Provided By Contractor)					
Report Review	1	lump	$ 15,000	$ 15,000	
			Subtotal	$ 15,000	
Reporting					
Construction Completion Report (CCR)	1	lump	$ 30,000	$ 30,000	
			Subtotal	$ 30,000	
Total Capital Cost			**Subtotal**	**$ 978,223**	
O&M					
Mobilization	0	lump	$ 200	$ -	*Included in monthly Site visit*
Vapor-related O&M	2	lump	$ 2,000	$ 4,000	*Flow meters, blower, cleaning, parameters*
Water-related O&M	4	lump	$ 500	$ 2,000	*Flow meters, pumps, cleaning, parameters*
GTS-related O&M (water treatment)	1	lump	$ 800	$ 800	*Nominal additional GTS/Wetland O&M cost*
Reporting - escrow for annual report	1	lump	$ 500	$ 500	*AHA IT operation/performance discussion*
Project Management	1	lump	$ 300	$ 300	
				$ 7,600	*Monthly*
Total Annual O&M Cost			**Subtotal**	**$ 91,200**	*Annually*

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
STORMWATER POND AREA (SPA)-ONLY COSTS FOR ALTERNATIVES 2 OR 3					
Inspect and Maintain Cap					
Work Plan					
Existing	1	lump	$ -	$ -	*Included in prior design submittal*
Total Capital Cost			**Subtotal**	**$ -**	
O&M - Annual Inspections					
Mobilization	2	hrs	$ 120	$ 240	*Professional Geologist or Engineer*
Inspection: Photos, Notes	4	hrs	$ 120	$ 480	*Professional Geologist or Engineer*
Report Text and Recommendations/Repairs	12	hrs	$ 120	$ 1,440	*Included in Annual O&M and Monitoring Rpt*
Project Management	4	hrs	$ 120	$ 480	
Escrow for CAP repairs	1	lump	$ 2,000	$ 2,000	*Fill rills/erosion, overseed*
			Subtotal	**$ 4,640**	*Annually*
MPE in Seep IT and 2 Additional ITs					
Design					
Draft, Draft Final, Final Design	1	lump	$ 200,000	$ 200,000	*Reviews, comments, revisions*
O&M Plan	1	lump	$ 15,000	$ 15,000	*Additional of MPE to plans*
			Subtotal	$ 215,000	
Construction					
Preconstruction					
Bid Support	1	lump	$ 10,000	$ 10,000	*Contractor selection*
Mobilization, Work Plans, Permits, etc.	1	lump	$ 100,000	$ 100,000	*Driller and Contractor*
Utility Locates	1	lump	$ 2,000	$ 2,000	
			Subtotal	$ 112,000	
Upgrade Existing Seep IT Extraction Sumps					
SVE pipe connections, valve, meter	3	each	$ 8,000	$ 24,000	*Connect SVE lines to well heads*
SVE Conveyance Trenching	1,850	ft	$ 20	$ 37,000	*To blower equipment building on north end*
2" Vacuum Extraction Line	3,765	ft	$ 14	$ 52,710	
Oversight	1	Lump	10%	$ 11,371	
			Subtotal	$ 125,081	
2 New Interceptor Trenches (ITs)					
East Trench - With Gravel, Bottom 6" CPEP	1,400	ft	$ 140	$ 196,000	*Excavator, Bioslurry, High compaction*
West Trench - With Gravel, Bottom 6" CPEP	1,400	ft	$ 140	$ 196,000	*Excavator, Bioslurry, High compaction*
Extraction Sumps with 10' Sump into Rock	6	each	$ 100,000	$ 600,000	*Well, pump, meters, connections, panel, etc.*
Conveyance Trenching	2,900	ft	$ 20	$ 58,000	
1" PVC Electrical Conduit and # 8 Wire	5,121	ft	$ 8	$ 40,968	
2" Vacuum Extraction Line	5,121	ft	$ 14	$ 71,694	
2" Water Conveyance Line	5,000	ft	$ 14	$ 70,000	
Water Effluent Tie Ins	2	each	$ 10,000	$ 20,000	*To existing conveyance lines*
Oversight	1	Lump	10%	$ 125,266	
			Subtotal	$ 1,377,928	
Vacuum Blower Equipment Building					
Building	1	each	$ 20,000	$ 20,000	*with insulation, vents, lighting, noise abate.*
Cost for XP Room - Division of Building	1	each	$ 5,000	$ 5,000	*for SVE blower, flow meters, valves, sample,*
SVE header	1	each	$ 5,000	$ 5,000	*etc. includes shipping, installation, etc.*
Rotary Lobe Blower w/ XP Motor 550 SCFM	1	each	$ 8,000	$ 8,000	*includes shipping, installation, etc.*
Moisture Separator	1	each	$ 3,000	$ 3,000	
Silencer	1	each	$ 2,600	$ 2,600	
Control Panel,RemoteTelemetry	1	each	$ 25,000	$ 25,000	
Electrical Power Drop	1	each	$ 5,000	$ 5,000	
Initial Test-Out-Prove-Out	1	each	$ 10,000	$ 10,000	
			Subtotal	$ 83,600	
Water Treatment					
Existing GTS - Wetlands	1	each	$ -	$ -	*Existing System sufficient - No added cost*
			Subtotal	$ -	*O&M costs itemized below*
Vapor Treatment					
Assumes None Required	0	each	$ -	$ -	*Operate to remain below deminimus conc.*
			Subtotal	$ -	
As-Builts Review (As-Builts Provided By Contractor)					
Survey for As-Builts, Wells, Etc.	1	lump	$ 10,000	$ 10,000	
Construction Completion Report (CCR)	1	lump	$ 15,000	$ 15,000	
			Subtotal	$ 25,000	
Reporting					
Construction Completion Report (CCR)	1	lump	$ 50,000	$ 50,000	
			Subtotal	$ 50,000	
Total Capital Cost			**Subtotal**	**$ 1,988,609**	

REMEDIAL ALTERNATIVES COST SUPPORT
FORMER COASTAL REFINERY, EL DORADO, KS

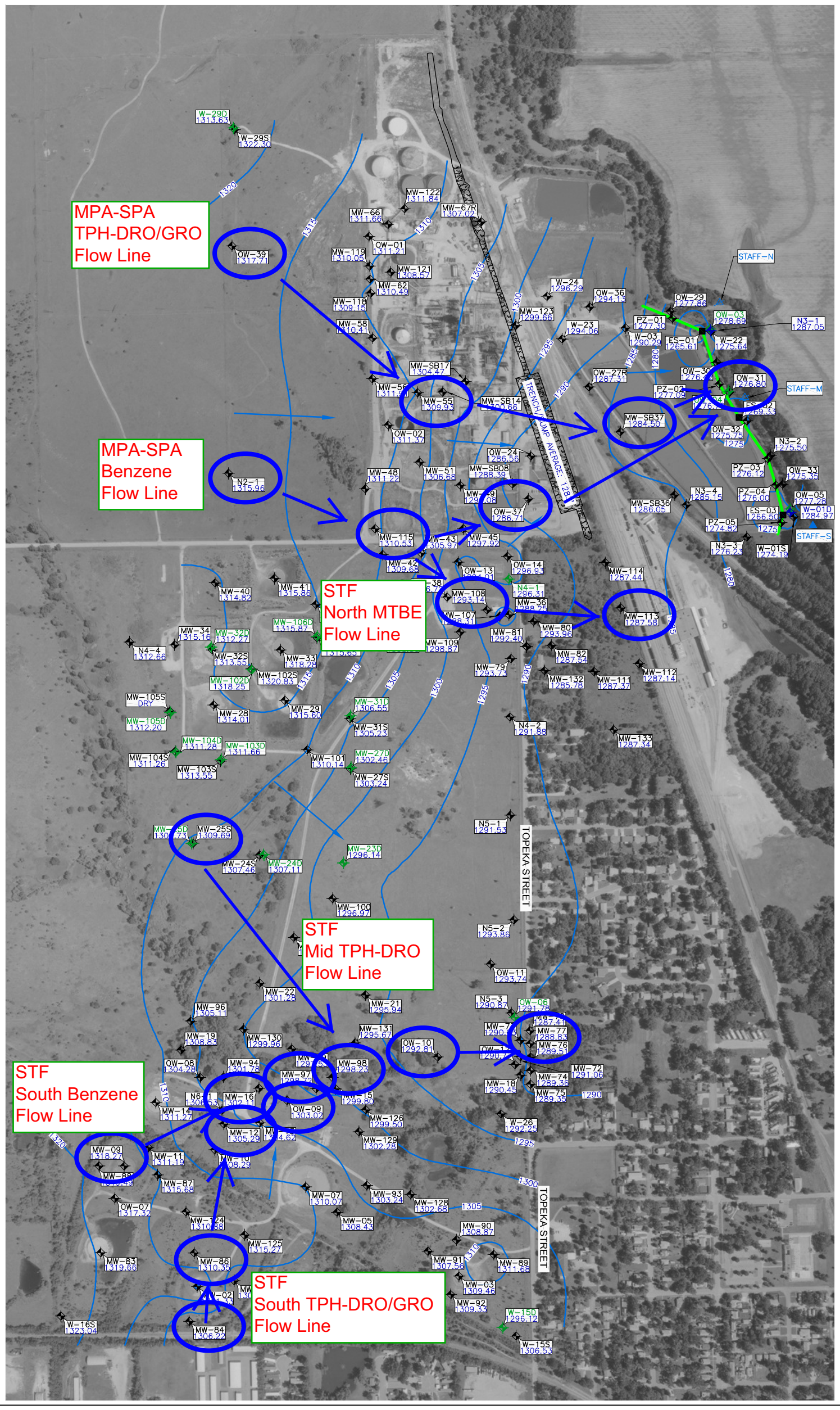
Item/Description	Estimated Quantity	Unit	Unit Cost	Total Cost	Comments
O&M					
Mobilization	0	lump	$ 200	$ -	*Included in monthly Site visit*
Vapor-related O&M	1	lump	$ 2,000	$ 2,000	*Flow meters, blower, cleaning, parameters*
IT-related O&M	6	each	$ 500	$ 3,000	*Flow meters, pumps, cleaning, parameters*
GTS-related O&M (water treatment)	1	lump	$ 300	$ 300	*Nominal additional GTS/Wetland O&M cost*
Reporting - escrow for annual report	1	lump	$ 300	$ 300	*SPA IT operation/performance discussion*
Project Management	1	lump	$ 200	$ 200	
				$ 5,800	*Monthly*
Total Annual O&M Cost			**Subtotal**	**$ 69,600**	*Annually*

APPENDIX D1

MNA WELL SELECTION FIGURES

MWH

Print Date: January 30, 2014



LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)	W-01D	FLORENCE LIMESTONE MONITORING WELL (NOT USED FOR CONTOURING)		POTENTIOMETRIC SURFACE CONTOUR (5 FOOT CONTOUR INTERVAL)
OW-06	FORT RILEY LIMESTONE MONITORING WELL (NOT USED FOR CONTOURING)	STAFF-S	SURFACE WATER GAUGE LOCATION		INFERRED POTENTIOMETRIC SURFACE CONTOUR
W-39	PESTER MONITORING WELL – WATER LEVEL ALSO GAUGED BY PESTER	STAFF-N	DESTROYED STAFF GAUGE LOCATION		GROUNDWATER FLOW DIRECTION
				NM	NOT MEASURED

SCALE

0 300' 600'

SCALE IN FEET

TITLE

POTENTIOMETRIC SURFACE MAP
OCTOBER 2, 2013

FIGURE

DESIGNED BY	M. WARNER	01/14
DRAWN BY	M. WARNER	01/14
CHECKED BY	C. PHILIPS	01/14
APPROVED BY	J. GARNSEY	01/14
PROJECT MANAGER	J. GARNSEY	01/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: EL DORADO REFINERY, EL DORADO, KS

PROJECT: EL PASO MERCHANT ENERGY - PETROLEUM CO

TITLE: POTENTIOMETRIC SURFACE MAP
OCTOBER 2, 2013

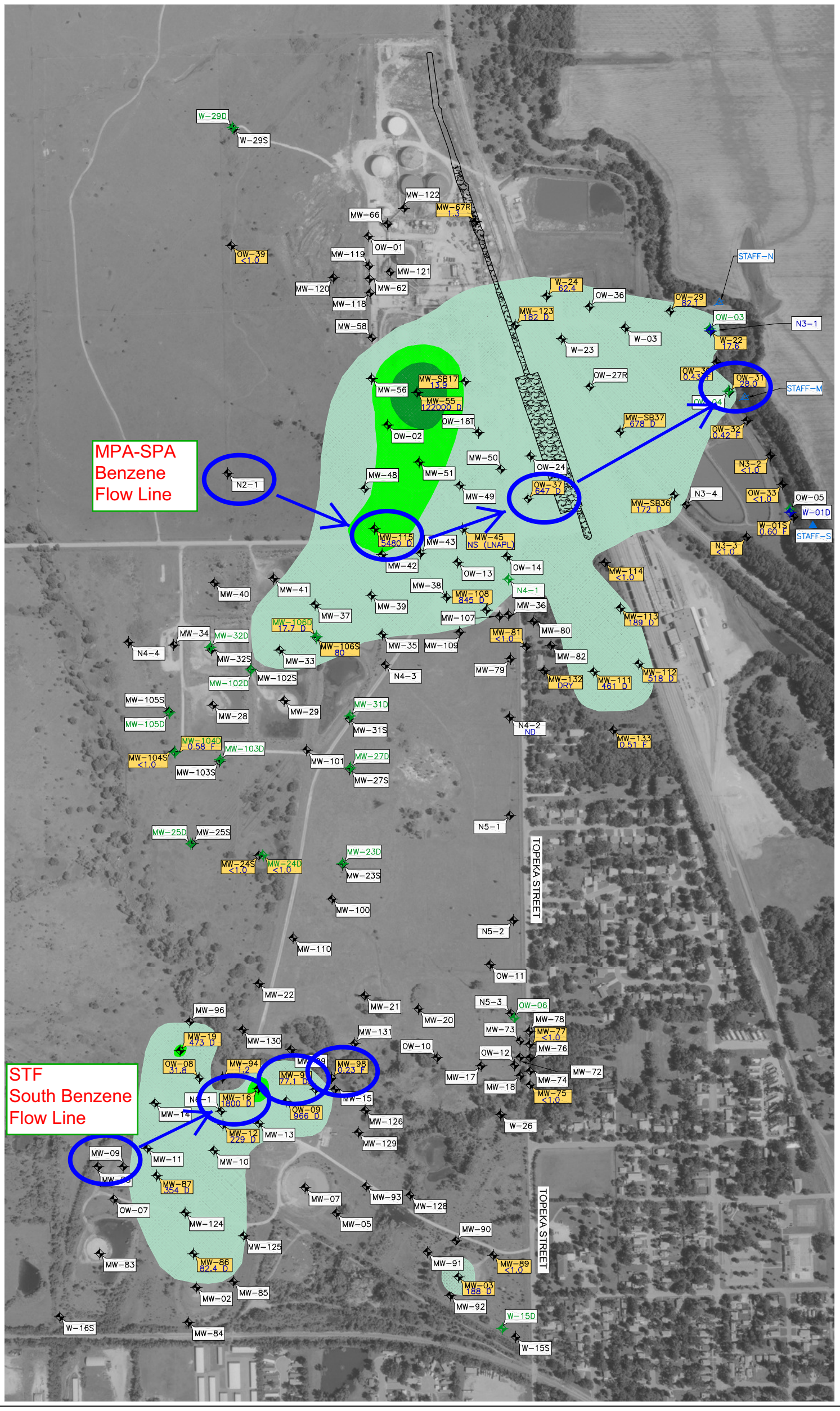
MWH

FIGURE: D1-A

REVISION: 1

FILE NAME: El Dorado PSM.dwg

Print Date: January 31, 2014



LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
OW-06	FORT RILEY LIMESTONE MONITORING WELL
W-01D	FLORENCE LIMESTONE MONITORING WELL
STAFF-S	SURFACE WATER GAUGE LOCATION
MW-98	WELL IN MONITORING PROGRAM

	BENZENE <5 ug/L
	BENZENE 5 – 1,000 ug/L
	BENZENE >1,000 – 10,000 ug/L
	BENZENE >10,000 ug/L

NOTES

1.6	BENZENE CONCENTRATION IN ug/L
<1.0	NOT DETECTED
NS	NOT SAMPLED
D	SAMPLE DILUTION REQUIRED FOR ANALYSIS. REPORTED VALUES REFLECT THE DILUTION.
F	ANALYTE WAS POSITIVELY IDENTIFIED BUT THE REPORTED CONCENTRATION IS ESTIMATED; REPORTED CONCENTRATION IS LESS THAN THE REPORTING LIMIT, BUT GREATER THAN THE METHOD DETECTION LIMIT.
J	DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.

KDHE RBSL FOR BENZENE: 5 ug/L

SCALE

0 300' 600'

SCALE IN FEET

TITLE

BENZENE IN GROUNDWATER
OCTOBER 23 - OCTOBER 31, 2012

FIGURE

DESIGNED BY	W. PICKENS	01/14
DRAWN BY	M. WARNER	01/14
CHECKED BY	C. PHILIPS	01/14
APPROVED BY	D. MICK	01/14
PROJECT MANAGER	D. MICK	01/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: EL DORADO REFINERY, EL DORADO, KS

PROJECT: EL PASO MERCHANT ENERGY - PETROLEUM CO

TITLE: BENZENE IN GROUNDWATER
OCTOBER 3 - OCTOBER 10, 2013

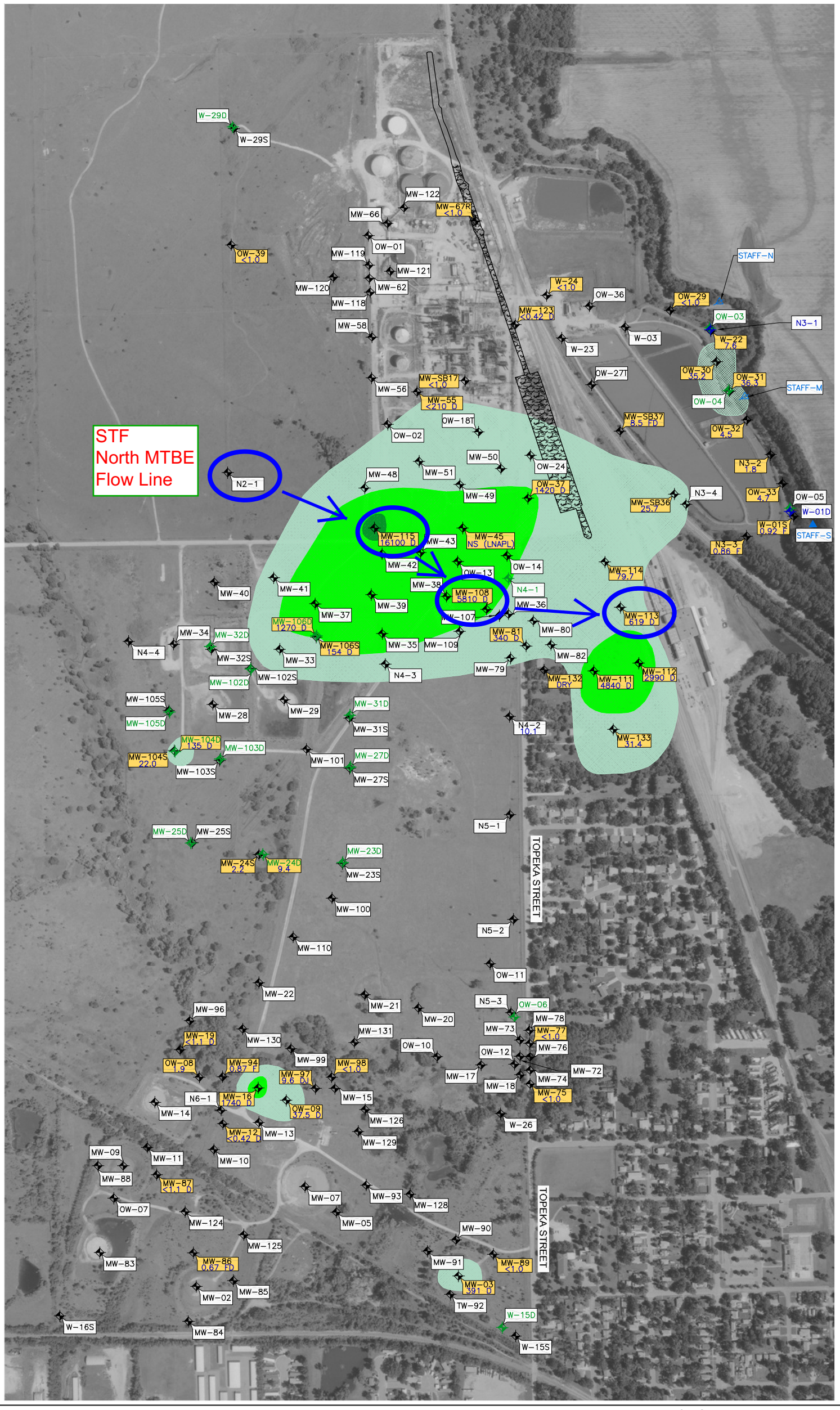
MWH

FIGURE: D1-B

REVISION: 1

FILE NAME: EDR Fig 4-1 Benzene Conc Map.dwg

Print Date: January 31, 2014



LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
OW-06	FORT RILEY LIMESTONE MONITORING WELL
W-01D	FLORENCE LIMESTONE MONITORING WELL
STAFF-S	SURFACE WATER GAUGE LOCATION
MW-98	WELL IN MONITORING PROGRAM

	MTBE <20 ug/L
	MTBE 20 – 1,000 ug/L
	MTBE >1,000 – 10,000 ug/L
	MTBE >10,000 ug/L

NOTES

1.8	MTBE CONCENTRATION IN ug/L
<1.0	NOT DETECTED
NS	NOT SAMPLED
D	SAMPLE DILUTION REQUIRED FOR ANALYSIS. REPORTED VALUES REFLECT THE DILUTION.
F	ANALYTE WAS POSITIVELY IDENTIFIED BUT THE REPORTED CONCENTRATION IS ESTIMATE; REPORTED CONCENTRATION IS LESS THAN THE REPORTING LIMIT, BUT GREATER THAN THE METHOD DETECTION LIMIT.
J	DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.

KDHE RBSL FOR MTBE: 133 ug/L

SCALE

0 300' 600'

SCALE IN FEET

TITLE

MTBE IN GROUNDWATER
OCTOBER 3 - OCTOBER 10, 2013

FIGURE

DESIGNED BY	W. PICKENS	01/14
DRAWN BY	M. WARNER	01/14
CHECKED BY	C. PHILIPS	01/14
APPROVED BY	D. MICK	01/14
PROJECT MANAGER	D. MICK	01/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: EL DORADO REFINERY, EL DORADO, KS

PROJECT: EL PASO MERCHANT ENERGY - PETROLEUM CO

TITLE: MTBE IN GROUNDWATER
OCTOBER 3 - OCTOBER 10, 2013

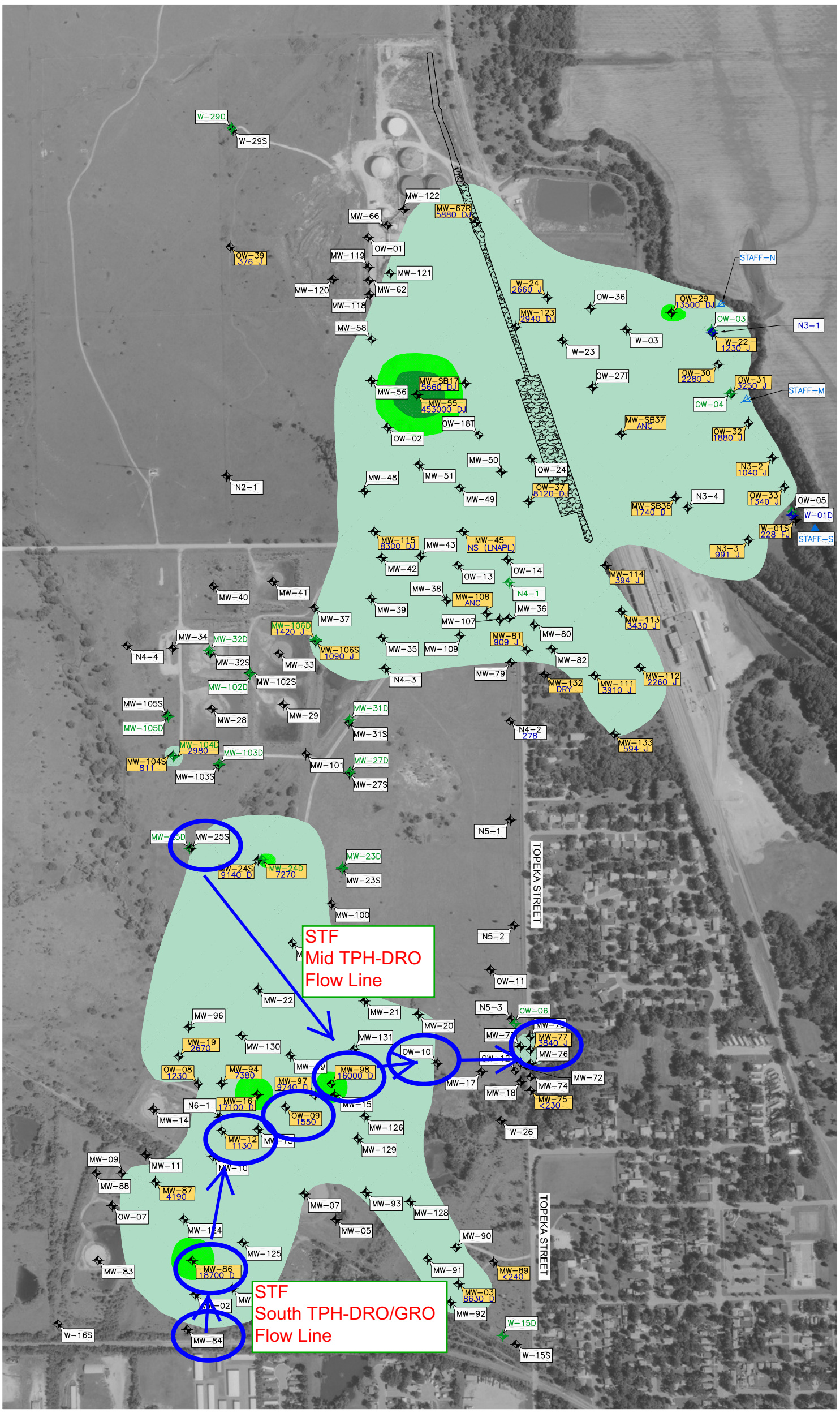
MWH

FIGURE: D1-C

REVISION: 1

FILE NAME: EDR Fig 4-2 MTBE Conc Map.dwg

Print Date: February 3, 2013



LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
OW-06	FORT RILEY LIMESTONE MONITORING WELL
W-01D	FLORENCE LIMESTONE MONITORING WELL
STAFF-S	SURFACE WATER GAUGE LOCATION
MW-98	WELL IN MONITORING PROGRAM

	TPH-DRO <500 ug/L
	TPH-DRO 500 – 10,000 ug/L
	TPH-DRO >10,000 – 100,000 ug/L
	TPH-DRO >100,000 ug/L

NOTES

123	TPH-DRO CONCENTRATION IN ug/L
<240	NOT DETECTED
NS	NOT SAMPLED
ANC	ANALYTE NOT COLLECTED DUE TO LOW SAMPLE VOLUME
D	SAMPLE DILUTION REQUIRED FOR ANALYSIS. REPORTED VALUES REFLECT THE DILUTION.
F	ANALYTE WAS POSITIVELY IDENTIFIED BUT THE REPORTED CONCENTRATION IS ESTIMATE.
J	DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.

KDHE RBSL FOR TPH-DRO: 500 ug/L

SCALE

0 300' 600'

SCALE IN FEET

TITLE

TPH-DRO IN GROUNDWATER
OCTOBER 3 - OCTOBER 10, 2013

FIGURE

DESIGNED BY	W. PICKENS	02/14
DRAWN BY	M. WARNER	02/14
CHECKED BY	C. PHILIPS	02/14
APPROVED BY	D. MICK	02/14
PROJECT MANAGER	D. MICK	02/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: EL DORADO REFINERY, EL DORADO, KS

PROJECT: EL PASO MERCHANT ENERGY - PETROLEUM CO

TITLE: TPH-DRO IN GROUNDWATER OCTOBER 3 - OCTOBER 10, 2013

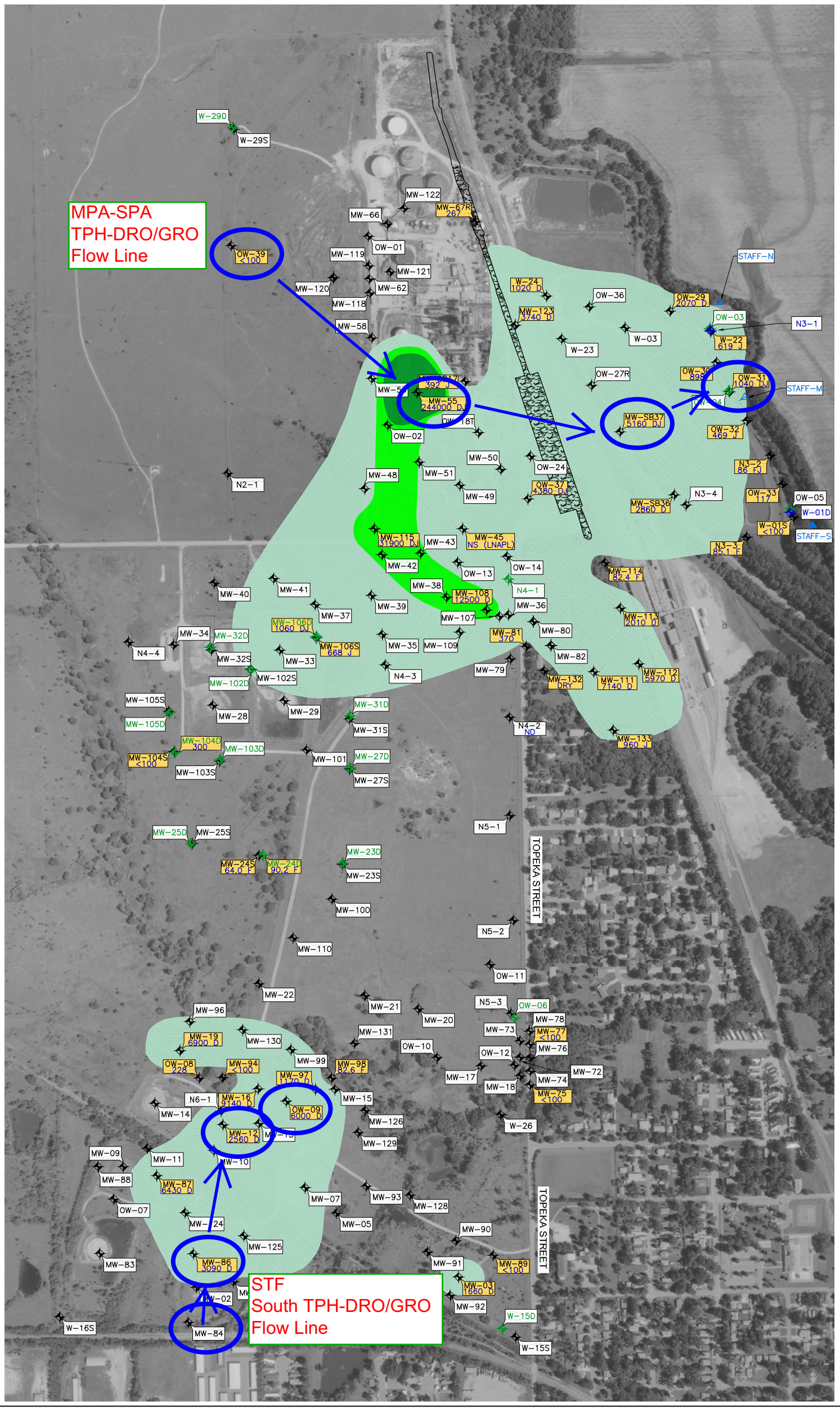
MWH

FIGURE: D1-D

REVISION: 1

FILE NAME: EDR Fig 4-3 TPH-DRO Conc Map.dwg

Print Date: February 3, 2013



TITLE

TPH-GRO IN GROUNDWATER
OCTOBER 3 - OCTOBER 10, 2013

FIGURE

LEGEND

OW-10	SHALLOW MONITORING WELL (ALLUVIUM AND WEATHERED BEDROCK)
OW-06	FORT RILEY LIMESTONE MONITORING WELL
W-01D	FLORENCE LIMESTONE MONITORING WELL
STAFF-S	SURFACE WATER GAUGE LOCATION
MW-98	WELL IN MONITORING PROGRAM

	TPH-GRO <500 ug/L
	TPH-GRO 500 – 10,000 ug/L
	TPH-GRO >10,000 – 100,000 ug/L
	TPH-GRO >100,000 ug/L

NOTES

133	TPH-GRO CONCENTRATION IN ug/L
<100	NOT DETECTED
NS	NOT SAMPLED
ANC	ANALYTE NOT COLLECTED DUE TO LOW SAMPLE VOLUME
D	SAMPLE DILUTION REQUIRED FOR ANALYSIS. REPORTED VALUES REFLECT THE DILUTION.
F	ANALYTE WAS POSITIVELY IDENTIFIED BUT THE REPORTED CONCENTRATION IS ESTIMATED.
J	DATA ARE ESTIMATED DUE TO ASSOCIATED QUALITY CONTROL DATA.

KDHE RBSL FOR TPH-GRO: 500 ug/L

SCALE

0 300' 600'

SCALE IN FEET

DESIGNED BY	W. PICKENS	02/14
DRAWN BY	M. WARNER	02/14
CHECKED BY	C. PHILIPS	02/14
APPROVED BY	D. MICK	02/14
PROJECT MANAGER	D. MICK	02/14
CLIENT APPROVAL	B. KELLMANN	
CLIENT REFERENCE NO		

KINDER MORGAN

PROJECT LOCATION: EL DORADO REFINERY, EL DORADO, KS

PROJECT: EL PASO MERCHANT ENERGY - PETROLEUM CO

TITLE: TPH-GRO IN GROUNDWATER
OCTOBER 3 - OCTOBER 10, 2013

MWH

FIGURE: D1-E

REVISION: 1

FILE NAME: EDR Fig 4-4 TPH-GRO Conc Map.dwg

APPENDIX D2

MPA SOIL EXCAVATION SUPPORT

MWH

Cut/Fill Report

Generated: 2014-04-10 13:11:57
By user: langdaj
Drawing: D:\pwworkdir - jason\dms14958\D:\pwworkdir - jason\dms14958\10503354 ASBUILT TOPO.dwg

Volume Summary

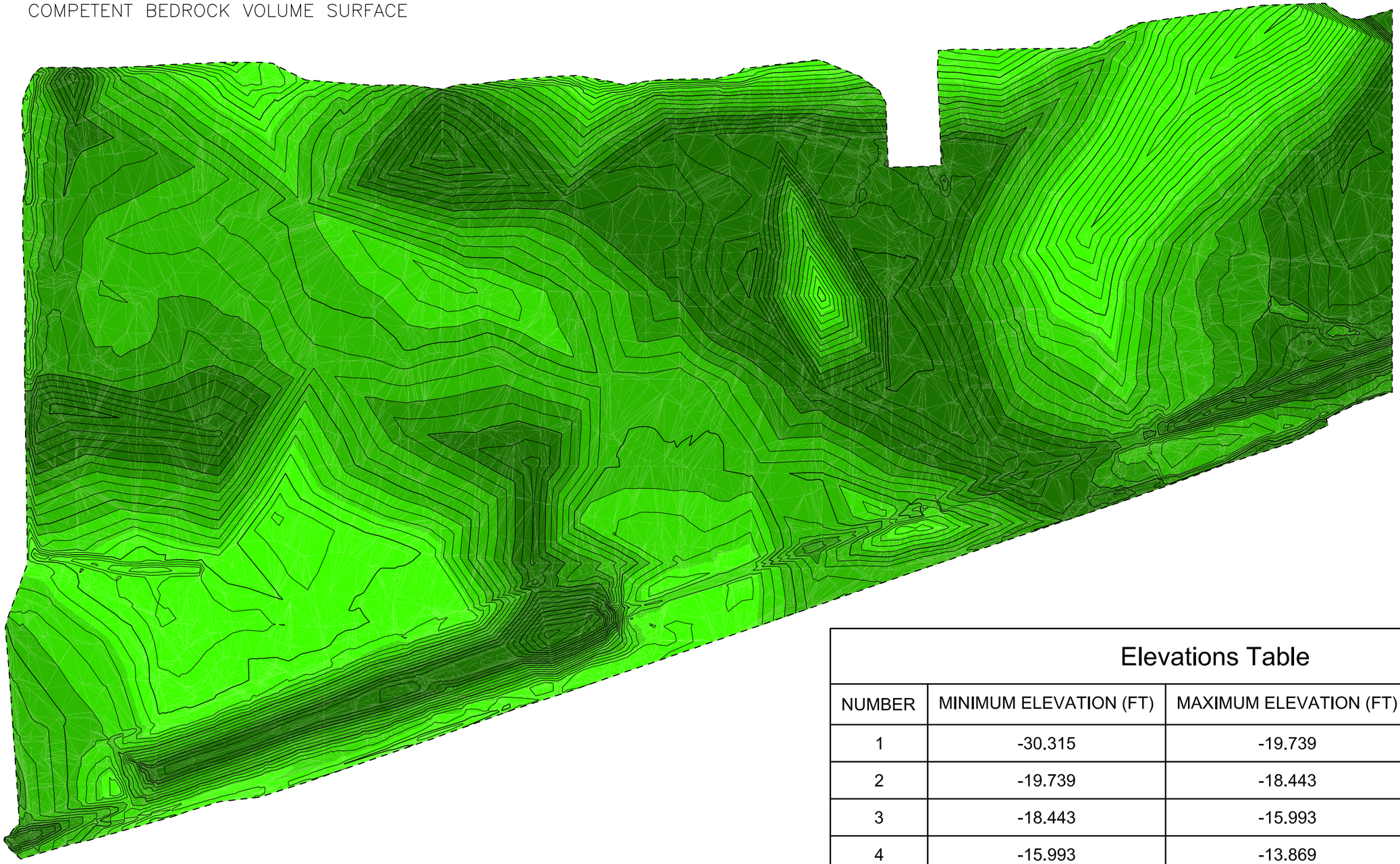
Name	Type	Cut Factor	Fill Factor	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
VOL - COMPETENT TO FINAL	full	1.000	1.000	1706794.58	0.00	856673.98	856673.98<Fill>
VOL - WEATHERED TO FINAL	full	1.000	1.000	1706794.58	2.47	568424.68	568422.21<Fill>

Totals

	2d Area (Sq. Ft.)	Cut (Cu. Yd.)	Fill (Cu. Yd.)	Net (Cu. Yd.)
Total	3413589.16	2.47	1425098.65	1425096.18<Fill>

* Value adjusted by cut or fill factor other than 1.0

COMPETENT BEDROCK VOLUME SURFACE

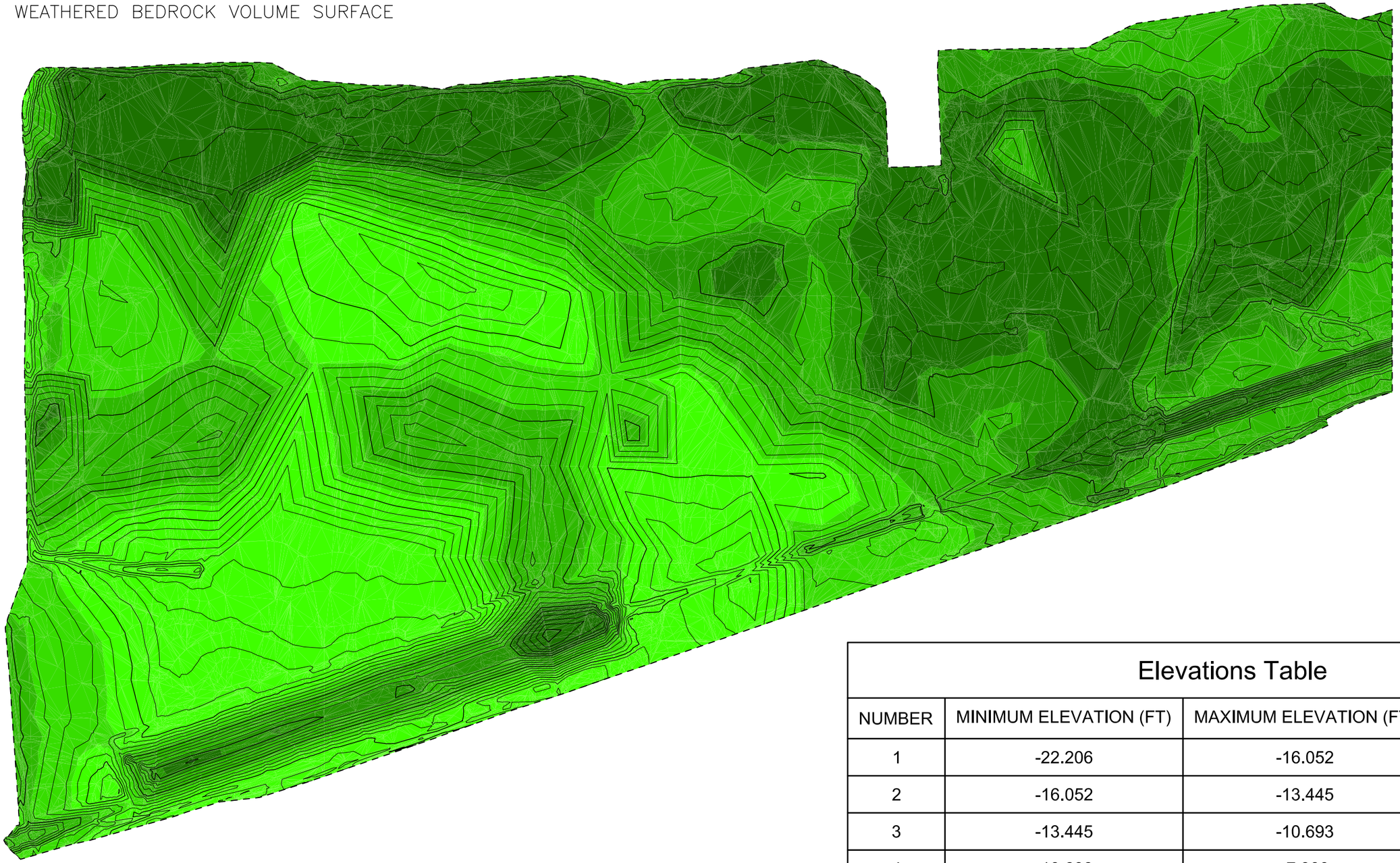


Name	Cut Factor	Fill Factor	2d Area	Cut
VOL – COMPETENT TO FINAL	1.000	1.000	1706794.58 Sq. Ft.	856673.76 Cu. Yd.

Elevations Table

NUMBER	MINIMUM ELEVATION (FT)	MAXIMUM ELEVATION (FT)	COLOR	AREA (FT)
1	-30.315	-19.739		190648.7
2	-19.739	-18.443		104548.5
3	-18.443	-15.993		215878.8
4	-15.993	-13.869		273663.5
5	-13.869	-12.018		254092.9
6	-12.018	-9.942		248509.6
7	-9.942	-7.490		225449.5
8	-7.490	-0.544		194003.1

WEATHERED BEDROCK VOLUME SURFACE



Elevations Table

NUMBER	MINIMUM ELEVATION (FT)	MAXIMUM ELEVATION (FT)	COLOR	AREA (FT)
1	-22.206	-16.052		187751.6
2	-16.052	-13.445		204257.2
3	-13.445	-10.693		253187.4
4	-10.693	-7.900		210283.3
5	-7.900	-5.871		202193.5
6	-5.871	-4.745		208852.2
7	-4.745	-3.587		223917.1
8	-3.587	0.722		216352.2

Cut/Fill Summary

Name	Cut Factor	Fill Factor	2d Area	Cut
VOL – WEATHERED TO FINAL	1.000	1.000	1706794.58 Sq. Ft.	568424.45 Cu. Yd.