Final

Analysis of Brownfields Clean-up Alternatives (ABCA) and Work Plan for the Former Mahaffey Oil in Parma, Idaho

Prepared for:

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On behalf of Canyon County

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Acronyms and Abbreviations

ABCA	Analysis of Brownfields Clean-up Alternatives
AST	aboveground storage tank
ASTM	American Society for Testing and Materials
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BMP	Best Management Practice
BTEX	benzene, toluene, ethyl benzene, and total xylenes
CFR	Code of Federal Regulations
COC	contaminant of concern
ESA	Environmental Site Assessment
ESC	ESC Lab Sciences
HAZWOPER	Hazardous Waste Operations and Emergency Response
ICP	Institutional Controls Plan
IDAPA	Idaho Administrative Procedures Act
IDEQ	Idaho Department of Environmental Quality
IDWR	Idaho Department of Water Resources
ISCO	In-situ chemical oxidation
MNA	monitored natural attenuation
MTBE	methyl tert-butyl ether
NPDES	National Pollutant Discharge Elimination System
NTP	Notice to Proceed
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Act
PAH	Polycyclic Aromatic Hydrocarbon
PCS	petroleum contaminated soil
PID	photo-ionization detector
QAPP	Quality Assurance Project Plan
RCRA	Resource Conservation and Recovery Act
RUSL	Residential Use Screening Level
REM	Risk Evaluation Manual
SVE	soil vapor extraction

TCLP	Toxicity Characteristic Leaching Program
TerraGraphics	TerraGraphics Environmental Engineering, Inc.
UECA	Idaho's Uniform Environmental Covenants Act
USEPA	U.S. Environmental Protection Agency
VCP	Voluntary Cleanup Program
VOC	volatile organic compound
VRA	Voluntary Remediation Agreement

Section 1.0 Introduction

Canyon County entered into the Voluntary Cleanup Program (VCP) with the Idaho Department of Environmental Quality (IDEQ). The VCP is designed to encourage innovation and cooperation between the state, local communities, and private parties to revitalize properties with hazardous substances or petroleum contamination. Canyon County contracted TerraGraphics Environmental Engineering, Inc. (TerraGraphics) to develop this Analysis of Brownfields Clean-up Alternatives (ABCA) and Voluntary Remediation Work Plan (Work Plan) for the Former Mahaffey Oil located at 102 South Roswell Boulevard in Parma, Idaho, hereinafter, referred to as "the site" or "the subject property." This ABCA is required by IDEQ to meet the requirements for participation in Idaho's Revolving Loan Fund (RLF). In accordance with Idaho Administrative Procedures Act (IDAPA) Idaho Land Remediation Rules (IDAPA 58.01.18), this Work Plan, submitted for IDEQ approval, has identified the remediation standards to ensure that substantial present or probable future risk to human health or the environment is eliminated or reduced to protective levels based upon present and reasonably anticipated future uses of the site (IDAPA 58.01.18(02)b).

This ABCA describes the evaluation methods used to determine the preferred remedial option to address contamination issues associated with the site. The remedial alternatives are evaluated on the basis of protection of human health and the environment, ease of implementation, cost of remediation, sustainability, ability to meet proposed land use, and compliance with applicable standards. This ABCA and Work Plan will be open for a 30-day public comment period where the community can review the proposed cleanup alternatives and provide feedback. Comments will be addressed prior to this the finalization of this ABCA.

1.1 Purpose

The purpose of this ABCA/Work Plan is to briefly summarize "information about the site and contamination issues, cleanup standards, applicable laws, cleanup alternatives considered, and the proposed cleanup" (USEPA 2012). It also provides a detailed description of the tasks involved in implementation of the preferred cleanup alternative.

1.2 Report Structure

Section 1 Introduction provides an overview and brief description of the purpose and scope of the ABCA.

Section 2 Background includes a brief site history and a summary of prior environmental investigations at the site.

Section 3 Development of Clean-up Goals and Objectives includes a discussion of the current and future land use, contaminants of concern (COCs), and identified clean-up objectives and goals for the site.

Section 4 Identification of Clean-up Alternatives identifies and describes proposed clean-up alternatives.

Section 5 Detailed Analysis of Clean-up Alternatives describes the criteria used to evaluate the proposed clean-up alternatives presented in Section 4.

Section 6 Comparative Analysis of Clean-up Alternatives compares the analysis of the four proposed alternatives against the evaluation criteria and ranks them based on scores of "1" (low success) to "3" (high success), producing a preferred alternative with the best ranking score.

Section 7 Preferred Alternative Work Plan provides the design details necessary to implement the preferred alternative.

Section 8 References and Resources Used provides references for reports cited and used for resource information in this document.

Section 2.0 Background

2.1 Site Location and Description

The site address is 102 South Roswell Boulevard in Parma, Canyon County, Idaho. The site is spatially located at approximately latitude 43.785600 North and longitude 116.948800 West on parcel R3882300000 at an elevation of approximately 2,222 feet above sea level.

The property can be accessed from South Roswell Boulevard, which runs northeast-southwest, and South Street, an alley south of the subject property. A railroad line borders the property to the north. The site area is approximately 0.888 acres and all structural remnants have been removed. Much of the property is covered in gravel or asphalt. Figure 1 shows the site location and layout.

2.2 Site Use History

The site was first used in the 1930s as an oil company depot. Since the 1970s or early 1980s, the site was used as a petroleum bulk plant. The County obtained a tax deed for the property on June 29, 2009, because of unpaid taxes.

2.3 Site Development Plan

Canyon County wishes to clean up the property to sell for future site development.

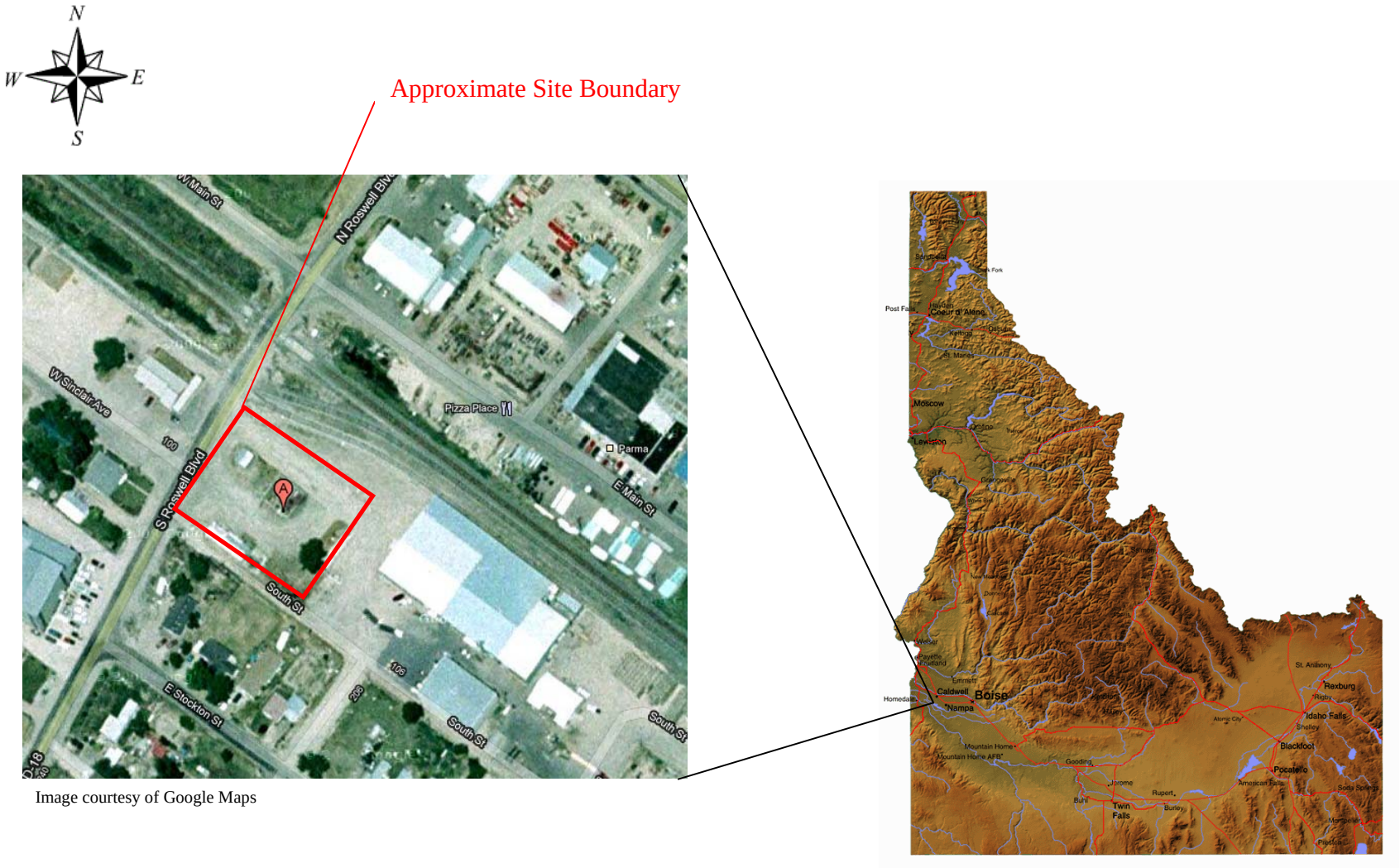


Image courtesy of Google Maps

Project No. 12057	TerraGraphics Environmental Engineering, Inc.	**Former Mahaffey Oil** **102 S Roswell Blvd. Parma, Idaho**	Date: 12/03/12
Scale: no scale			
Requestor: M. Procsal		**Figure 1. Site Location**	
Drafter: M. Procsal			

2.4 Summary of Previous Assessments

2.4.1 Site Petroleum Release Assessments – 2002-2004

In 2002, utility workers discovered petroleum contamination while excavating a utility trench along Roswell Boulevard. A confirmed petroleum release was issued by IDEQ on September 3, 2002. Environmental samples collected at the site in 2003 and 2004 indicated the presence of petroleum impacted soil and groundwater. Soil samples collected on November 17, 2003, indicated elevated levels of benzene, toluene, ethylbenzene, and total xylenes (BTEX), and naphthalene. Methyl tert-butyl ether (MTBE) was analyzed but was not detected above the laboratory detection limit. Three groundwater samples collected on January 23, 2004 from three groundwater monitoring wells southwest of the site dispenser island indicated elevated levels of BTEX. Naphthalene and MTBE were analyzed but were not detected above their respective laboratory detection limits. The source and cause of the release were unknown but likely occurred from the product lines that connected the ASTs to the dispenser island.

2.4.2 Phase I Environmental Site Assessment – 2011

TerraGraphics completed the *Phase I Environmental Site Assessment Report: Mahaffey Oil, 102 S. Roswell Road Parma, Idaho 83660* in April 2011 (TerraGraphics 2011a). TerraGraphics made the following recommendations:

- Soil and groundwater sampling near the former dispenser island and around the former AST tank hold to delineate the vertical and lateral extent of petroleum impacted areas. Gasoline, leaded gasoline, and diesel constituents are the likely chemicals of concern.
- Soil and groundwater sampling near the former storage building. Oil range constituents are the potential chemicals of concern.
- Sampling to evaluate potential off-site migration.
- Lead paint survey including soil sampling and analysis in and around the former storage building.
- Asbestos-containing material inspection during lead paint soil sampling.
- Characterize the fluids/sludge in the sump vault for removal and disposal.
- Abandon the sump and determine if the sump was/is connected to the sewer or drain field through utility locate service. If the sump was discharging to a drain field then additional assessment will be required in this area.
- Remove treated lumber.

2.4.3 Initial Phase II Environmental Site Assessment – 2011

TerraGraphics completed a Phase II Environmental Site Assessment (ESA) on July 26, 2011. This investigation, conducted in accordance with the *Quality Assurance Project Plan for Phase II Environmental Site Assessment at the Former Mahaffey Oil, Parma, Idaho* (TerraGraphics 2011b), confirmed that petroleum impacted soil and groundwater are present at the site. The results are documented in the *Final Phase II Environmental Site Assessment Report, Former Mahaffey Oil Parma, Idaho* (TerraGraphics 2011c). The contamination is generally located near

the former AST hold and around and just south of the former dispenser island area. Based on the findings of this assessment, IDEQ requested additional Phase II ESA investigation sampling to further define the zone of greatest impact and to delineate the extent of petroleum impacted soil and groundwater downgradient. The additional sampling, outlined below, was conducted in accordance with the *Quality Assurance Project Plan (QAPP) for Additional Phase II Environmental Site Assessment at the Former Mahaffey Oil site in Parma, Idaho* (TerraGraphics 2012).

2.4.4 Additional Phase II Environmental Site Assessment – 2012

Site assessment activities were completed on August 8, 2012 and on September 28, 2012, in accordance with the *Quality Assurance Project Plan (QAPP) for Additional Phase II Environmental Site Assessment at the Former Mahaffey Oil site in Parma, Idaho* (TerraGraphics 2012). The soil borings completed on August 8 revealed additional petroleum impacts near the AST hold that had not been identified in the 2011 assessment, therefore additional follow up assessment activities were completed in September.

2.4.4.1 Field Activities

2.4.4.1.1 Direct Push Soil Sampling for PID Screening and Volume Calculation

On August 8, 2012, a total of 25 borings were advanced to determine the lateral extent of soil contamination through photo-ionization detector (PID) screening (BH-14 through BH-38). Although the vertical extent of petroleum impacted soil may have extended deeper than 5 feet, the purpose for PID screening during this was to calculate a proposed excavation volume to a depth of 6 feet below ground surface (bgs) since the presence of a shallow groundwater system would limit excavation efforts beyond this extent. Soil was screened with a PID and the highest reading was recorded. Boring BH-39 encountered a water line; therefore, PID screening results are not available for this location. Soil borings were advanced throughout the property on an approximate 20 foot grid to in order to calculate soil volumes for potential excavation. Borings were advanced in succession in all directions until PID readings were found to be zero. An isocontour map showing the 100 parts per million (ppm) contour is shown in Figure 2.

2.4.4.1.2 Direct Push Soil Sampling

On September 28, 2012, a total of 8 borings (BH-40 through BH-47) were advanced using an AMS PowerProbe ™ 9600 equipped with a Stanley MB-156 hammer, a single tube Geoprobe® 2-inch diameter 5-foot length macro-core barrel driven in 5-foot increments (e.g., 0-5 feet, 5-10 feet, 10-15 feet, etc.) to the target depth of the borehole. A new Geoprobe® macro-core liner was used to collect each sample interval. All soil samples were screened in the field using a portable MiniRae® (PID) to check for the presence of volatile organic compounds (VOCs). Soil samples were collected based on the highest PID reading and sent to ESC Lab Sciences in Mt. Juliet, Tennessee (ESC) for VOCs, and polycyclic aromatic hydrocarbon (PAH). Samples were analyzed using: US Environmental Protection Agency (USEPA) Method 8260B for VOCs, USEPA Method 8270C and for PAHs. Metals were analyzed for investigation derived waste disposal purposes and to aid in the development of potential remediation alternatives including excavation and landfarm processing.

In general, the lithology at the site consists of clays and silts from 0 feet to 4 feet bgs and sands and gravels from 4 feet to 10 feet bgs.

Soil analytical results were compared to the Residential Use Screening Levels (RUSLs) defined by Idaho Administrative Procedures Act (IDAPA) 58.01.24 *Standards and Procedures for Application of Risk Based Action at Petroleum Release Sites*.

2.4.4.1.3 Groundwater Sampling

On September 28, 2012, TerraGraphics installed ¾-inch prepack wells at four boring locations (DPW-7, DPW-8, DPW-9, DPW-10). Subsurface groundwater samples were collected as per American Society for Testing and Materials (ASTM) D 6724-04, *Standard Guide for Direct Push Groundwater Monitoring Wells* (ASTM 2004). Groundwater samples were collected using a low-flow peristaltic pump. New peristaltic tubing was used to collect water from each groundwater monitoring well. Prior to sample collection, wells were developed using low flow over-purge methods until groundwater quality parameters stabilized (pH, conductivity, temperature, dissolved oxygen, and oxidation/reduction potential). Groundwater samples were collected from each temporary groundwater monitoring well and analyzed using: USEPA Method 8260B for VOCs, USEPA Method 8270C for PAHs, USEPA Method 8011 for ethylene dibromide, and USEPA Method 6010 for total recoverable lead.

2.4.4.2 Results

2.4.4.2.1 Direct Push Soil Analysis

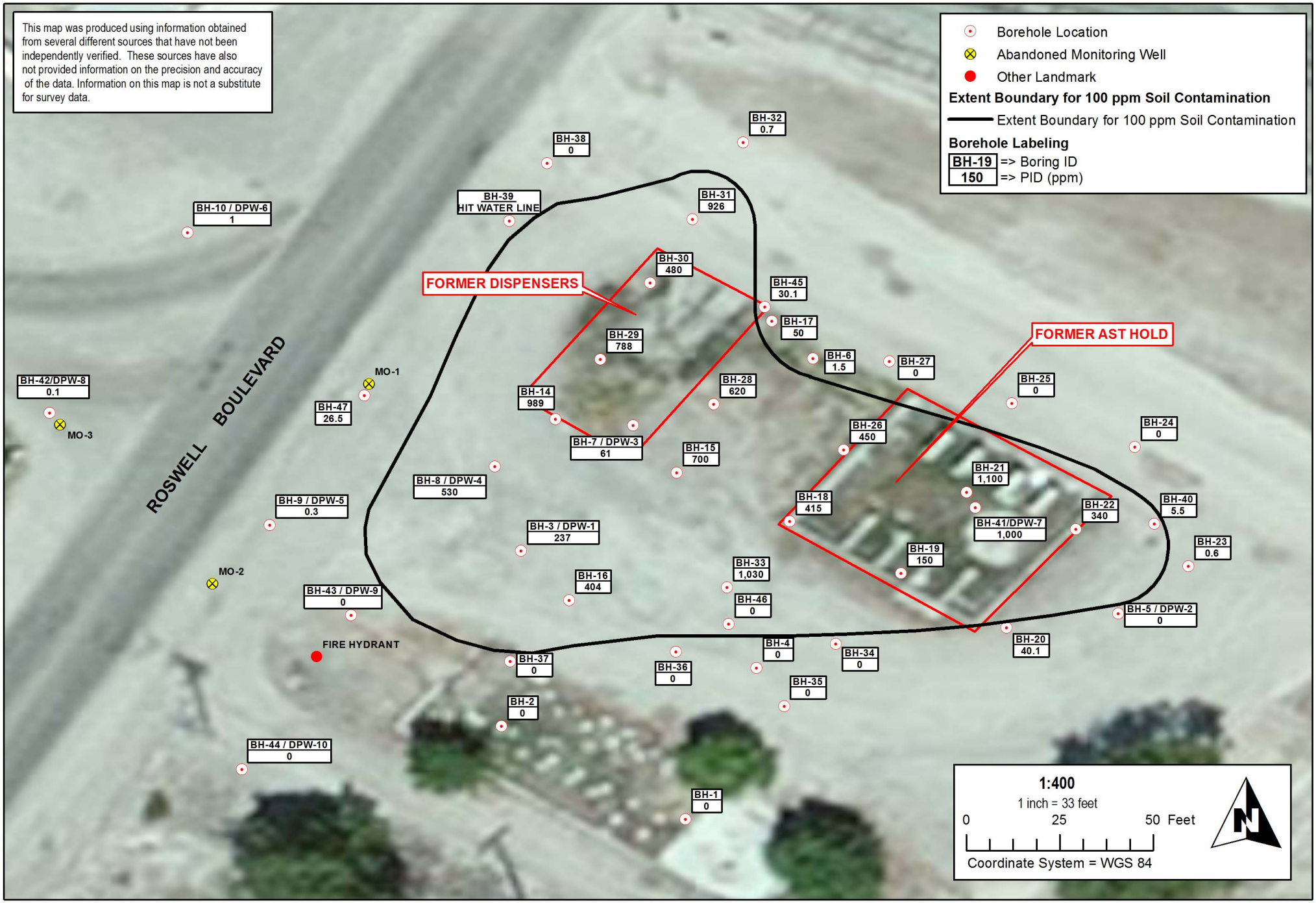
Table 1 summarizes the soil quality results from the 2011 and 2012 site assessment activities. The results show that 7 of 13 samples exceed one or more of the residential use screening levels defined by Table 2 in IDAPA 58.01.24.

2.4.4.2.2 Groundwater Analysis

Table 2 summarizes the groundwater quality results from the 2011 and 2012 site assessment activities. The results show that 5 of 10 groundwater samples exceed one or more of the RUSLs defined by Table 2 in IDAPA 58.01.24. However, impacts to groundwater do not appear to have reached downgradient locations to the extent of DPW-6, DPW-8, DPW-9, or DPW-10.

2.4.4.2.3 Contaminated Soil Volume Calculation

The approximate extent of the site contamination plume was determined by PID readings over 100 ppm. Although concentrations below 100 ppm likely still exceed the soil screening levels this value has been chosen as a baseline to guide potential cleanup efforts since there is a sharp lateral transition between impacted and non-impacted soils. In general, site contamination is highest near the center of the former AST hold and near the dispenser islands. The plume appears to cover most of the property frontage along Roswell Boulevard and extends east up to, and including, the former AST hold. Based on this approximate boundary and to a depth of 6 feet bgs, the amount of impacted soil is approximately 2,700 cubic yards. Investigation derived waste results show that soil meets the Resource Conservation and Recovery Act (RCRA)-Toxicity Characteristic Leaching Procedure (TCLP) hazardous waste criteria (Table 3).



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File: Idaho/Special_Projects/Mahaffey_Oil/figure2_20121203	Requestor: M. Procsal	Project Name: Mahaffey Oil ESA	Site Layout with Sample Locations
Print Date: December 17, 2012	Project Manager: M. Procsal		Figure 2
Project Number: 12057	Cartographer: B. Bailey		

Table 1
Soil Analytical Results (mg/kg)
Former Mahaffey Oil
Parma, Idaho

Sample ID/Sample Date	Sample Depth (feet bgs)	Benzene	Toluene	Ethylbenzene	Total Xylenes	Naphthalene	methyl-t-butyl ether (MTBE)	1,2-Dichloroethane (EDC)	Ethylene Dibromide (EDB)	Acenaphthene	Anthracene	Benzo[a] anthracene	Benzo[a] pyrene	Benzo[b] fluoranthene	Benzo[k] fluoranthene	Chrysene	Fluoranthene	Fluorene	Pyrene
BH-3 5FT 7/26/11	5	**10**	**83**	**24**	**150**	**6.5 J**	**< 1.3***	**< 1.3***	**< 1.3***	0.011	0.012	< 0.0080	0.0011 J	< 0.0080	< 0.0080	< 0.0080	0.0020 J	0.021	0.0063 J
BH-6 5FT 7/26/11	5	**0.059 J**	0.096 J	**0.18**	0.12 J	**< 0.33***	< 0.065	**< 0.065***	**< 0.065***	0.0037 J, J3	0.0047 J, J3	< 0.0078	< 0.0078	< 0.0078	< 0.0078	< 0.0078	< 0.0078	0.0018 J	0.0024 J
BH-7 6.5FT 7/26/11	6.5	**0.17 J**	0.12 J	**1.8**	2.6	**6.2**	**< 0.32***	**< 0.32***	**< 0.32***	0.42	0.14	0.0026 J	< 0.0077	< 0.0077	< 0.0077	0.0024 J	0.008	0.73	0.054
BH-8 6FT 7/26/11	6	**20**	**180**	**48**	**330**	**9.1 J**	**< 6.4***	**< 6.4***	**< 6.4***	0.023	0.015	< 0.0077	< 0.0077	< 0.0077	< 0.0077	< 0.0077	0.0041 J	0.038	0.0078
BH-9 5FT 7/26/11	5	0.0068	0.0073 J	< 0.0060	0.0029 J	0.0088 J	< 0.0060	< 0.0060	**< 0.0060***	< 0.0072	< 0.0072	<0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072
BH-40 5FT 9/28/12	5	0.0036	0.00090 J	< 0.0013	< 0.0013	0.00098 J	< 0.0013	< 0.0013	**<0.0013***	< 0.0079	< 0.0079	<0.0079	< 0.0079	< 0.0079	< 0.0079	< 0.0079	< 0.0079	< 0.0079	< 0.0079
BH-41 5FT 9/28/12	5	**< 2.8***	**< 14***	**39**	**180**	**23**	**< 2.8***	**< 2.8***	**< 2.8***	0.23	0.11 J	0.0046 J	0.0022 J	0.0052 J	0.0042 J	0.0054 J	0.012	0.29	0.05
BH-42 5FT 9/28/12	5	0.0019	< 0.0072	< 0.0014	< 0.0043	0.0012 J	< 0.0014	< 0.0014	**<0.0014***	< 0.0081	< 0.0081	< 0.0081	< 0.0081	< 0.0081	< 0.0081	< 0.0081	< 0.0081	< 0.0081	< 0.0081
BH-43 9FT 9/28/12	9	0.0027	< 0.0071	0.00056 J	0.0012 J	< 0.0085	< 0.0014	< 0.0014	**<0.0014***	< 0.0085	< 0.0085	< 0.0085	< 0.0085	< 0.0085	< 0.0085	< 0.0085	< 0.0085	< 0.0085	< 0.0085
BH-44 9FT 9/28/12	9	0.0015	< 0.0067	< 0.0013	< 0.0040	< 0.0067	< 0.0013	< 0.0013	**<0.0013***	< 0.0080	< 0.0080	< 0.0080	< 0.0080	< 0.0080	< 0.0080	< 0.0080	< 0.0080	< 0.0080	< 0.0080
BH-45 5FT 9/28/12	5	**0.040 J**	< 0.26	**0.57**	0.091 J	**0.67**	< 0.052	**< 0.052***	**<0.052***	0.012	0.0077	< 0.0064	< 0.0064	< 0.0064	< 0.0064	< 0.0064	0.0011 J	0.0084	0.0034 J
BH-46 5FT 9/28/12	5	0.00048 J	< 0.0067	< 0.0013	< 0.0040	< 0.0067	< 0.0013	< 0.0013	**<0.0013***	< 0.0080	< 0.0080	< 0.0080	< 0.0080	< 0.0080	< 0.0080	< 0.0080	< 0.0080	0.0021 J	< 0.0080
BH-47 5FT 9/28/12	5	**0.0260**	0.0024 J	0.0051	0.061	0.010	< 0.0012	< 0.0012	**<0.0012***	< 0.0072	< 0.0072	<0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	< 0.0072	0.0010 J
IDAPA Residential Use Screening Levels (mg/kg)		0.025	6.6	0.25	27	0.12	0.08	0.013	0.0001	200	3,200	0.09	0.02	0.2	1.9	9.5	1,400	240	1,000
Critical Pathway		GWP	GWP	VI	VI	VI	GWP	GWP	GWP	GWP	GWP	GWP	DC	DC	DC	GWP	GWP	GWP	GWP

Notes:
mg/kg = milligrams per kilogram
< = below reported detection limit
bgs = below ground surface
J = (EPA) Estimated value below the lowest calibration point. Confidence correlates with concentration.
J3 = The associated batch QC was outside the established quality control range for precision.
NA = Not Analyzed
Concentrations in **BOLD** are above one or more of the Screening Level as defined by IDAPA 58.01.24-Standards and Procedures for Application of Risk Based Action at Petroleum Release Sites
The higher concentration is reported for all duplicate samples.
- = no value established
* = Detection limit exceeds screening level.
a duplicate was collected at BH-41 and the higher concentration of the two are reported
GWP = groundwater protection
VI = vapor intrusion
DC = direct contract

Table 2
Water Analytical Results (mg/L)
Former Mahaffey Oil
Parma, Idaho

Sample ID/Sample Date	Depth to Water (feet bgs)	Lead	Benzene	Toluene	Ethylbenzene	Total Xylenes	Naphthalene	methyl-t-butyl ether (MTBE)	1,2-Dichloroethane (EDC)	Ethylene Dibromide (EDB)	Acenaphthene	Anthracene	Benzo[a] anthracene	Benzo[a] pyrene	Benzo[b] fluoranthene	Benzo[k] fluoranthene	Chrysene	Fluoranthene	Fluorene	Pyrene
DPW-1 7/26/11	3.51	< 0.005	**1.7**	**1.2**	**0.19**	1.3	0.058 J	< 0.025	**< 0.025****	< 0.000010	0.00040	0.000041 J	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	0.00048	0.000018 J
DPW-2 7/26/11	3.9	NA	< 0.0010	< 0.0050	< 0.0010	< 0.0030	< 0.0050	< 0.0010	< 0.0010	< 0.000010	0.000012 J	0.000024 J	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	<0.000050	< 0.00050
DPW-3 7/26/11	2.4*	< 0.005	**0.0320**	0.0021 J	0.0084	< 0.0030	0.0012 J	< 0.0010	0.00045 J	< 0.000010	0.00035	0.000033 J	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	0.00043	< 0.000050
DPW-4 7/26/11	4.01	< 0.005	**1.5**	**1.9**	**0.76**	3.4	**0.15**	< 0.025	**< 0.025****	< 0.000010	0.00058	0.00011	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	0.00082	< 0.000050
DPW-5 7/26/11	3.7	< 0.005	**2.0**	0.017 J	0.0131	0.059 J	0.023 J	< 0.025	**< 0.025****	< 0.000010	0.00019	0.000026 J	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	0.00017	< 0.000050
DPW-6 7/26/11	3.72	< 0.005	< 0.0010	0.0034 J	< 0.0010	< 0.0030	< 0.0050	< 0.0010	< 0.0010	< 0.000010	0.000014 J	0.0000084 J	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	0.0000092 J	< 0.000050
DPW-7 9/28/12	3.4	< 0.005	**0.02300**	0.0130	**0.1300**	0.3700	**0.082**	< 0.0010	< 0.0010	< 0.000010	0.00048	0.000033 J	*< 0.000024	*< 0.000023	*< 0.000028	*< 0.000027	< 0.00010	< 0.00010	0.0000092 J	< 0.000050
DPW-8 9/28/12	3.3	0.031	< 0.0010	< 0.0050	0.00058 J	0.0025 J	0.0026 J	< 0.0010	< 0.0010	< 0.000010	0.000038 J	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	0.000012 J	< 0.000050
DPW-9 9/28/12	3.1	< 0.0050	< 0.0010	< 0.0050	< 0.0010	< 0.0030	0.0010 J	< 0.0010	< 0.0010	< 0.000010	< 0.000050	0.0000091 J	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050
DPW-10 9/28/12	2.55	< 0.0050	< 0.0010	< 0.0050	< 0.0010	< 0.0030	0.000028 J	< 0.0010	< 0.0010	< 0.000010	< 0.000050	0.0000091 J	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050	< 0.000050
IDAPA Residential Use Screening Levels (mg/kg)		-	0.005	1	0.05	8.7	0.07	0.04	0.005	0.00005	2.2	11	0.00003	0.0002	0.00003	0.0003	0.003	1.5	1.5	1.1
Critical Pathway		-	I	I	VI	VI	VI	I	I	I	I	I	I	I	I	I	I	I	I	I

Notes:
mg/L = milligrams per Liter
< = less than the reported detection limit
*< = less than the minimum detection limit
bgs = below ground surface
J = (EPA) Estimated value below the lowest calibration point. Confidence correlates with concentration.
Concentrations in **BOLD** are above one or more of the Screening Level as defined by IDAPA 58.01.24-Standards and Procedures for Application of Risk Based Action at Petroleum Release Sites
EDB was anlyzed using method 8011.
The higher concentration is reported for all duplicate samples.
- = no value established
* = ground surface at this location was approximately 1 foot deeper than surrounding ground surface
** = Detection limit does not meet screening level.
I = ingestion
VI = vapor intrusion

Table 3
Investigation Derived Waste
Analytical Results (mg/L)
Former Mahaffey Oil
Parma, Idaho

Sample	Arsenic (mg/L)	Barium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Lead (mg/L)	Mercury (mg/L)	Selenium (mg/L)	Silver (mg/L)
IDW-S	< 0.050	0.92	< 0.050	< 0.050	0.18	<0.001	< 0.050	< 0.050
IDW-W	0.069	0.012	<0.0014	<0.004	0.0037	<0.000015	<0.065	0.005
RCRA-TCLP Hazardous Waste Criteria	5.0	100	1.0	5.0	5.0	0.2	1.0	5.0

Notes:
mg/L = milligram per liter
< = result is less than the reporting limit
Soil anlyzed for RCRA 8 Metals TCLP extraction
Water anlyzed for RCRA 8 Metals

Section 3.0 Development of Clean-up Goals and Objectives

3.1 Land Use

3.1.1 Current Land Use

The site is owned by Canyon County and is currently vacant and undeveloped. The adjacent property owner (JC Watson Packing Company) is leasing the property from the County and using it as a parking lot and driveway. All evidence of the AST hold, dispenser islands, and former storage building have been removed and the gravel lot has been re-graded by JC Watson Packing Company. The site is connected to city water and sewer services.

3.1.2 Anticipated Future Land Use

Cleanup target levels vary depending on whether the land use is residential or nonresidential as defined by IDEQ's Idaho Risk Evaluation Manual for Petroleum Releases (Petro REM) Screening Levels (IDEQ 2012). Therefore, evaluating current and reasonably likely future land uses at the site is critical to determining cleanup target levels and potential exposure points, exposure pathways, and exposure factors. The site is proposed for public nonresidential use.

3.1.3 Regional Land Use

Parma, Idaho, is located north-northwest of Nampa and Caldwell, Idaho, near the confluence of the Snake and Boise rivers. The community, with a population of about 1,983 (http://www.city-data.com/city/Parma-Idaho.html, accessed July 27, 2012), is located on the Union Pacific main line and on US Highway 95 (http://parmacity.net/, accessed July 27, 2012).

West of the site, across South Roswell Boulevard, are residential buildings. To the east is JC Watson Packing, an onion storage and packing operation. To the south, across the alley known as South Street, is a former residential lot that is now undeveloped and is owned by JC Watson Packing. To the north is a railroad line.

3.1.4 Water Use

The site does not use surface water as a water source since it is connected to city water. Three monitoring wells that were installed by a previous consultant were abandoned by the previous consultant sometime between 2004 and 2011.

Six temporary prepack groundwater sampling wells were installed during the initial Phase II ESA sampling performed in 2011; five wells were installed onsite and one well was installed west of the site. Four temporary sampling wells were installed during the 2012 assessment; two wells were installed onsite, and two wells were installed offsite at downgradient locations (south and west of the site). All temporary sampling wells were properly abandoned using accepted Idaho Department of Water Resources (IDWR) procedures.

3.2 Site Hazards and Contaminants of Concern

Site sampling has shown that BTEX, naphthalene, and PAHs in soil and BTEX, naphthalene, MTBE, EDB, EDC, and PAHs in groundwater are present at the site in concentrations that

exceed the RUSLs in IDAPA 58.01.24 and are the recognized site COCs. 2011 and 2012 site assessment results are summarized in Tables 1 and 2. The following sections provide information on those COCs.

3.3 Clean-up Goals, Objectives, and Applicable Standards

The overall goal of this ABCA is to reduce or eliminate exposures to physical, environmental, and health hazards at the site for the proposed site use. The current and anticipated future use of the site is non-residential and was considered in the evaluation cleanup objectives. In addition, the following pathways were considered in the evaluation: direct contact, inhalation from vapor intrusion, ingestion, and protection of groundwater. Although petroleum impacted groundwater in excess of the residential use screening levels was not discovered offsite to the extent of DPW-8, DPW-9, or DPW-10, future migration to this extent is possible and cleanup goals therefore consider both onsite and offsite impacts. In the absence of a site specific risk evaluation and/or site specific cleanup criteria, the goal will be achieved by remediating petroleum-contaminated soil and groundwater to below residential use screening levels.

Clean-up actions at the Former Mahaffey Oil site must provide for adequate protection of human health and the environment based on the current and future uses of the property. Cleanup target levels will be defined by the RUSLs as identified in IDAPA 58.01.24 *Standards and Procedures for Application of Risk Based Corrective Action at Petroleum Release Sites*.

Table 4. Residential Use Screening Level Concentrations for Soil and Groundwater (Table 2 IDAPA 58.01.24)

Analyte	Soil (mg/kg)		Groundwater (mg/L)		
	Screening Level	Critical Pathway	Screening Level	Critical Pathway	Basis for Ingestion Screening Level
Benzene	0.025	GWP	0.005	Ingestion	MCL
Toluene	6.6	GWP	1.0	Ingestion	MCL
Ethylbenzene	0.25	Vapor Intrusion	0.05	Vapor Intrusion	NA
Xylenes	27	Vapor Intrusion	8.7	Vapor Intrusion	NA
Naphthalene	0.12	Vapor Intrusion	0.07	Vapor Intrusion	NA
MTBE[1]	0.08	GWP	0.04	Ingestion	Risk-Based
EDB[1]	0.0001	GWP	0.00005	Ingestion	MCL
EDC[1]	0.013	GWP	0.005	Ingestion	MCL
Acenaphthene	200	GWP	2.2	Ingestion	Risk-Based
Anthracene	3,200	GWP	11	Ingestion	Risk-Based
Benz(a)anthracene	0.09	GWP	0.00003	Ingestion	Risk-Based
Banzo(a)pyrene	0.02	Direct Contact	0.0002	Ingestion	MCL
Benzo(b)fluoranthene	0.2	Direct Contact	0.00003	Ingestion	Risk-Based
Benzo(k)fluoranthene	1.9	Direct Contact	0.0003	Ingestion	Risk-Based
Chrysene	9.5	GWP	0.003	Ingestion	Risk-Based
Fluoranthene	1,400	GWP	1.5	Ingestion	Risk-Based
Fluorene	240	GWP	1.5	Ingestion	Risk-Based
Pyrene	1,000	GWP	1.1	Ingestion	Risk-Based
Lead[2]	800		NA	NA	NA

Notes:
1. Analyte not tested in site soils for this project.
2. Analyte not tested in site groundwater for this project. Screening level is based on Industrial Soil Regional Screening Levels (USEPA 2013).
mg/kg = milligram per kilogram
mg/L = milligram per liter
GWP = Ground Water Protection via petroleum contaminants in soil leaching to ground water
MCL = Maximum contaminant level
NA = not applicable

Section 4.0 Identification of Clean-up Alternatives

The following analysis was performed to consider a range of reasonable and proven response actions and clean-up alternatives based on contaminant concentrations, site characteristics, current and proposed site use, clean-up goals, associated human health hazards, and potential

exposure pathways. This section presents a compilation of potentially applicable technologies for the remediation of the identified COCs described in Section 3.0. The objective of this analysis is to identify alternatives to be evaluated further in Section 5.0.

For each of the potentially applicable alternatives, a brief description of the alternative and a short discussion of its advantages and disadvantages are presented.

4.1 Identification of Clean-up Alternatives

Six options are considered for clean-up of the Former Mahaffey Oil site:

1. Monitored natural attenuation.
2. A combination of contaminated soil removal with monitored natural attenuation.
3. In-situ chemical oxidation.
4. A combination of excavation and in-situ chemical oxidation.
5. Soil vapor extraction with air sparging.
6. No-Action.

4.1.1 Clean-up Alternative 1 – Monitored Natural Attenuation

Description
Monitored natural attenuation (MNA) is the reduction in the concentration and mass of a substance and its breakdown products in soil and/or groundwater due to naturally occurring physical, chemical, and biological processes without human intervention or enhancement. These processes include, but are not limited to, dispersion, diffusion, sorption and retardation, and degradation processes such as biodegradation and abiotic degradation (USEPA 1999).

Advantages

- MNA may be less intrusive and disruptive of the site and its infrastructure.
- The option may produce less waste, use less energy, may require less operation and maintenance (O&M) costs, and therefore overall costs may be less.
- MNA does not generate remediation wastes. However, risks from methane produced during natural biodegradation of petroleum hydrocarbons may be a concern.
- Reduced potential for cross-media transfer of contaminants commonly associated with ex-site treatment.
- Reduced risk of human exposure to contaminants near the source area.
- Natural biodegradation may result in the complete destruction of contaminants in-situ.
- May be used in conjunction with, or as follow-up to, active remedial measures.

Disadvantages

- An accurate site conceptual model should be developed to confirm that site characteristics are favorable for MNA.
- The estimated timeframe of MNA may not be comparable to an active remediation method.
- May fail to achieve the desired cleanup levels within a reasonable length of time (and an engineered remedy should instead be selected).

- The option may require institutional controls to ensure protection of human health and the environment through land use restrictions such as construction, and water use,
- Not suitable when contamination has impacted a receptor (e.g., impacted groundwater supply well, vapors in a building).
- Despite predictions that the contaminants are stationary, some migration of contaminants may occur. Not suitable if receptors might be affected. Performance monitoring will generally require more monitoring locations. Monitoring will extend over a longer period of time.
- It may be necessary to implement contingency measures. If so, this may increase overall cost of remediation.
- May be accompanied by changes in groundwater geochemistry that can mobilize other contaminants.

4.1.2 Clean-up Alternative 2 – Combination of Soil Excavation and Removal and Monitored Natural Attenuation

Description
The previously identified petroleum-contaminated soils will be excavated, removed, and land-farmed, and the resultant pit will be backfilled and compacted with clean soil. Groundwater will be monitored to ensure that any remaining contamination is not migrating offsite and that the overall contaminant mass is reducing over time.

Advantages
- The source of continued petroleum contamination at the site will be removed.
- Ongoing monitoring will provide information to aid in complete site closure.
- This clean-up method can be implemented with minimal disturbance to site operations.
- Requires no removal, treatment, storage, or discharge considerations for groundwater.

Disadvantages
- There are additional costs to continue site monitoring.
- It may not be possible to remove all contaminated soil from the site. Institutional controls, such as land use restrictions may be required to ensure the protection of human health and the environment by limiting exposure to any remaining COCs and protecting the integrity of the remedy.
- Shallow groundwater may limit the depth of excavation.

4.1.3 Clean-up Alternative 3 – In-situ Chemical Oxidation

Description
In-situ chemical oxidation (ISCO) involves the introduction of a chemical oxidant into the subsurface for the purpose of transforming groundwater or soil contaminants into less harmful chemical species. ISCO results in the transformation of a wide range of environmental contaminants and enhances mass transfer. The two most commonly used forms of injected

oxidants are permanganate (MnO_4^-) and Fenton's Reagent (hydrogen peroxide [H_2O_2] and Ferrous iron [Fe^{+2}]) or catalyzed hydrogen peroxide.

Advantages

- Reduces the anticipated clean-up times required for MNA and other remedial options.
- This clean-up method can be implemented with minimal disturbance to site operations.
- Requires no removal, treatment, or storage considerations for groundwater.

Disadvantages

- Efforts to stabilize the reaction rate in the subsurface are needed to enhance transport distances and persistence.
- May require a pilot test to determine which oxidant is the most suitable for the site conditions.
- Complex heterogeneous systems involving aquifer materials, soils, and groundwater introduce potential treatment inefficiencies due to imperfect reactive conditions.
- Strong oxidants may compromise subsurface utilities.

4.1.4 Clean-up Alternative 4 – Combination of Soil Excavation and In-situ Chemical Oxidation

Description

The previously identified petroleum-contaminated soils will be excavated, removed, and land-farmed, and the resultant pit will be backfilled with clean soil. ISCO will be implemented to transform the remaining groundwater or soil contaminants into less harmful chemical species.

Advantages

- Reduces the anticipated clean-up times required for MNA and other remedial options.
- This clean-up method can be implemented with minimal disturbance to site operations.
- Requires no removal, treatment, or storage considerations for groundwater.

Disadvantages

- There are additional costs to continue site monitoring.
- Several injection sites may be needed to provide an adequate radius of influence.

4.1.5 Clean-up Alternative 5 – Soil Vapor Extraction and Air Sparging

Description

Soil Vapor Extraction (SVE) is a remedial technology that removes volatile and some semi-volatile contaminants from the subsurface by applying a vacuum and inducing a controlled flow of air. A vacuum blower, connected to SVE wells that are screened above the groundwater table, is used to capture the soil gas and transport it above ground for treatment.

Air sparging is an in-situ remedial technology that reduces concentrations of volatile constituents in petroleum products that are adsorbed to soils and dissolved in groundwater. This technology, which is also known as "in-situ air stripping" and "in-situ volatilization," involves the injection of contaminant-free air into the subsurface saturated zone, enabling a phase transfer of

hydrocarbons from a dissolved state to a vapor phase. The air is then vented through the unsaturated zone. Air sparging is most often used together with soil vapor extraction, but it can also be used with other remedial technologies. Air sparging is generally more applicable to the lighter gasoline constituents (i.e., BTEX), because they readily transfer from the dissolved to the gaseous phase.

Advantages

- There is readily available equipment with easy installation for this method.
- This clean-up method can be implemented with minimal disturbance to site operations.
- This option has short treatment times; usually less than 1 to 3 years under optimal conditions.
- This clean-up method is proven as highly effective for remediating BTEX constituents.
- This option requires no removal, treatment, storage, or discharge considerations for groundwater.
- SVE with air sparging promotes in-situ biodegradation.

Disadvantages

- This clean-up method cannot be used if free product exists.
- A pilot test is required to determine radius of influence and design considerations.
- Low permeability soils require high vacuum which may be costly.
- Soil with a high organic contact or that is extremely dry has a high sorption capacity and reduces vapor removal.
- Stratified soils may cause air sparging to be ineffective.
- Some interactions among complex chemical, physical, and biological processes are not well understood.

4.1.6 Clean-up Alternative 6 – No-Action

Description

The No-Action alternative assumes no remediation actions will be undertaken at the site and must be considered as part of the comparative analysis process.

Advantages

- Cleanup costs of this alternative would be zero, although limited costs have already been incurred for site investigations.

Disadvantages

- This would prevent the use of the site including future development due to risks posed to users including inhalation, direct contact, and ingestion, during construction activities.

Section 5.0 Detailed Analysis of Clean-up Alternatives

5.1 Description of Evaluation Criteria

The clean-up alternatives identified for the site (see Section 4.0) are evaluated in this section based on the following performance criteria:

1. Overall protection of human health and the environment
2. Ease of implementation
3. Cost of remediation
4. Sustainability – O&M and long-term effectiveness
5. Ability to meet proposed building use
6. Short-term impacts to the environment – "green" remediation approaches

The following sections describing these performance criteria serve as a basis for conducting a comparative analysis of the proposed remedial alternatives.

5.1.1 Overall Protection of Human Health and the Environment

This criterion is used to evaluate whether human health and the environment are adequately protected. Human health protection includes reducing risk to acceptable levels, either by reducing contamination concentrations or eliminating potential routes for exposure by implementing specific training to meet regulatory requirements. Environmental protection includes minimizing or avoiding negative impacts to natural, cultural, and historical resources.

5.1.2 Ease of Implementation

Ease of implementation refers to the technical and administrative feasibility of carrying out an alternative and the availability of the required services and materials. The following factors are considered for each alternative:

- The likelihood of technical difficulties in constructing the alternative and delays due to technical problems.
- The potential for regulatory constraints to develop (e.g., as a result of uncovering buried cultural resources or encountering endangered species).
- The availability of necessary equipment, specialists, and provisions, as applicable.

5.1.3 Cost

This criterion considers the cost of implementing an alternative, including capital costs, O&M costs, opportunity costs, and monitoring costs.

5.1.4 Sustainability – Operation and Maintenance and Long-term Effectiveness

Sustainability includes an assessment for the potential need to replace the alternative's technical components in the long term. In addition, this criterion evaluates the ease of O&M procedures required for the site.

5.1.5 Ability to Meet Proposed Building and Land Use

This criterion addresses the clean-up alternative's ability to meet the requirements for public use. These requirements include the preservation of the site as a whole.

5.1.6 Short-term Impacts to the Environment – "Green" Remediation Approaches

This criterion evaluates the potential short-term impacts to the environment as a result of onsite activities. In addition, consideration is made for reducing the overall environmental footprint and impact to the environment as a result of onsite activities.

5.2 Detailed Analyses of Alternatives

All of the proposed alternatives have the potential to provide for overall protection of human health and the environment and will be designed so they are in compliance with applicable federal, state, and local regulations. Since a No-Action alternative does not meet the goal for protection of human health and the environment, and current risks at the site are unacceptable for the proposed site use, this alternative was not evaluated for the clean-up alternatives.

5.2.1 Detailed Analysis of Alternative 1 – Monitored Natural Attenuation

5.2.1.1 Overall Protection of Human Health and the Environment

MNA works best where site conditions are favorable. Under appropriate field conditions, the regulated compounds BTEX may naturally degrade through microbial activity and ultimately produce non-toxic end products (e.g., carbon dioxide and water). Where microbial activity is sufficiently rapid, the dissolved BTEX contaminant plume may stabilize (i.e., stop expanding), and contaminant concentrations in both groundwater and soil may eventually decrease to levels below regulatory standards. Following degradation of a dissolved BTEX plume, a residue consisting of heavier petroleum hydrocarbons of relatively low solubility and volatility will typically be left behind in the original source (spill) area. Although this residual contamination may have relatively low potential for further migration, it still may pose a threat to human health or the environment either from direct contact with soils in the source area or by continuing to slowly leach contaminants to groundwater. For these reasons, MNA alone is generally not sufficient to remediate petroleum release sites. Implementation of source control measures in conjunction with MNA is almost always necessary. Other controls (e.g., institutional controls), in accordance with applicable state and federal requirements, may also be necessary to ensure protection of human health and the environment.

5.2.1.2 Ease of Implementation

Through TerraGraphics' site investigations in 2011 and 2012, site characterization has already been completed. The implementation of Alternative 1 will include installing a sufficient number of monitoring wells (upgradient, within the site, and downgradient) to provide baseline levels, to monitor the mass reduction, and to assess if offsite migration is occurring. Monitoring wells could be installed less than 18 feet bgs using a direct push drill rig. Groundwater monitoring should be completed quarterly.

5.2.1.3 Cost

MNA has a relatively low up-front cost that includes the installation of a sufficient number of monitoring wells. However, performance monitoring should continue until remediation objectives have been achieved, and longer if necessary to verify that the site no longer poses a threat to human health or the environment. Typically, monitoring is continued for a specified period (e.g., one to three years) after remediation objectives have been achieved to ensure that concentration levels are stable and remain below target levels. Groundwater monitoring costs are estimated at $15,000 to $20,000 per year.

5.2.1.4 Sustainability – Operations and Maintenance and Long-term Effectiveness

MNA often requires a longer time-frame to meet remedial goals compared to more active remedies. Monitoring is also continued for a specified period (e.g., one to three years) after remediation objectives have been achieved to ensure that concentration levels are stable and remain below target levels. Additionally, contingency remedies may need to be established if the contaminant plume does not change.

5.2.1.5 Ability to Meet Proposed Building and Land Use

MNA would meet the desired land-use requirements as they pertain to the COCs provided that land development does not immediately occur

5.2.1.6 Short-term Impacts to the Environment – "Green" Remediation Approaches

There is little disturbance to the environment during MNA and there is a reduced volume of investigation derived wastes. Direct push technology for groundwater sampling does not result in drill cuttings or excess soil waste and related investigation derived waste. Many current groundwater sampling procedures utilize low-flow sampling equipment during monitoring to minimize purge volumes and energy consumption while producing little investigation derived waste.

5.2.2 Detailed Analysis of Alternative 2 – Combination of Excavation/Removal of Petroleum-contaminated Soils and Monitored Natural Attenuation

5.2.2.1 Overall Protection of Human Health and the Environment

This alternative will remove the main source of site contamination, as determined through site testing and analysis. However, some contamination may remain at the site and ongoing groundwater monitoring of natural attenuation processes will ensure that any remaining contamination does not migrate offsite and will provide data on the remaining amounts of contamination over time. Transportation of hazardous materials wastes also poses a potential, but negligible, short-term risk to human health and the environment.

5.2.2.2 Ease of Implementation

The site area demonstrating the highest contamination has been delineated to the extent possible. Nearby contractors are available to excavate this area using a backhoe and transport the soil to the closest landfarm. Monitoring wells can be installed during the soil excavation. Groundwater monitoring should be completed quarterly.

5.2.2.3 Cost

Overall costs for this alternative will be higher since it combines both the removal of the contamination source and ongoing monitoring to aid in site closure. Mobilization fees and laboratory fees would incur during quarterly monitoring events. Excavation costs are estimated at $170,000 to $200,000 and groundwater monitoring costs are estimated at $15,000 to $20,000 per year.

5.2.2.4 Sustainability – Operations and Maintenance and Long-term Effectiveness

Since the contamination source will be removed, the period of time for natural attenuation may be shortened which may lead to a reduced monitoring time frame. Since contamination data is known, institutional controls may be removed from the site once it reaches compliance with regulations or institutional controls may even be eliminated.

5.2.2.5 Ability to Meet Proposed Building and Land Use

Since contamination data is known, institutional controls may be removed from the site once it reaches compliance with regulations or institutional controls may even be eliminated.

5.2.2.6 Short-term Impacts to the Environment – "Green" Remediation Approaches

This alternative would have significant short-term impacts due to the amount of fossil fuels being used for excavation and transportation. Additionally, the disturbance of the contaminated soils may increase the short-term environmental exposure potential. Additional fossil fuels will be burned during the quarterly monitoring events.

The excavated soils will be landfarmed which will allow for soil reuse. Direct push technology for groundwater sampling does not result in drill cuttings or excess soil waste and related investigation derived waste. Many current groundwater sampling procedures utilize low-flow sampling equipment during monitoring to minimize purge volumes and energy consumption while producing little investigation derived waste.

5.2.3 Detailed Analysis of Alternative 3 – In-situ Chemical Oxidation

5.2.3.1 Overall Protection of Human Health and the Environment

This alternative would transform the soil and groundwater contaminants into less harmful chemical species.

5.2.3.2 Ease of Implementation

Injection wells would need to be installed in several locations on a grid for optimum delivery of oxidants to all petroleum impacted areas. Permits may be required for the injection of an oxidizing agent into the site groundwater.

5.2.3.3 Cost

The cost of the type of oxidant used will drive the overall cost of this clean-up alternative. Mobilization fees and laboratory fees would incur during quarterly monitoring events. The cost to implement a site-wide injection could be as high as $200,000 along with groundwater monitoring costs estimated at $15,000 to $20,000 per year.

5.2.3.4 Sustainability – Operations and Maintenance and Long-term Effectiveness

This alternative may require institutional controls to ensure that human health is adequately protected. Quarterly monitoring will also be needed to determine the effectiveness of the chemical oxidation and to ensure that human health is adequately protected.

5.2.3.5 Ability to Meet Proposed Building and Land Use

Institutional controls may be needed until remaining site contaminant concentrations are known.

5.2.3.6 Short-term Impacts to the Environment – "Green" Remediation Approaches

There is little disturbance to the environment during monitored natural attenuation and there is a reduced volume of investigation derived wastes generated from the groundwater monitoring well installation.

5.2.4 Detailed Analysis of Alternative 4 – Combination of Soil Excavation and In-situ Chemical Oxidation

5.2.4.1 Overall Protection of Human Health and the Environment

This alternative will remove the main source of site contamination, as determined through site testing and analysis. However, some contamination may remain at the site and the introduction of an oxidizing chemical will ensure that any remaining contamination will be transformed into less harmful chemical species. Transportation of hazardous materials wastes also poses a potential, but negligible, short-term risk to human health and the environment.

5.2.4.2 Ease of Implementation

The site area demonstrating the highest contamination has been delineated to the extent possible. Nearby contractors are available to excavate this area using a backhoe and transport the soil to the closest landfarm. Injection wells can be installed during the soil excavation. Permits may be required for the injection of an oxidizing agent into the site groundwater.

5.2.4.3 Cost

Overall costs for this alternative will be higher since it combines the removal of the contamination source, injection of chemical oxidants, and ongoing monitoring to aid in site closure. Excavation costs are estimated at $170,000 to $200,000, chemical oxidation at $20,000 to $40,000, and groundwater monitoring costs are estimated at $15,000 to $20,000 per year.

5.2.4.4 Sustainability – Operations and Maintenance and Long-term Effectiveness

This alternative may require institutional controls to ensure that human health is adequately protected. Quarterly monitoring will also be needed to determine the effectiveness of the chemical oxidation and to ensure that human health is adequately protected.

5.2.4.5 Ability to Meet Proposed Building and Land Use

The main contamination source will be removed from the site. However, it is possible that some contamination will remain and institutional controls may need to be set in place to protect human

health and the environment for any future land use. Monitoring would be necessary to determine when groundwater meets acceptable use criteria.

5.2.4.6 Short-term Impacts to the Environment – "Green" Remediation Approaches

This alternative would have significant short-term impacts due to the amount of fossil fuels being used for excavation and transportation. Additionally, the disturbance of the contaminated soils may increase the short-term environmental exposure potential. Additional fossil fuels will be burned during the quarterly monitoring events.

The excavated soils will be landfarmed which will allow for soil reuse. Direct push technology for the installation of injection wells does not result in drill cuttings or excess soil waste and related investigation derived waste.

5.2.5 Detailed Analysis of Alternative 5 – Soil Vapor Extraction and Air Sparging

5.2.5.1 Overall Protection of Human Health and the Environment

Due to the low permeability clay soil in the saturated zone and the shallow depth to groundwater, SVE with air sparging will not effectively remediate the site contaminants and may even facilitate the further off-site contaminant migration.

5.2.5.2 Ease of Implementation

An SVE and air sparging system can be left onsite without disturbing the current or future site use. A direct push drill rig to will be necessary to complete the construction of the air sparging and soil vapor extraction wells. However, this option requires detailed pilot testing and monitoring to ensure vapor control and limit contamination migration.

5.2.5.3 Cost

Low permeability soils, such as the clay found at the site, require high vacuum which may be costly. Overall costs are estimated at $30,000 to $50,000 to implement along with $50,000 to $60,000 per year in operations and maintenance and monitoring.

5.2.5.4 Sustainability – Operations and Maintenance and Long-term Effectiveness

Quarterly monitoring will be needed to determine the effectiveness of the SVE and air sparge system and to ensure that human health is adequately protected.

5.2.5.5 Ability to Meet Proposed Building and Land Use

Institutional controls may need to be set in place to protect human health and the environment for any future land use. Monitoring would be necessary to determine when groundwater meets acceptable use criteria.

5.2.5.6 Short-term Impacts to the Environment – "Green" Remediation Approaches

Fossil fuels will be burned during the installation of the injection wells and during the quarterly monitoring events.

Direct push technology for the installation of injection wells does not result in drill cuttings or excess soil waste and related investigation derived waste.

Section 6.0 Comparative Analysis of Clean-up Alternatives

6.1 Alternative Ranking Criteria

Table 5 compares the analysis of the four proposed alternatives against the evaluation criteria. Alternatives with higher scores are considered better options for the owners. Rankings were made on a scale of "1" through "3" with:

- 1 = Low Success,
- 2 = Moderate or Average Success, and
- 3 = High Success.

Table 5. Comparative Analysis of Clean-up Alternatives

Cleanup Alternative	Overall Protection of Human Health and the Environment	Ease of Implementation	Cost-Effective Approach towards Remediation	Sustainability -O&M and Long-term Effectiveness	Ability to Meet Proposed Land Use	"Green" remediation approach	Total Score
1. Monitored natural attenuation.	2	3	2	2	3	3	15
2. Combination of soil excavation/removal and monitored natural attenuation.	2	3	3	2	3	3	16
3. In-situ chemical oxidation.	2	2	1	3	3	3	14
4. Combination of soil excavation/removal and in-situ chemical oxidation.	3	2	1	3	3	3	15
5. Soil Vapor Extraction and Air Sparging.	1	1	1	1	3	2	9
6. No-Action.	1	3	3	1	1	1	10

Notes:

(1=Low Success, 2=Medium Success, 3=High Success)

(For Cost: 1=High Cost, 2=Medium Cost, 3=Low Cost)

6.2 Summary

Alternatives 1 through 4 were similarly ranked yet they each score differently in significant areas. Alternatives 3 and 4 have a higher overall long-term effectiveness but are much more costly, while alternative 5 has lower long-term effectiveness. Alternatives 5 and 6 appear to be the least effective alternative. Alternative 2, a combination of soil excavation/removal and

MNA, is the most cost effective alternative in combination with having a high likelihood of success and protection of human health and the environment.

Section 7.0 Preferred Alternative Work Plan

The following sections describe the design details necessary to implement the preferred alternative, which is a ***Combination of Soil Excavation and Removal and Monitored Natural Attenuation (SER/MNA)***, and includes excavation, removal, and land-farming of petroleum-contaminated soils. After excavation, the resultant pit will be backfilled and compacted with clean soil. Groundwater will be monitored to ensure that any remaining contamination is not migrating offsite and that the overall contaminant mass is reducing over time through natural attenuation.

After excavation, MNA will reduce the concentration and mass of the petroleum and its breakdown products in soil and/or groundwater through naturally occurring physical, chemical, and biological processes. This will occur without human intervention or enhancement.

7.1 Applicable Standards

Remedial actions at the Former Mahaffey Oil site must provide for adequate protection of human health and the environment based on the current and future uses of the property as guided by the IDAPA 58.01.24 *Standards and Procedures for Application of Risk Based Corrective Action at Petroleum Release Sites*.

Remedial effectiveness initially will be evaluated by comparing conformational samples (soil and water) to the RUSLs as provided in IDAPA 58.01.24 *Standards and Procedures for Application of Risk Based Corrective Action at Petroleum Release Sites* (see Table 4 in Section 3.0). The County will prepare a Quality Assurance Project Plan (QAPP) for the Former Mahaffey Oil Site that outlines the approach to ensure data collected is of sufficient quality to make management decisions compared to the RUSLs.

7.2 Design Details

Table 6 summarizes the remediation tasks and construction materials required to complete the Work Plan. The Construction Contractor will complete the removal of petroleum contaminated soil (PCS) as outlined within the project specifications. The remediation tasks are summarized in Table 5.

Table 6. Required Construction Materials for Preferred Alternative

Remediation Tasks	Construction Materials Required
Install site controls around perimeter of contaminated excavation area and imported material stockpile; establish stabilized construction site exit and entrance points to prevent sediment track out; and suppress dust during site operations.	Silt fence or equivalent Best Management Practice (BMP), imported crushed aggregates and onsite water truck
Excavate surface and subsurface petroleum impacted soils; dewater and dry before hauling and offsite disposal	None

Contaminated water collection and disposal	Water tank and pump
Backfill, compact and grade the excavated area with imported materials; construct gravel parking area to match grade.	Imported soil materials suitable for foundation material and imported crushed aggregates for parking lot surface
Install new monitoring well network. Environmental Consultant will conduct	PVC, PVC screen, silica sand, bentonite chips and grout, concrete, cap, lock Environmental Consultant will supply materials
Monitoring and maintenance of the remedy Environmental Consultant will conduct	None Environmental Consultant will supply materials

7.2.1 Site Controls

Temporary erosion and sediment controls will be installed to prevent contaminant migration off site. The excavated area will be positively graded at all times to minimize the excess runoff of saturated materials excavated below the water table. A silt fence or equivalent BMP will be installed around the perimeter of the excavation area and the imported material stockpile if the contractor chooses to stage clean import materials on site. Construction of stabilized access entrance and exit points will be utilized to establish a roadbed suitable for haul trucks and prevent sediment trackout. Dust suppression will occur during working hours of construction anytime there is visual identification of dust. All site controls will be constructed in a manner that is consistent with the objectives of the USEPA National Pollutant Discharge Elimination System (NPDES) permit stormwater best management practices, with considerations for the local conditions at the site.

7.2.2 Remediation of Petroleum Impacted Soils

The approximate surface area of petroleum impacted soils designated for removal is 0.3 acres and approximate removal volume is 2,700 cubic yards. In general, the lithology at the site consists of clays and silts from 0 feet to 4 feet bgs and sands and gravels from 4 feet to 10 feet bgs. The remediation and removal of petroleum impacted soils will occur within the vertical and horizontal extents of petroleum contamination. The extent of the site contamination plume was determined by portable MiniRae® PID readings from soil samples over 100 ppm. The approximate horizontal extents of site contamination are indicated on the Plans and the vertical extent is anticipated to be to a depth of 6 feet bgs.

The Environmental Consultant will use PID readings, olfactory and visual inspection to determine all contaminated materials have been removed. In addition, the Environmental Consultant will collect soil samples for VOC analysis in accordance with USEPA Sampling Method 5035 (USEPA 1996). The Consultant will also collect soil samples for PAH analysis by filling the appropriate containers with a clean gloved hand. Soil samples will be collected from side walls and base of excavation pit to evaluate the effectiveness of the cleanup.

During excavation, it is very likely the Contractor will encounter wet or soaked petroleum impacted materials due to the shallow groundwater table. The Contractor will stage or stockpile the wet and dripping materials within the perimeter of the contaminated work area and assure materials are sufficiently dry (moisture content such that no visible dripping occurs) prior to

loading and hauling materials offsite for disposal. The Contractor may aerate materials to expedite drying prior to loading and transporting offsite if necessary. The Contractor will haul petroleum-contaminated materials to the Pickles Butte Landfill, a certified landfill that accepts PCS.

7.2.3 Collection and Disposal of Contaminated Water

All onsite water that impedes construction and comes in contact with contaminated material will be collected and transported off site for disposal. The sources of water include surface water such as rainfall, groundwater seepage in the excavation zone and decontamination water. The Contractor will pump and store water in tanks to dewater areas of excavation when encountering groundwater. All collected water will be disposed at an approved regulated disposal facility.

7.2.4 Backfill, Compaction and Grading the Affected Area

Imported backfill materials will be used to fill the excavated area after all contaminated materials have been removed and hauled offsite. The Contractor may choose to stockpile imported materials on site prior to placement but must be maintained in a separate area away from the contaminated zone. After complete removal of contaminated materials, as approved by the Environmental Consultant, the Contractor will install clean import materials to fill the excavated area. Clean soil will be obtained from a commercially available source. The Contractor will provide certification from the borrow source that the imported backfill is not contaminated. Certification of clean soil is detailed in the QAPP. Imported backfill materials will be placed, compacted, and graded according to the specifications. If necessary, the Contractor may partially backfill excavated areas in order to minimize the effects of groundwater upwelling or to gain access to other petroleum impacted soils within the work zone.

7.2.5 Groundwater Monitoring Network

Three new 2-inch diameter pre-pack groundwater monitoring wells will be installed at the site once the area has been backfilled and re-graded. Two wells will be installed down gradient and one within the excavation footprint by the Environmental Consultant to monitor the natural attenuation of the remaining petroleum impacted groundwater.

7.3 Completion Milestones

Table 7 below lists the completion milestones and target completion dates for the site remediation. The remediation timeline start date coincides with the date of final agency approval of this Work Plan. Remediation milestones are described below and will follow the Voluntary Consent Program (VCP) agreed upon milestones.

Table 7. Former Mahaffey Oil Remediation Completion Milestones

Completion Milestones	Target Completion Dates
Notice to Proceed/Start Construction	Approximately 5 weeks after public comments are received
Complete Construction	Approximately 2 weeks after Construction Start
Implement Ground Monitoring	3 Months Post-Construction
Completion Report Final	8-12 weeks from construction completion

7.3.1 Notice to Proceed/Start Construction

After approval by IDEQ and USEPA, this Work Plan will be posted for public comment for 30 days. After this review period, USEPA and IDEQ will address any outstanding comments and then issue a notice to proceed (NTP) to the Owner. Following the issuance of a NTP, the Owner and Environmental Consultant will meet with the Contractor to clarify the terms and expectations of the contract. The Contractor will then begin to mobilize equipment and workers to the site as soon as weather permits. At this time, a timeline target date of August 15, 2013, has been set for this milestone. Construction is projected to occur following final approval of the Work Plan.

7.3.2 Construction Phase

The construction schedule is shown in four general tasks (Table 7) to indicate items that will likely be completed before others can proceed. Task 1 is necessary prior to the commencement of construction activities to prevent contaminant tracking off site. Task 2 involves excavation, dewatering, staging wet materials and hauling and disposal off site. The Contractor and Environmental Consultant will work closely during this task to assure all petroleum impacted soils are removed and that no offsite migration of contaminated materials occurs. Task 3 involves placing and compacting backfill and resurfacing affected areas at the site to match to the existing gravel parking area. Task 4 includes installing three new monitoring wells and implementing quarterly groundwater monitoring as detailed in the QAPP. Additionally, certain subtasks and work may commence concurrently throughout the project work, including sorting and stockpiling of removed waste and debris.

Completion of all the Construction Phase Tasks 1 through 4 is required to reach the construction completion milestone. Note that the construction phasing of this project will be left up to the Contractor, so if the order of completion of construction phase tasks in Table 7 does not satisfy the Contractor, the Contractor will approach the Environmental Consultant and Owner prior to construction.

The completion report will be submitted to IDEQ by the Environmental Consultant approximately 30 days following the construction completion report. This report will summarize remediation activities and will note any deviation from the remediation design and timeline. Quarterly groundwater monitoring reports will be submitted to IDEQ by the Environmental

Consultant approximately 30 days following the receipt of analytical results. Construction is projected to be completed 30 days from the start of construction Task 3.

Table 8. Remediation Phase Tasks

Remediation Phase Tasks	
Task 1	*Install Site Controls* Silt fence or BMP equivalent Stabilized construction entrance/exit Dust suppression with water truck
Task 2	*Removal and disposal of petroleum impacted soils* Excavation of petroleum impacted soils and debris in designated contaminated zone. Dewatering excavated area to maintain operating conditions Screening of soils Staging of saturated waste materials Loading and hauling waste to a regulated disposal facility Sampling soils
Task 3	*Backfill, compacting and resurfacing of the excavated area* Place and compact imported materials Final finished grade and match entire impacted area of gravel parking lot Apply oil and/or appropriate dust suppression to reconstructed surface
Task 4	*Install monitoring wells – Environmental Consultant will perform* Install two downgradient monitoring wells. Initiate quarterly monitoring in accordance with the QAPP

7.3.3 Monitoring of the Remedy

The Draft QAPP outlines procedures for soil sampling during remediation and quarterly groundwater sampling after remediation completion. In-situ soil screening with a PID along with soil sampling will assist with excavation activities. Quarterly groundwater monitoring will evaluate the effectiveness of the remedy. The Environmental Consultant will conduct groundwater sampling on a quarterly basis. Groundwater results will be summarized in a quarterly memo submitted to IDEQ. Remediation goals will be met by comparing groundwater concentrations to the RUSLs. In the event that groundwater concentrations do not meet remediation goals within a reasonable timeframe, a site-specific risk assessment may be performed to determine alternative remediation goals based upon site use.

7.3.4 Risk Evaluation and Environmental Covenant (if Necessary)

Should excavation activities not remove all the PCS to below the action level, a site specific Risk Evaluation will be performed to determine the probability of an adverse effect on human health and the environment by those petroleum constituents that still remain at the site.

In the event that groundwater concentrations exceed the RUSLs and natural attenuation does not appear to be an effective approach an environmental covenant may be utilized to create activity and use limitations on soil excavation and the extraction of groundwater under the Uniform Environmental Covenants Act (UECA), Chapter 30, Title 55, Idaho Code. If an environmental covenant is needed, it should state that the portion of the Property where cleanup activities are focused, and any portion thereof, may be used for commercial and industrial uses only and that the property shall not be used for residential purposes, agricultural purposes, or any permanently occupied human habitation (including hotels or motels), school, day care, or hospital use.

7.3.5 Progress Reports

Canyon County will submit quarterly progress reports to IDEQ. The progress reports will:

- Describe remedial activities undertaken to comply with the Voluntary Remediation Agreement (VRA).
- Describe all work planned for the next quarter with estimated schedules for the work.
- Describe any changes from the Work Plan, problems encountered, schedule modifications, and solutions for addressing any actual or anticipated challenges.

7.3.6 Completion Report Final

Once construction is finished, a Construction Completion Report will be completed by the construction contractor and provided to Canyon County. Canyon County will incorporate the construction completion report into the Voluntary Remediation Work Plan Completion Report (WCR). The WCR will be submitted to IDEQ for review with a request for a Certificate of Completion for the site. The WCR will align with the VCP milestones.

7.3.7 Timeline Uncertainties

There are several uncertainties that could cause delays in the proposed timeline. These uncertainties include delays caused by required regulatory review and compliance (i.e., Work Plan approval and construction permitting), the availability of specific materials necessary for the remediation to be completed, and delays caused by weather.

7.4 Construction Oversight

An Environmental Consultant will conduct construction oversight; observe progress and quality of the construction and remediation of the site, on behalf of the Owner. The Environmental Consultant will be onsite throughout construction (i.e., 5 days/week for 2 weeks total).

The Environmental Consultant will track construction progress, act as a liaison between the Owner and the construction Contractor, observe the quality of construction, provide the Owner and IDEQ with periodic progress reports, and perform clean soil quality assurance testing. Soil sampling during construction will be completed in accordance with the Draft QAPP.

The Environmental Consultant will report to the Owner and IDEQ any part of the Contractor's work in progress: i) that s/he believes will not produce a completed project that conforms generally to the contract documents or will imperil the integrity of the design concept of the completed project, ii) that has been damaged, or iii) that does not meet the approval. The

Environmental Consultant will advise the Owner of that part of work in progress that should be corrected or rejected, and/or requires observation, special testing, or approval.

7.5 Health and Safety Plan

The Contractors will perform work in a safe manner, comply with all federal, state, and local safety rules and regulations, including, but not limited to, the Occupational Safety and Health Act (OSHA) of 1970. Remediation contractors will provide written documentation that all employees engaged in work at the site have received the OSHA 40 hour Hazardous Waste Operations and Emergency Response (HAZWOPER) Training required under the Code of Federal Regulations (CFR) Title 29 Part 1910.120. Remediation contractors will be required to demonstrate compliance with 29 CFR 1910.120 by submittal of a Health and Safety Plan for the scope of work at the site at least seven days prior to commencing work.

Remediation contractors will have the sole and complete obligation to provide a safe and healthful working environment for their employees and for other persons at the site who may be exposed to the contracted work. Remediation contractors will be required to undertake reasonable efforts to prevent injuries to personnel and will, at all times, maintain all equipment in a safe operating condition.

Section 8.0 References and Resources Used

29 Code of Federal Regulations (CFR) 1910.120, "Hazardous Waste Operations and Emergency Response," Title 29, *Code of Federal Regulations*, Part 1910.

American Society for Testing and Materials (ASTM). 2004. D 6724-04, *Standard Guide for Direct Push Groundwater Monitoring Wells*.

Idaho Administrative Procedures Act (IDAPA). 58.01.24. Application of Risk Based Corrective Action at Petroleum Release Sites.

IDAPA. 58.01.18. Idaho Land Remediation Rules.

Idaho Department of Environmental Quality (IDEQ), 2004. Risk Evaluation Manual. Boise, ID. April.

IDEQ, 2012. Idaho Risk Evaluation Manual for Petroleum Releases. Boise, ID. August.

Idaho Statute. Title 55 Chapter 30. Uniform Environmental Covenants Act.

Parma City Data Directory (http://www.city-data.com/city/Parma-Idaho.html, accessed July 27, 2012); (http://parmacity.net/, accessed July 27, 2012).

TerraGraphics Environmental Engineering, Inc. (TerraGraphics), 2011a. Phase I Environmental Site Assessment Report: 102 S. Roswell Road, Parma, ID 83660. Prepared for Idaho Department of Environmental Quality. April 25, 2011.

TerraGraphics, 2011b. Quality Assurance Project Plan for Phase II Environmental Site Assessment at the Former Mahaffey Oil, Parma, Idaho. Prepared for the Idaho Department of Environmental Quality, July 21, 2011.

TerraGraphics, 2011c. Phase II Environmental Site Assessment at the Former Mahaffey Oil, Parma, Idaho. Prepared for the Idaho Department of Environmental Quality, September 30, 2011.

TerraGraphics, 2012. Quality Assurance Project Plan (QAPP) for Additional Phase II Environmental Site Assessment at the Former Mahaffey Oil site in Parma, Idaho. Revision #2.0. Prepared for Idaho Department of Environmental Quality, September 26, 2012.

TerraGraphics, 2013. Draft Quality Assurance Project Plan (QAPP) for the Former Mahaffey Oil in Parma, Idaho. Prepared for Idaho Department of Environmental Quality, June 2013.

US Environmental Protection Agency (USEPA), 1996. Sampling Methods 5035.

USEPA, 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Correction Action, and Underground Storage Tank Sites. OSWER directive 9200.4-17P. April 21, 1999.

USEPA, 2012. "Frequently Asked Questions." <http://www.epa.gov/brownfields/proposal_guides/FY13_FAQs.pdf> Accessed November 28, 2012.

USEPA, 2013. Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites. Last updated May 2013.