GW-001

2 of 2

Bloomfield Refinery
River Terrance
Voluntary Corrective Measures
Bioventing System Annual Report

Submitted .2013

For Duration
Jan. 2012 – Dec. 2012

Appendix A

20.6.2.3103 STANDARDS FOR GROUND WATER OF 10,000 mg/l TDS CONCENTRATION OR LESS: The following standards are the allowable pH range and the maximum allowable concentration in ground water for the contaminants specified unless the existing condition exceeds the standard or unless otherwise provided in Subsection D of Section 20.6.2.3109 NMAC. Regardless of whether there is one contaminant or more than one contaminant present in ground water, when an existing pH or concentration of any water contaminant exceeds the standard specified in Subsection A, B, or C of this section, the existing pH or concentration shall be the allowable limit, provided that the discharge at such concentrations will not result in concentrations at any place of withdrawal for present or reasonably foreseeable future use in excess of the standards of this section. These standards shall apply to the dissolved portion of the contaminants specified with a definition of dissolved being that given in the publication "*methods for chemical analysis of water and waste of the U.S. environmental protection agency*," with the exception that standards for mercury, organic compounds and non-aqueous phase liquids shall apply to the total unfiltered concentrations of the contaminants.

A. Human Health Standards-Ground water shall meet the standards of Subsection A and B of this section unless otherwise provided. If more than one water contaminant affecting human health is present, the toxic pollutant criteria as set forth in the definition of toxic pollutant in Section 20.6.2.1101 NMAC for the combination of contaminants, or the Human Health Standard of Subsection A of Section 20.6.2.3103 NMAC for each contaminant shall apply, whichever is more stringent. Non-aqueous phase liquid shall not be present floating atop of or immersed within ground water, as can be reasonably measured.

(1) Arsenic (As).....0.1 mg/l
(2) Barium (Ba).....1.0 mg/l
(3) Cadmium (Cd).....0.01 mg/l
(4) Chromium (Cr).....0.05 mg/l
(5) Cyanide (CN).....0.2 mg/l
(6) Fluoride (F).....1.6 mg/l
(7) Lead (Pb).....0.05 mg/l
(8) Total Mercury (Hg).....0.002 mg/l
(9) Nitrate (NO_3 as N).....10.0 mg/l
(10) Selenium (Se).....0.05 mg/l
(11) Silver (Ag).....0.05 mg/l
(12) Uranium (U).....0.03 mg/l
(13) Radioactivity: Combined Radium-226 & Radium-228.....30 pCi/l
(14) Benzene.....0.01 mg/l
(15) Polychlorinated biphenyls (PCB's).....0.001 mg/l
(16) Toluene.....0.75 mg/l
(17) Carbon Tetrachloride.....0.01 mg/l
(18) 1,2-dichloroethane (EDC).....0.01 mg/l
(19) 1,1-dichloroethylene (1,1-DCE).....0.005 mg/l
(20) 1,1,2,2-tetrachloroethylene (PCE).....0.02 mg/l
(21) 1,1,2-trichloroethylene (TCE).....0.1 mg/l
(22) ethylbenzene.....0.75 mg/l
(23) total xylenes.....0.62 mg/l
(24) methylene chloride.....0.1 mg/l
(25) chloroform.....0.1 mg/l
(26) 1,1-dichloroethane.....0.025 mg/l
(27) ethylene dibromide (EDB).....0.0001 mg/l
(28) 1,1,1-trichloroethane.....0.06 mg/l
(29) 1,1,2-trichloroethane.....0.01 mg/l
(30) 1,1,2,2-tetrachloroethane.....0.01 mg/l
(31) vinyl chloride.....0.001 mg/l
(32) PAHs: total naphthalene plus monomethylnaphthalenes.....0.03 mg/l
(33) benzo-a-pyrene.....0.0007 mg/l

B. Other Standards for Domestic Water Supply

(1) Chloride (Cl).....250.0 mg/l
(2) Copper (Cu).....1.0 mg/l
(3) Iron (Fe).....1.0 mg/l
(4) Manganese (Mn).....0.2 mg/l
(6) Phenols.....0.005 mg/l
(7) Sulfate (SO_4).....600.0 mg/l
(8) Total Dissolved Solids (TDS).....1000.0 mg/l
(9) Zinc (Zn).....10.0 mg/l
(10) pH.....between 6 and 9

C. Standards for Irrigation Use - Ground water shall meet the standards of Subsection A, B, and C of

this section unless otherwise provided.

(1) Aluminum (Al)..... .....5.0 mg/l
(2) Boron (B) .....0.75 mg/l
(3) Cobalt (Co) .....0.05 mg/l
(4) Molybdenum (Mo) .....1.0 mg/l
(5) Nickel (Ni) .....0.2 mg/l

[2-18-77, 1-29-82, 11-17-83, 3-3-86, 12-1-95; 20.6.2.3103 NMAC - Rn, 20 NMAC 6.2.III.3103, 1-15-01; A, 9-26-04]
[Note: For purposes of application of the amended numeric uranium standard to past and current water discharges (as of 9-26-04), the new standard will not become effective until June 1, 2007. For any new water discharges, the uranium standard is effective 9-26-04

Table of New Mexico and USEPA Groundwater Standards

Metals	(mg/l)
Antimony	0.006 [2]
Arsenic	0.01 [2]
Barium	1.0
Beryllium	0.004 [2]
Cadmium	0.005 [2]
Chromium	0.05
Cobalt	0.05
Copper	1.0
Cyanide	0.2
Lead	0.015[2]
Mercury	0.002
Nickel	0.200
Selenium	0.05
Silver	0.05
Uranium	0.03
Vanadium	0.26[3]
Zinc	10.0

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Semivolatiles	(ug/l)
1,2,4-Trichlorobenzene	70 [2]
1,2-Dichlorobenzene	600[2]
1,3-Dichlorobenzene	Ne
1,4-Dichlorobenzene	75[2]
2,4,5-Trichlorophenol	3,700 [3]
2,4,6-Trichlorophenol	6.1 [3]
2,4-Dichlorophenol	110 [3]
2,4-Dimethylphenol	730 [3]
2,4-Dinitrophenol	73 [3]
2,4-Dinitrotoluene	0.22[3]
2,6-Dinitrotoluene	37 [3]
2-Chloronaphthalene	2900[3]
2-Chlorophenol	180[3]
2-Methylnaphthalene	150[3]
2-Methylphenol	1,800 [3]
2-Nitroaniline	110 [3]
2-Nitrophenol	Ne
3,3'-Dichlorobenzidine	0.15[3]
3+4-Methylphenol	180 [3]
3-Nitroaniline	Ne
4,6-Dinitro-2-methylphenol	Ne
4-Bromophenyl phenyl ether	Ne
4-Chloro-3-methylphenol	Ne
4-Chloroaniline	0.34[3]
4-Chlorophenyl phenyl ether	Ne
4-Nitroaniline	3.4[3]
4-Nitrophenol	Ne
Acenaphthene	2200[3]
Acenaphthylene	Ne

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Semivolatiles	(ug/l)
Aniline	12 [3]
Anthracene	1100[3]
Azobenzene	0.12[3]
Benz(a)anthracene	0.029 [3]
Benzo(a)pyrene	0.2 [2]
Benzo(b)fluoranthene	0.029 [3]
Benzo(g,h,i)perylene	Ne
Benzo(k)fluoranthene	0.29 [3]
Benzoic acid	150,000 [3]
Benzyl alcohol	1800[3]
Bis(2-chloroethoxy)methane	110[3]
Bis(2-chloroethyl)ether	0.012[3]
Bis(2-chloroisopropyl)ether	Ne
Bis(2-ethylhexyl)phthalate	6[3]
Butyl benzyl phthalate	35[3]
Carbazole	Ne
Chrysene	2.9 [3]
Dibenz(a,h)anthracene	0.0029 [3]
Dibenzofuran	Ne
Diethyl phthalate	29,000 [3]
Dimethyl phthalate	Ne
Di-n-butyl phthalate	Ne
Di-n-octyl phthalate	Ne
Fluoranthene	1,500 [3]
Fluorene	1500[3]
Hexachlorobenzene	1.0 [2]
Hexachlorobutadiene	0.86 [3]
Hexachlorocyclopentadiene	50 [2]
Hexachloroethane	4.8 [3]

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Semivolatiles	(ug/l)
Indeno(1,2,3-cd)pyrene	0.029 [3]
Isophorone	71[3]
Naphthalene	0.14[3]
Nitrobenzene	0.12[3]
N-Nitrosodimethylamine	0.00042 [3]
N-Nitrosodi-n-propylamine	0.0096 [3]
N-Nitrosodiphenylamine	14 [3]
Pentachlorophenol	1 [2]
Phenanthrene	Ne
Phenol	5[3]
Pyrene	1100[3]
Pyridine	37 [3]

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Volatiles	(ug/l)
1,1,1,2-Tetrachloroethane	0.52[3]
1,1,1-Trichloroethane	60
1,1,2,2-Tetrachloroethane	10
1,1,2-Trichloroethane	5[2]
1,1-Dichloroethane	25
1,1-Dichloroethene	5
1,1-Dichloropropene	Ne
1,2,3-Trichlorobenzene	Ne
1,2,3-Trichloropropane	0.0096[3]
1,2,4-Trichlorobenzene	70.0[2]
1,2,4-Trimethylbenzene	15.0 [3]
1,2-Dibromo-3-chloropropane	0.2 [2]
1,2-Dibromoethane (EDB)	0.05[2]
1,2-Dichlorobenzene	600.0 [2]
1,2-Dichloroethane (EDC)	5[2]
1,2-Dichloropropane	5.0 [2]
1,3,5-Trimethylbenzene	12[3]
1,3-Dichlorobenzene	Ne
1,3-Dichloropropane	730 [3]
1,4-Dichlorobenzene	75.0 [2]
1-Methylnaphthalene	2.3[3]
2,2-Dichloropropane	Ne
2-Butanone	710.0 [3]
2-Chlorotoluene	730.0 [3]
2-Hexanone	Ne
2-Methylnaphthalene	150[3]
4-Chlorotoluene	2600[3]
4-Isopropyltoluene	Ne
4-Methyl-2-pentanone	Ne

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Volatiles	(ug/l)
Acetone	22000[3]
Benzene	5 [2]
Bromobenzene	20[3]
Bromodichloromethane	0.12[3]
Bromoform	8.5 [3]
Bromomethane	8.7 [3]
Carbon disulfide	1,000 [3]
Carbon Tetrachloride	5[2]
Chlorobenzene	100.0 [2]
Chloroethane	Ne
Chloroform	100
Chloromethane	190 [3]
cis-1,2-DCE	70 [2]
cis-1,3-Dichloropropene	0.4 [3]
Dibromochloromethane	0.15[3]
Dibromomethane	370[3]
Dichlorodifluoromethane	390 [3]
Ethylbenzene	700 [2]
Hexachlorobutadiene	0.86 [3]
Isopropylbenzene	680[3]
Methyl tert-butyl ether (MTBE)	12[3]
Methylene Chloride	5[2]
Naphthalene	0.14[3]
n-Butylbenzene	Ne
n-Propylbenzene	Ne
sec-Butylbenzene	Ne
Styrene	100[2]
tert-Butylbenzene	Ne
Tetrachloroethene (PCE)	5 [2]

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

Volatiles	(ug/l)
Toluene	750
trans-1,2-DCE	100 [2]
trans-1,3-Dichloropropene	0.4 [3]
Trichloroethene (TCE)	5 [2]
Trichlorofluoromethane	1,300 [3]
Vinyl chloride	1
Xylenes, Total	620

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

Table of New Mexico and USEPA Groundwater Standards

General Chemistry	(mg/l)
Alkalinity, Total (As CaCO3)	Ne
Bicarbonate	Ne
Calcium	Ne
Carbonate	Ne
Chloride	250
Fluoride	1.6
Iron	1
Magnesium	Ne
Manganese	0.2
Nitrogen, Nitrate (As N)	10
Nitrogen, Nitrite (As N)	1[2]
Nitrate (As N)+Nitrite (As N)	10
Potassium	Ne
Sodium	Ne
Sulfate	600

Groundwater Standards are WQCC 20NMAC 6.2.3103 unless otherwise indicated

2 - Federal Maximum Contaminant Level

3 - USEPA Regional Screening Levels (April 2009)

Ne - not established

NEW MEXICO ENVIRONMENT DEPARTMENT

Risk Assessment Guidance for Site Investigations and Remediation

February 2012

VOLUME I

TIER 1: SOIL SCREENING GUIDANCE TECHNICAL BACKGROUND DOCUMENT

Hazardous Waste Bureau
and
Ground Water Quality Bureau
Voluntary Remediation Program

TABLE OF CONTENTS
VOLUME I

Tables

Figures

Appendices

LIST OF ACRONYMS

ASTDR	Agency for Toxic Substances and Disease Registry
CalEPA	California Environmental Protection Agency
CMTP	Composite Model for Leachate Migration with Transformation Products
COPC	Contaminants of Potential Concern
CSM	Conceptual Site Model
DAF	Dilution Attenuation Factor
DQO	Data Quality Objectives
EPA/ORD	Environmental Protection Agency Office of Research and Development
GWQB	Groundwater Quality Bureau
HEAST	Health Effects Assessment Summary Tables
HWB	Hazardous Waste Bureau
IEUBK	Integrated Exposure Uptake Biokinetic
IRIS	Integrated Risk Information System
IUR	Inhalation Unit Risk
MRL	Minimum Risk Level
NAPL	Non-aqueous Phase Liquid
NMAC	New Mexico Administrative Code
NMED	New Mexico Environment Department
NRCS	National Resource Conservation Service
PAH	Polycyclic Aromatic Hydrocarbon
PCB	Polychlorinated Biphenyl
PEF	Particulate Emission Factor
PPRTV	Provisional Peer-reviewed Toxicity Value
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RfC	Reference Concentration
RfD	Reference Dose
SCEM	Site Conceptual Exposure Model
SSG	Soil Screening Guidance
SSL	Soil Screening Level
TEF	Toxicity Equivalency Factor
UCL	Upper Confidence Limit
US EPA	United States Environmental Protection Agency
VFs-	Volatilization Factor
VOC	Volatile Organic Compound
WQCC	Water Quality Control Commission

1.0 INTRODUCTION

The New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) and the Ground Water Quality Bureau (GWQB) have developed this soil screening guidance (SSG) for internal department use within corrective action programs. The SSG discusses the methodology used to derive chemical-specific soil screening levels (SSLs). In addition, guidance is provided to assist in identifying and evaluating appropriate exposure pathways and receptors. Finally, this document provides generic SSLs for chemicals commonly found at contaminated sites based on default exposure parameters under residential and non-residential land-use scenarios.

The SSG provides site managers with a framework for developing and applying the SSLs, and is likely to be most useful for determining whether areas or entire sites are contaminated to an extent that warrants further investigation. It is intended to assist and streamline the site investigation and corrective action process by focusing resources on those sites or areas that pose the greatest risk to human health and the environment. Implementation of the methodologies outlined within this SSG may significantly reduce the time necessary to complete site investigations and cleanup actions at certain sites, as well as improve the consistency of these investigations.

Between various sites there can exist a wide spectrum of contaminant types and concentrations. The level of concern associated with those concentrations depends on several factors, including the likelihood of exposure to levels of potential concern to human health or to ecological receptors. At one end of the spectrum are levels that clearly warrant a response action; at the other end are levels that are below regulatory concern. Appropriate cleanup goals for a site may fall anywhere within this range depending on site-specific conditions. It is important to note that SSLs do not in themselves represent cleanup standards, and the SSLs alone do not trigger the need for a response action or define "unacceptable" levels of contamination in soil. Screening levels such as SSLs identify the lower end of this spectrum – levels below which there is generally no need for further concern—provided the conditions associated with the development of the SSLs are consistent with the site being evaluated.

1.1 Organization of the Document

The NMED SSG is organized into five major sections with supporting appendices. The remainder of Section 1 addresses the purpose of the NMED SSLs and outlines the scope of the document. Section 2 outlines the receptors, exposure pathways, and exposure assumptions used in calculating the NMED SSLs. It also discusses the risk levels on which the SSLs are predicated and presents the SSL model assumptions. Finally, Section 2 discusses site assessment/characterization activities that should be completed prior to comparing site contaminant concentrations with SSLs. These activities include development of data quality objectives, conducting site sampling, preparation of a preliminary conceptual site model (CSM), and identification of contaminants of potential concern (COPCs). Section 3 provides a detailed description of the process used to develop pathway-specific SSLs. Included in this section is a discussion of the human health basis for the SSLs, additive risk, and acute exposures. Additional topics discussed in Section 3 include chemical specific parameters used to develop the SSLs and

calculating volatilization factors, particulate emission factors and soil saturation limits. Section 4 presents methodologies for assessing the potential for migration of contaminants to groundwater from contaminated soil in concert with generic and site-specific leaching models. Finally, Section 5 addresses special use considerations for addressing contaminant concentrations in soil and notes specific problems that can arise when applying the SSLs to specific sites. Generic SSLs for contaminants are presented in Table A-1 of Appendix A. Table A-2 of Appendix A presents the default exposure factor values used in the generation of the NMED SSLs. Physical-chemical values in the calculation of the SSLs are presented in Tables B-1 and B-2 of Appendix B. Toxicity criteria are presented in Table C-1 of Appendix C. Additional discussion of polychlorinated biphenyls (PCBs) is provided in Appendix D.

1.2 Scope of the Soil Screening Guidance

The SSG incorporates readily obtainable site data and utilizes methods from various United States Environmental Protection Agency (US EPA) risk assessment guidance and derives site-specific screening levels for selected contaminants and exposure pathways. Key attributes of the SSG include default values for generic SSLs where site-specific information is unavailable, and the identification of parameters for which site-specific information is needed for the development of site-specific SSLs. The goal of the SSG is to provide a consistent approach for developing site-specific SSLs for evaluating facilities under the auspices of the corrective action process within NMED.

The NMED SSLs are based on a 1E-05 target risk for carcinogens, or a hazard quotient of 1 for noncarcinogens. In instances where an individual contaminant has the capacity to elicit both types of responses, the SSLs preferentially report the screening value representative of the lowest (most stringent) contaminant concentration in environmental media. SSLs for migration to groundwater are based on NMED-specific tap water SSLs. As such, the NMED SSLs serve as a generic benchmark for screening level comparisons of contaminant concentrations in soil. NMED anticipates that the SSLs will be used as a tool to facilitate prompt identification of those contaminants and areas that represent the greatest risks to human health and the environment. While concentrations above the NMED SSLs presented in this document do not automatically designate a site as "contaminated" or trigger the need for a response action, detected concentrations in site soils exceeding screening levels suggest that further evaluation is appropriate. Further evaluation may include additional sampling to further characterize the nature and extent of contamination, consideration of background levels, reevaluation of COPCs or associated risk and hazard using site-specific parameters, and/or a reassessment of the assumptions associated with the generic SSLs (e.g., appropriateness of route-to-route extrapolations, use of chronic toxicity values to evaluate childhood and construction-worker exposures).

Prior to calculating site-specific SSLs, each relevant chemical specific parameter value and toxicological datum should be checked against the most recent version of its source to determine if updated data are available.

In the event that a NMED SSL is not listed for a given chemical, other sources of screening levels should be consulted, such as the US EPA Regional Screening Levels (RSLs) (US EPA, 2011) or a review of toxicological data should be conducted and if available a screening level

calculated for that given chemical. Care should be used when other sources of screening levels are used to ensure that target risk/levels used in development of the levels are consistent with those applied by NMED. For example, the US EPA carcinogenic RSLs are based on a 1E-06 risk level and must be adjusted to a 1E-05 risk level for use.

1.2.1 Exposure Pathways

A complete exposure pathway consists of (1) a source, (2) a mechanism of contaminant release, (3) a receiving or contact medium, (4) a potential receptor population, and (5) an exposure route. All five elements must be present for the exposure pathway to be considered complete.

SSLs have been developed for use in evaluating three discrete exposure scenarios representing a variety of potential land uses: residential, commercial/industrial, and construction. The SSG presents lists of potential pathways for each scenario, though these lists are not intended to be exhaustive. Instead, each list represents a set of typical exposure pathways likely to account for the majority of exposure to contaminants in soil at a given site. These include:

- Direct (or incidental) ingestion of soil,
- Dermal contact with soil,
- Inhalation of volatiles and fugitive dusts from contaminated soil, and
- Migration of chemicals through soil to an underlying potable aquifer or water-bearing unit.

Under some site-specific situations, additional complete exposure pathways may be identified. In these cases, a site-specific evaluation of risk is warranted under which additional exposure pathways can be considered. If other land uses and exposure scenarios are determined to be more appropriate for a site (e.g., vapor intrusion pathway, home gardening/farming, recreational land use, and/or Native American land use), the exposure pathways addressed in this document should be modified or augmented accordingly or a site-specific risk assessment should be conducted. Early identification of the need for additional information is important because it facilitates development of a defensible sampling and analysis strategy.

The exposure pathways evaluated addressed in this guidance are presented by land-use scenario in Table 1-1.

Table 1-1. Exposure Pathways Evaluated in Soil Screening Guidance

Potential Exposure Pathway	Residential	Commercial /Industrial	Construction
Direct ingestion of soil	✓	✓	✓
Dermal contact with soil	✓	✓	✓
Inhalation of dust and volatiles from soil	✓	✓	✓
Inhalation of VOCs from vapor intrusion[a]	--	--	--

[a] the inhalation of dust and volatiles from contaminated soil does not account for exposure via vapor intrusion. If volatile organic compounds are present, then the vapor intrusion pathway must be evaluated in addition to the comparison of dust and volatile concentrations against the SSLs.

1.2.2 Exposure Assumptions

SSLs represent risk-based concentrations in soil derived from equations combining exposure assumptions with toxicity criteria following the US EPA's preferred tiered hierarchy of toxicological data (US EPA 2009a, 2006, 2003, and 1997a). The models and assumptions used were developed to be consistent with the Superfund concept of "reasonable maximum exposure" (US EPA 1989 and 2009a). This is intended to provide an upper-bound estimate of chronic exposure by combining both average and conservative (i.e., 90^{th} to 95^{th} percentile) values in the calculations. The default intake and duration assumptions presented here are intended to be protective of all potentially exposed populations for each land use consideration. Exposure point concentrations in soil should reflect either directly measured or estimated values using fate and transport models. When assessing chronic, long-term exposures, the maximum detected site concentration should be used for an initial screen against the SSLs. A more refined assessment may include use of an estimate of the average [95 percent upper confidence level (UCL) of the mean] concentration if sufficient site data to allow for an accurate estimation of the UCL. Where the potential for acute toxicity may be of concern, estimates based on the maximum exposure may be more appropriate.

The resulting estimate of exposure is then compared with chemical-specific toxicity criteria. To calculate the SSLs, the exposure equations and pathway models are rearranged to back calculate an "acceptable level" of a contaminant in soil corresponding to a specific level of target risk or hazard.

1.2.3 Target Risk and Hazard

Target risk and hazard levels for human health are risk management-based criteria for carcinogenic and non-carcinogenic responses, respectively, to determine: (1) whether site-related contamination poses an unacceptable risk to human health and requires corrective action or (2) whether implemented corrective action(s) sufficiently protects human health. If an estimated risk or hazard falls within the target range, the risk manager must decide whether or not the site poses an unacceptable risk. This decision should take into account the degree of inherent conservatism or level of uncertainty associated with the site-specific estimates of risk and hazard. An estimated risk that exceeds these targets, however, does not necessarily indicate that the current conditions are not safe or that they present an unacceptable risk. Rather, a site risk calculation that exceeds a target value may simply indicate the need for further evaluation or refinement of the exposure model.

For cumulative exposure via the ingestion, inhalation, and dermal pathways, toxicity criteria are used to calculate an acceptable level of contamination in soil. SSLs are based on a carcinogenic risk level of one-in-one-hundred thousand (1E-05) and a non-carcinogenic hazard quotient of 1. A carcinogenic risk level is defined as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. The non-carcinogenic hazard quotient assumes that there is a level of exposure below which it is unlikely for even sensitive populations to experience adverse health effects.

1.2.4 SSL Model Assumptions

The models used to calculate inhalation exposure and protection of groundwater based on potential migration of contaminants in soil are intended to be utilized at an early stage in the site investigation process when information regarding the site may be limited. For this reason, the models incorporate a number of simplifying assumptions. For instance, the models assume an infinite contaminant source, i.e. a constant concentration is maintained for the duration of the exposure period. Although this is a highly conservative assumption, finite source models require accurate data regarding source size and volume. Such data are unlikely to be available from limited sampling efforts. The models also assume that contamination is homogeneous throughout the source and that no biological or chemical degradation occurs. Where sufficient site-specific data are available, more detailed finite-source models may be used in place of the default model assumptions presented in this SSG.

2.0 DEVELOPMENT OF PATHWAY SPECIFIC SOIL SCREENING LEVELS

The following sections present the technical basis and limitations used to calculate SSLs for residential, commercial/industrial, and construction land use scenarios. The equations used to evaluate inhalation and migration to groundwater include a number of easily obtainable site-specific input parameters. Where site-specific data are not available, conservative default values are presented. The equations used are presented in Sections 2.2, 2.3, and 2.4. Generic SSLs calculated for 220 chemicals, using these default values, are presented in Table A-1 of Appendix A.

2.1 Human Health Basis

The toxicity criteria used for calculating the SSLs are presented in Table C-1 of Appendix C. The primary sources for the human health benchmarks follow the US EPA Superfund programs tiered hierarchy of human health toxicity values (US EPA 2011, 2003):

1) Integrated Risk Information System (IRIS) (US EPA 2011) (www.epa.gov/iris),
2) Provisional peer reviewed toxicity values (PPRTVs) (now available on-line at http://hhpprtv.ornl.gov/),
3) Agency for Toxic Substances and Disease Registry (ATSDR) (http://www.atsdr.cdc.gov/) and minimal risk levels (MRLs) (http://www.atsdr.cdc.gov/mrls/index.asp),
4) California EPA's Office of Environmental and Health Hazard Assessment values (CalEPA) (http://www.oehha.ca.gov/air/allrels.html and http://www.oehha.ca.gov/risk/pdf/tcdb072109alpha.pdf), and
5) Health Effects Assessment Summary Tables (HEAST) (US EPA 1997a).

Special assumptions were also applied in determining appropriate toxicological data for certain chemicals.

Dioxins/Furans. Toxicity data for the congeners for the dioxin and furan congeners were assessed using the 2005 World Health Organization's (WHO) toxicity equivalency factors (TEF) (Van den berg, et al 2006) and are summarized in Table 2-1. The TEFs were applied to available toxicity data for 2,3,7,8-TCDD.

Table 2-1. Dioxin and Furan Toxicity Equivalency Factors

Dioxin and Furan Congeners	TEF
Chlorinated dibenzo-p-dioxins	
2,3,7,8-TCDD	1
1,2,3,7,8-PeCDD	1
1,2,3,4,7,8-HxCDD	0.1
1,2,3,6,7,8-HxCDD	0.1
1,2,3,7,8,9-HxCDD	0.1
1,2,3,4,6,7,8-HpCDD	0.01
OCDD	0.0003
Chlorinated dibenzofurans	
2,3,7,8-TCDF	0.1
1,2,3,7,8-PeCDF	0.03
2,3,4,7,8-PeCDF	0.3
1,2,3,4,7,8-HxCDF	0.1
1,2,3,6,7,8-HxCDF	0.1
1,2,3,7,8,9-HxCDF	0.1
2,3,4,6,7,8-HxCDF	0.1
1,2,3,4,6,7,8-HpCDF	0.01
1,2,3,4,7,8,9-HpCDF	0.01
OCDF	0.0003

PCBs. Toxicity for the non-ortho [International Union of Pure and Applied Chemistry (IUPAC) numbers 77, 81, 126, and 169)] and mono-ortho congeners (IUPAC numbers 105, 114, 118, 123, 156, 157, 167, and 189) for the PCB congeners were assessed using the 2005 WHO TEFs (Van den berg, et al 2006) while TEFs for di-ortho congeners (IUPAC numbers 170 and 180) are taken from Ahlborg, et al, 1993 (see Table 2-2).

Table 2-2. PCB TEFs

IUPAC No.	Structure	TEF
77	3,3',4,4'-TetraCB	0.0001
81	3,4,4',5-TetraCB	0.0003
105	2,3,3',4,4'-PeCB	0.00003
114	2,3,4,4',5-PeCB	0.00003
118	2,3',4,4',5-PeCB	0.00003
123	2',3,4,4',5-PeCB	0.00003
126	3,3',4,4',5-PeCB	0.1
156	2,3,3',4,4',5-HxCB	0.00003
157	2,3,3',4,4',5'-HxCB	0.00003
167	2,3',4,4',5,5'-HxCB	0.00003
169	3,3',4,4',5,5'-HxCB	0.03
189	2,3,3',4,4',5,5'-HpCB	0.00003
170	2,2',3,3',4,4',5-HpCB	0.0001
180	2,2',3,4,4',5,5'-HpCB	0.00001

Cadmium. IRIS provides an oral reference dose (RfD) for both water and food. For deriving the tap water SSL, the RfD for water was applied and for the soil-based SSL, the RfD for food was applied.

Vanadium. The oral RfD from IRIS was modified to be based on the molecular weight of vanadium versus vanadium sulfate.

Lead. The US EPA recommended levels for lead, based on blood-lead modeling (Integrated Exposure Uptake Biokinetic Model, IEUBK) were applied.

Total Chromium. The IUR for total chromium is based on a ratio of 1:6 (Cr VI:CrIII) as noted in IRIS. If there is reason to believe that this ratio for total chromium is not representative of site conditions, then valence-specific site concentrations and SSLs for chromium III and chromium VI should be applied.

Chromium VI. The IUR for chromium VI was derived by multiplying the total chromium IUR by 7. This is because the total chromium IUR from IRIS is based on a ratio of 1:6 (Cr VI:CrIII).

2.1.1 Additive Risk

It is important to note that no consideration is provided in the calculation of individual NMED SSLs for additive risk when exposures to multiple chemicals occur. The SSG addresses this issue in Section 5. Because the NMED SSLs for carcinogenic effects correspond to a 1E-05 risk level individually, exposure to multiple contaminants may result in a cumulative site risk that is above the anticipated risk management range. While carcinogenic risks of multiple chemicals are simply added together, the issue of additive hazard is more complex for noncarcinogens because of the theory that a threshold exists for noncarcinogenic effects. This threshold is defined as the level below which adverse effects are not expected to occur, and represents the basis for the RfD and reference concentration (RfC). Since adverse effects are not expected to occur at the RfD or RfC and the SSLs are derived by setting the potential exposure dose to the RfD or RfC, the SSLs do not address the risk of exposure to multiple chemicals at levels where the individual chemicals alone would not be expected to cause any adverse effects. In such cases, the SSLs may not provide an accurate indicator for the likelihood of harmful effects. As a first-tier screening approach, noncarcinogenic effects should be considered additive. In the event that the hazard index results in a value above the target level of 1, noncarcinogenic effects may be evaluated for those chemicals with the same toxic endpoint and/or mechanism of action. The sources provided in Section 2.1 should be consulted to determine the endpoint and/or target organ system prior to attempting to evaluate the additive health effects resulting from simultaneous exposure to multiple contaminants.

2.1.2 Acute Exposures

The exposure assumptions used to develop the SSLs are based on a chronic exposure scenario and do not account for situations where high-level exposures may result in acute toxic effects. Such situations may arise when contaminant concentrations are very high, or may result from

specific site-related conditions and/or behavioral patterns (i.e., pica behavior in children). Such exposures may be of concern for those contaminants that primarily exhibit acute health effects. Toxicological information regarding cyanide and phenol indicate that acute effects may be of concern for children exhibiting pica behavior. Pica is typically described as a compulsive craving to ingest non-food items (such as clay or paint). Although it can be exhibited by adults as well, it is typically of greatest concern in children because they often exhibit behavior (e.g., outdoor play activities and greater hand-to-mouth contact) that results in greater exposure to soil than for a typical adult. In addition, children also have a lower overall body weight relative to the predicted intake.

2.1.3 Early-Life Exposures to Carcinogens

US EPA's (2005) Supplemental Guidance states that early life exposures (i.e., neonatal and early life) to carcinogens can result in an increase in cancer risk later in life from exposures to certain carcinogens. US EPA's (2005) suggestion is to apply age-specific factors to the estimated cancer risks. The life stages that were considered were: 1) children under 2 years of age; and 2) children aged 2 to 6 years; 3) children 6 years to 16 years of age; and 4) after 16 years of age. Effects of mutagenicity have been incorporated into the SSLs for those contaminants which are considered carcinogenic by a mutagenic mode of action.

2.1.4 Direct Ingestion

Exposure to contaminants through incidental ingestion of soil can result from the inadvertent consumption of soils adhering to the hands, food items, or objects that are placed into the mouth. It can also result from swallowing dust particles that have been inhaled and deposited in the mouth and subsequently swallowed. Commercial/industrial, construction workers, and residential receptors may inadvertently ingest soil that adheres to their hands while involved in work- or recreation-related activities. Calculation of SSLs for direct ingestion are based on the methodology presented in US EPA's *Risk Assessment Guidance for Superfund (RAGS): Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), Interim* (US EPA 1991 2001), *Soil Screening Guidance: Technical Background Document* (US EPA 1996a), and *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA 2002a).

2.1.5 Dermal Absorption

Exposure to soil contaminants may result from dermal contact with contaminated soil and the subsequent absorption of contaminants through the skin. Contact with soil is most likely to occur as a result of digging, gardening, landscaping, or outdoor recreation activities. Excavation activities may also be a potential source of exposure to contaminants, particularly for construction workers. Calculation of the screening levels for ingestion of soil under the residential exposure scenario is based on the methodology presented in US EPA's *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), Interim* (1991), and *Soil Screening Guidance: Technical Background Document* (US EPA 1996a). The suggested default input values used to develop the NMED SSLs are consistent with US EPA's interim *RAGS, Part E,*

Supplemental Guidance for Dermal Risk Assessment (US EPA 2004).

2.1.6 Inhalation

US EPA toxicity data indicate that risks from exposure to some chemicals via the inhalation pathway far outweigh the risk via ingestion or dermal contact; therefore, the NMED SSLs have been designed to address inhalation of volatiles and fugitive dusts. To address the soil/sediment-to-air pathways, the SSL calculations incorporate a volatilization factor (VF) for volatile contaminants (See Section 3.1) and a particulate emission factor (PEF) (See Section 3.3) for nonvolatile and volatile contaminants. The SSLs follow the procedures for evaluating inhalation soil, volatile organic compounds (VOCs), and fugitive dust particles presented in US EPA's *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment), Final (US EPA 2009a), Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), Interim* (US EPA 1991), *Soil Screening Guidance: Technical Background Document* (US EPA 1996a), *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (US EPA 1998a), and *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA 2002a).

VOCs may adhere to soil particles or be present in interstitial air spaces in soil, and may volatilize into ambient air. This pathway may be particularly significant if the VOC emissions are concentrated in indoor spaces of onsite buildings, or buildings that may be built in the future. The NMED SSLs do not account for vapor intrusion and inhalation of volatile organics volatilized into indoor air. If vapor intrusion into indoor air is a concern, additional analysis of this pathway may be necessary and the latest guidance on evaluating the vapor intrusion pathway should be consulted: for example, the US EPA's 2002 *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Soil Vapor Intrusion Guidance.* For the purpose of calculating the NMED SSLs, VOCs are considered those chemicals having a Henry's Law constant greater than 1E-05 atm-m^3/mole and a molecular weight less than 200 g/mole.

Inhalation of contaminants via inhalation of fugitive dusts is assessed using a PEF that relates the contaminant concentration in soil/sediment with the concentration of respirable particles in the air due to fugitive dust emissions. It is important to note that the PEF used to address residential and commercial/industrial exposures evaluates only windborne dust emissions and does not consider emissions from traffic or other forms of mechanical disturbance which could lead to a greater level of exposure. The PEF used to address construction worker exposures evaluates windborne dust emissions and emissions from vehicle traffic associated with construction activities. Therefore, the fugitive dust pathway should be considered carefully when developing the CSM at sites where receptors may be exposed to fugitive dusts by other mechanisms. The development of the PEF for both residential and non-residential land uses is discussed further in Section 3.3.

2.2 Residential land uses

Residential exposures are assessed based on child and adult receptors. As discussed below, the child forms the basis for evaluation of noncarcinogenic effects incurred under residential exposures, while carcinogenic responses are modeled based upon age-adjusted values to account for exposures averaged over a lifetime. Under most circumstances, onsite residential receptors are expected to be the most conservative receptor basis for risk assessment purposes due to the assumption that exposure occurs 24 hours a day, 350 days per year, extending over a 30-year exposure duration. Table 2-3 provides a summary of the exposure characteristics and parameters associated with a residential land use receptor.

Table 2-3. Summary of the Residential Land Use Receptors

Exposure Characteristics	• Substantial soil exposure (esp. children) • High soil ingestion rate (esp. children) • Significant time spent indoors • Long-term exposure • Surface and subsurface soil exposure (0-10 feet below ground surface, bgs)
Default Exposure Parameters	
Exposure frequency (days/yr)	350
Exposure duration (yr)	6 (child) 24 (adult)
Soil ingestion rate (mg/day)	200 (child) 100 (adult)
Body Weight (kg)	15 (child) 70 (adult)
Skin surface area exposed (cm^2)	2,800 (child) 5,700 (adult)
Skin-soil adherence factor (mg/cm^2)	0.2 (child) 0.07 (adult)

2.2.1 Residential Receptors

A residential receptor is assumed to be a long-term receptor occupying a dwelling within the site boundaries and thus is exposed to contaminants 24 hours per day, and is assumed to live at the site for 30 years (representing the 90^{th} percentile of the length of time someone lives in a single location), remaining onsite for 350 days per year. Exposure to soil (to depths of zero to 10 feet below ground surface) is expected to occur during home maintenance activities, yard work and landscaping, and outdoor play activities. The SSLs do not take into consideration ingestion of homegrown produce/meat/dairy or inhalation of volatiles migrating indoors via vapor intrusion.

If these pathways are complete, analysis of risks resulting from these additional exposure pathways must be determined and added to the risks determined using the SSL screen.

Contaminant intake is assumed to occur via three exposure pathways – direct ingestion, dermal absorption, and inhalation of volatiles and fugitive dusts. For the residential scenario, both adult and child receptors were evaluated because children often exhibit behavior (e.g., greater hand-to-mouth contact) that can result in greater exposure to soils than those associated with a typical adult. In addition, children also have a lower overall body weight relative to the predicted intake.

Equations 1 and 2 are used to calculate cumulative SSLs for a residential receptor exposed to non-carcinogenic and carcinogenic contaminants via all three exposure pathways (ingestion of soil, inhalation of soil, and dermal contact with soil). Default exposure parameters are provided for use when site-specific data are not available.

Equation 1
Combined Exposures to Noncarcinogenic Contaminants in Soil, Residential Scenario

$$C_{oral} = \frac{THQ \times AT_r \times BW_c}{EF_r \times ED_c \times (1/RfD_o) \times IRS_c \times (10^{-6})}$$

$$C_{inh} = \frac{THQ \times AT_r}{EF_r \times ED_c \times ET_{rs} \times (1/RfC) \times [(1/VF_s) + (1/PEF_w)]}$$

$$C_{dermal} = \frac{THQ \times AT_r \times BW_c}{EF_r \times ED_c \times [1/(RfD_o \times GIABS)] \times SA_c \times AF_c \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{res} = \frac{1}{\frac{1}{C_{oral}} + \frac{1}{C_{inh}} + \frac{1}{C_{dermal}}}$$

Parameter	Definition (units)	Default
C_{oral}	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
C_{dermal}	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
C_{inh}	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{res}	Soil screening level, all pathways (mg/kg)	Chemical-specific
THQ	Target hazard quotient	1
BW_c	Body weight, child (kg)	15

AT_r	Averaging time, noncarcinogens (days)	ED_c x 365
EF_r	Exposure frequency, resident (day/yr)	350
ED_c	Exposure duration, child (years)	6
ET_{rs}	Exposure time, resident (hour/day x day/hour)	1
IRS_c	Soil ingestion rate, child (mg/day)	200
RfD_o	Oral reference dose (mg/kg-day)	Chemical-specific
SA_c	Dermal surface area, child (cm^2/day)	2,800
AF_c	Soil adherence factor, child (mg/cm^2)	0.2
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
ABS_d	Skin absorption factor (unitless)	Chemical-specific
RfC	Inhalation reference concentration (mg/m^3)	Chemical-specific
10^{-6}	Unit conversion factor (kg)/mg	10^{-6}
VF_s	Volatilization factor for soil (m^3/kg)	See Equation 22
PEF_w	Particulate emission factor (m^3/kg)	See Equation 24

Equation 2
Combined Exposures to Carcinogenic Contaminants in Soil, Residential Scenario

$$C_{oral} = \frac{TR \times AT_r}{CFS_o \times EF_r \times IFS_{adj} \times 10^{-6}}$$

$$C_{inh} = \frac{TR \times AT_r}{IUR \times 1000 \times EF_r \times \left(\frac{1}{VF_s} + \frac{1}{PEF_w}\right) \times ED_r \times ET_{rs}}$$

$$C_{dermal} = \frac{TR \times AT_r}{EF_r \times SFS_{adj} \times \frac{CFS_o}{GIABS} \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{res} = \frac{1}{\frac{1}{C_{oral}} + \frac{1}{C_{inh}} + \frac{1}{C_{dermal}}}$$

Parameter	Definition (units)	Default
C_{oral}	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
C_{dermal}	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
C_{inh}	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{res}	Soil screening level, all pathways (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
EF_r	Exposure frequency, resident (day/yr)	350

IFS_{adj}	Age-adjusted soil ingestion factor ([mg-yr]/[kg-day]) (See Equation 3)	114
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
SFS_{adj}	Age-adjusted dermal factor ([mg-yr]/[kg-day]) (See Equation 4)	361
ABS_d	Skin absorption factor (unitless)	Chemical-specific
1000	Unit conversion factor (µg/mg)	1000
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
ED_r	Exposure duration, resident (years)	30
ET_{rs}	Exposure time, resident (hour/day x day/hour)	1
10^{-6}	Unit conversion factor (kg/mg)	10^{-6}
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
VF_s	Volatilization factor for soil (m^3/kg)	See Equation 22
PEF_w	Particulate emission factor (m^3/kg)	See Equation 24

Noncarcinogenic contaminants are evaluated based solely on childhood exposures using Equation 1. By combining the higher contaminant intake rates with the lower relative body weight, "childhood only" exposures lead to a lower, or more conservative, risk-based concentration compared to an adult-only exposure. In addition, this approach is considered conservative because it combines the higher 6-year exposure for children with chronic toxicity criteria.

Unlike non-carcinogens, the duration of exposure to carcinogens is averaged over the lifetime of the receptor because of the assumption that cancer may develop even after actual exposure has ceased. As a result, the total dose received is averaged over a lifetime of 70 years. In addition, to be protective of exposures in a residential setting, the carcinogenic exposure parameter values are age-adjusted to account for exposures incurred in children (1-6 years of age) and adults (7-31 years of age). Carcinogenic exposures are age-adjusted to account for the physiological differences between children and adults as well as behavioral differences that result in markedly different relative rates of exposure. Equations 3 and 4 are used to calculate age-adjusted ingestion, dermal and inhalation factors which account for the differences in soil ingestion rate, skin surface area, soil adherence factors, inhalation rate, and body weight for children versus adults. The age-adjusted factors calculated using these equations are applied in Equation 2 to develop generic NMED SSLs for carcinogenic effects.

Equation 3
Calculation of Age-Adjusted Soil Ingestion Factor

$$IFS_{adj} = \frac{ED_c \times IRS_c}{BW_c} + \frac{(ED_r - ED_c) \times IRS_a}{BW_a}$$

Parameter	Definition (units)	Default
IFS_{adj}	Age-adjusted soil ingestion factor for carcinogens [(mg-yr)/(kg-day)]	114
ED_c	Exposure duration, child (years)	6
IRS_c	Soil ingestion rate, child (mg/day)	200

BW_c	Body weight, child (kg)	15
ED_r	Exposure duration, resident (years)	30
IRS_a	Soil ingestion rate, adult (mg/day)	100
BW_a	Body weight, adult (kg)	70

Equation 4
Calculation of Age-Adjusted Soil Dermal Factor

$$SFS_{adj} = \frac{ED_c \times AF_c \times SA_c}{BW_c} + \frac{(ED_r - ED_c) \times AF_a \times SA_a}{BW_a}$$

Parameter	Definition (units)	Default
SFS_{adj}	Age-adjusted dermal factor for carcinogens [(mg-yr)/(kg-day)]	361
ED_c	Exposure duration, child (years)	6
AF_c	Soil adherence factor, child (mg/cm^2)	0.2
SA_c	Dermal surface area, child (cm^2/day)	2,800
BW_c	Body weight, child (kg)	15
ED_r	Exposure duration, resident (years)	30
AF_a	Soil adherence factor, adult (mg/cm^2)	0.07
SA_a	Dermal surface area, adult (cm^2/day)	5,700
BW_a	Body weight, adult (kg)	70

Equations 1 and 2 are appropriate for all chemcials with the exception of vinyl chloride and those carcinogens exhibiting mutegenic toxicity. For vinyl chloride, the US EPA IRIS database provides cancer slope factors for both a child and an adult. The child-based cancer slope factor takes into consideration potential risks during the developmental stages of childhood and thus is more protective than the adult cancer slope factor. The equations used to derive the SSLs for vinyl chloride incorporate age adjustments for exposure and are presented in Equation 5. As vinyl chloride does not have an adsorption factor, dermal risks are not assessed.

Equation 5
Combined SSL for Vinyl Chloride
Residential Scenario

$$C_{vc-oral} = \frac{TR}{\left(\frac{CFS_o \times EF_r \times IFS_{adj} \times 10^{-6}}{AT}\right) + \left(\frac{CFS_o \times IRS_c \times 10^{-6}}{BW_c}\right)}$$ Equation 5

$$C_{vc-inh} = \frac{TR}{\left(\frac{IUR \times EF_r \times ED \times ET_{rs} \times 1000}{AT \times VF} + \left(\frac{IUR}{VF} \times 1000\right)\right)}$$ Equation 6

Combined Exposures:

$$SSL_{res-vc} = \frac{1}{\frac{1}{C_{vc-oral}} + \frac{1}{C_{vc-inh}}}$$

Parameter	Definition (units)	Default
$C_{vc-oral}$	Contaminant concentration (mg/kg)	Chemical-specific
C_{vc-inh}	Contaminant concentration (mg/kg)	Chemical-specific
C_{res-vc}	Combined SSL for vinyl chloride (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
BW_c	Body weight, child (kg)	15
AT	Averaging time, carcinogens (days)	25,550
EF_r	Exposure frequency, resident (day/yr)	350
IFS_{adj}	Age-adjusted soil ingestion factor ([mg-yr]/[kg-day]) (See Equation 3)	114
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
IRS_c	Child soil ingestion factor (mg/day)	200
10^{-6}	Unit conversion factor (kg/mg)	10^{-6}
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
EF_r	Exposure frequency, resident (day/yr)	350
ED	Exposure duration (yr)	30
ET_{rs}	Exposure time (hour/day x day/hour)	1
1000	Conversion factor (µg/mg)	1000
VF	Volatilization factor for soil (m^3/kg)	See Equation 22

Equations 6 through 11 show the derivation of the SSLs for carcinogenic chemicals exhibiting mutagenic properties. Mutagenicity is only assessed for the residential scenario.

Equation 6
SSL for Ingestion of Soil- Mutagens

$$C_{mu-oral} = \frac{TR \times AT_r}{CFS_o \times EF_r \times IFSM_{adj} \times 10^{-6}}$$

Parameter	Definition (units)	Default
$C_{mu-oral}$	Contaminant concentration (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor (mg/kg-day)$^{-1}$	Chemical-specific
EF_r	Exposure frequency, resident (day/yr)	350
$IFSM_{adj}$	Age-adjusted soil ingestion rate (mg-yr/kg-day) (See Equation 7)	489.5
10^{-6}	Conversion factor (kg/mg)	10^{-6}

Equation 7
Calculation of Age-Adjusted Soil Ingestion Factor, Mutagens

$$IFSM_{adj} = \frac{ED_{0-2} \times IRS_c \times 10}{BW_c} + \frac{ED_{2-6} \times IRS_c \times 3}{BW_c} + \frac{ED_{6-16} \times IRS_a \times 3}{BW_a} + \frac{ED_{16-30} \times IRS_a \times 1}{BW_a}$$

Parameter	Definition (units)	Default
$IFSM_{adj}$	Age-adjusted soil ingestion factor for mutagens [(mg-yr)/(kg-day)]	489.5
ED_{0-2}	Exposure duration, child (years)	2
ED_{2-6}	Exposure duration, child (years)	4
ED_{6-16}	Exposure duration, adult (years)	10
ED_{16-30}	Exposure duration, adult (years)	24
IRS_c	Soil ingestion rate, child (mg/day)	200
IRS_a	Soil ingestion rate, adult (mg/day)	100
BW_c	Body weight, child (kg)	15
BW_a	Body weight, adult (kg)	70
BW_a	Body weight, adult (kg)	70

Equation 8
SSL for Inhalation of Soil- Mutagens

$$C_{mu-inh} = \frac{TR \times AT_r}{(EF_r \times ET_{rs} \times 1000) \times [(ED_{0-2} \times IUR \times 10) + (ED_{2-6} \times IUR \times 3) + (ED_{6-16} \times IUR \times 3) + (ED_{16-30} \times IUR \times 1)] \times \left(\frac{1}{VF_s} + \frac{1}{PEF_w}\right)}$$

Parameter	Definition (units)	Default
C_{mu-inh}	Contaminant concentration (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
IUR	Inhalation Unit Risk $(\mu g/m^3)^{-1}$	Chemical-specific
EF_r	Exposure frequency, resident (day/yr)	350
ED	Exposure duration (yr)	
	ED_{0-2}	2
	ED_{2-6}	4
	ED_{6-16}	10
	ED_{16-30}	14
ET_{rs}	Exposure time (hour/day x day/hour)	1
1000	Conversion factor (µg/mg)	1000
VF_s	Volatilization factor for soil (m^3/kg)	See Equation 22
PEF_w	Particulate emission factor (m^3/kg)	See Equation 24

Equation 9
SSL for Dermal Contract with Soil- Mutagens

$$C_{mu-dermal} = \frac{TR \times AT_r}{\frac{CFS_o}{GIABS} \times EF_r \times DFSM_{adj} \times ABS_d \times 10^{-6}}$$

Parameter	Definition (units)	Default
$C_{mu-dermal}$	Contaminant concentration (mg/kg)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
CFS_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
EF_r	Exposure frequency, resident (day/yr)	350
$DFSM_{adj}$	Age-adjusted soil contact factor (mg-yr/kg-day) (See Equation 10)	1445
ABS_d	Skin absorption factor (unitless)	Chemical-specific
10^{-6}	Conversion factor (kg/mg)	10^{-6}

Equation 10
Calculation of Age-Adjusted Soil Contact Factor, Mutagens

$$DFSM_{adj} = \frac{ED_{0-2} \times AF_c \times SA_c \times 10}{BW_c} + \frac{ED_{2-6} \times AF_c \times SA_c \times 3}{BW_c} + \frac{ED_{6-16} \times AF_a \times SA_a \times 3}{BW_a} + \frac{ED_{16-30} \times AF_a \times SA_a \times 1}{BW_a}$$

Parameter	Definition (units)	Default
$DFSM_{adj}$	Age-adjusted soil contact factor for mutagens [(mg-yr)/(kg-day)]	1445
ED_{0-2}	Exposure duration, child (years)	2
ED_{2-6}	Exposure duration, child (years)	4
ED_{6-16}	Exposure duration, adult (years)	10
ED_{16-30}	Exposure duration, adult (years)	14
AF_c	Soil adherence factor, child (mg/cm^2)	0.02
AF_a	Soil adherence factor, adult (mg/cm^2)	0.07
SA_c	Exposed skin area, child, (cm^2/day)	2800
SA_a	Exposed skin area, adult, (cm^2/day)	5700
BW_c	Body weight, child (kg)	15
BW_a	Body weight, adult (kg)	70

The overall SSL for the residential scenario for mutagens is determined following Equation 11.

Equation 11
Determination of the Combined SSL
Mutagens

$$SSL_{res-mu} = \frac{1}{\frac{1}{C_{mu-oral}} + \frac{1}{C_{mu-inh}} + \frac{1}{C_{mu-dermal}}}$$

Parameter	Definition (units)	Default
SSL_{res-mu}	Cumulative SSL for mutagens (mg/kg)	Chemical-specific
$C_{mu-oral}$	Concentration from soil ingestion (mg/kg) (See Equation 6)	Receptor-specific
C_{mu-inh}	Concentration from inhalation (mg/kg) (See Equation 8)	Receptor-specific
$C_{mu-dermal}$	Concentration from dermal exposure (mg/kg) (See Equation 9)	Receptor-specific

2.3 Non-residential land uses

Non-residential land uses encompass all commercial and industrial land uses and focus on two very different receptors -- a commercial/industrial worker and a construction worker. Unlike those calculated for residential land-uses, NMED SSLs for non-residential land uses are based solely on exposures to adults. Consequently, exposures to carcinogens are not age-adjusted. Due to the wide range of activities and exposure levels a non-residential receptor may be

exposed to during various work-related activities, it is important to ensure that the default exposure parameters are representative of site-specific conditions. Table 2-4 provides a summary of the exposure characteristics and parameters for non-residential land use receptors.

Table 2-4. Summary of Non-Residential Land Use Receptors

Receptor	Commercial/Industrial Worker	Construction Worker
Exposure Characteristics	• Substantial soil exposures • High soil ingestion rate • Long-term exposure • Exposure to surface and shallow subsurface soils (0-1 foot bgs) • Adult-only exposure	• Exposed during construction activities only • Short-term exposure • Very high soil ingestion and dust inhalation rates • Exposure to surface and subsurface soils (0-10 feet bgs)
Default Exposure Parameters		
Exposure frequency (days/yr)	225	250
Exposure duration (yr)	25	1
Soil ingestion rate (mg/day)	100	330
Body Weight (kg)	70	70
Skin surface area exposed (cm^2)	3,300	3,300
Skin-soil adherence factor (mg/ cm^2)	0.2	0.3

2.3.1 Commercial/Industrial Worker

The commercial/industrial scenario is considered representative of on-site workers who spend all or most of their workday outdoors. A commercial/industrial worker is assumed to be a long-term receptor exposed during the course of a work day as either (1) a full time employee of a company operating on-site who spends most of the work day conducting maintenance or manual labor activities outdoors or (2) a worker who is assumed to regularly perform grounds-keeping activities as part of his/her daily responsibilities. Exposure to surface and shallow subsurface soils (i.e., at depths of zero to 1 ft below ground surface) is expected to occur during moderate digging associated with routine maintenance and grounds-keeping activities. A commercial/industrial receptor is expected to be the most highly exposed receptor in the outdoor environment under generic or day-to-day commercial/industrial conditions. Thus, the screening levels for this receptor are expected to be protective of other reasonably anticipated indoor and outdoor workers at a commercial/industrial facility. However, screening levels developed for the commercial/industrial worker may not be protective of a construction worker due to the latter's increased soil contact rate during construction activities. In addition, the SSLs for the commercial/industrial worker do not account for inhalation of volatiles indoors via vapor intrusion.

Equations 12 and 13 were used to develop generic SSLs for cumulative exposure to carcinogenic and non-carcinogenic contaminants by all exposure pathways. Default exposure parameters (US EPA 2002a) are provided and were used in calculating the NMED SSLs.

Equation 12
Combined Exposures to Carcinogenic Contaminants in Soil
Commercial/Industrial Scenario

$$C_{CI-oral} = \frac{TR \times AT_{CI} \times BW_{CI}}{CFS_o \times EF_{CI} \times ED_{CI} \times IR_{CI} \times 10^{-6}}$$

$$C_{CI-inh} = \frac{TR \times AT_{CI}}{IUR \times 1000 \times EF_{CI} \times \left(\frac{1}{VF_s} + \frac{1}{PEF_w}\right) \times ED_{CI} \times ET_{CI}}$$

$$C_{CI-dermal} = \frac{TR \times AT_{CI} \times BW_{CI}}{EF_{CI} \times ED_{CI} \times \frac{CFS_o}{GIABS} \times SA_{CI} \times AF_{CI} \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{CI} = \frac{1}{\frac{1}{C_{CI-oral}} + \frac{1}{C_{CI-inh}} + \frac{1}{C_{CI-dermal}}}$$

Parameter	Definition (units)	Default
$C_{CI\text{-}oral}$	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
$C_{CI\text{-}dermal}$	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
$C_{CI\text{-}inh}$	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{CI}	Contaminant concentration, all pathways (mg/kg)	Chemical-specific
TR	Target Risk	1E-05
BW_{CI}	Body weight, adult (kg)	70
AT_{CI}	Averaging time, carcinogens (days)	25,550
EF_{CI}	Exposure frequency, commercial/industrial (day/yr)	225
ED_{CI}	Exposure duration, commercial/industrial (years)	25
IR_{CI}	Soil ingestion rate, commercial/industrial (mg/day)	100
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
SA_{CI}	Dermal surface area, commercial/industrial (cm^2/day)	3,300
AF_{CI}	Soil adherence factor, commercial/industrial (mg/cm^2)	0.2
ABS_d	Skin absorption factor (unitless)	Chemical-specific

ET_{CI}	Exposure time, commercial/industrial (8 hours/per 24 hours)	0.33
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
1000	Unit conversion (µg/mg)	1000
VF_s	Volatilization factor for soil (m^3/kg)	See Equation 22
PEF_w	Particulate emission factor (m^3/kg)	See Equation 24

Equation 13
Combined Exposures to Noncarcinogenic Contaminants in Soil
Commercial/Industrial Scenario

$$C_{CI-oral} = \frac{THQ \times AT_{CI} \times BW_a}{EF_{CI} \times ED_{CI} \times (1/RfD_o) \times IR_{CI} \times (10^{-6})}$$

$$C_{CI-inh} = \frac{THQ \times AT_{CI}}{EF_{CI} \times ED_{CI} \times ET_{CI} \times (1/RfC) \times [(1/VF_s) + (1/PEF_w)]}$$

$$C_{CI-dermal} = \frac{THQ \times AT_{CI} \times BW_a}{EF_{CI} \times ED_{CI} \times [1/(RfD_o \times GIABS)] \times SA_{CI} \times AF_{CI} \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{CI} = \frac{1}{\frac{1}{C_{CI-oral}} + \frac{1}{C_{CI-inh}} + \frac{1}{C_{CI-dermal}}}$$

Parameter	Definition (units)	Default
$C_{CI\text{-}oral}$	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
$C_{CI\text{-}dermal}$	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
$C_{CI\text{-}inh}$	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{CI}	Soil screening level, all pathways (mg/kg)	Chemical-specific
THQ	Target hazard quotient	1
BW_a	Body weight, adult (kg)	70
AT_{CI}	Averaging time, noncarcinogens (days)	ED x 365
EF_{CI}	Exposure frequency, commercial/industrial (day/yr)	225
ED_{CI}	Exposure duration, commercial/industrial (years)	25
IR_{CI}	Soil ingestion rate, commercial/industrial (mg/day)	100
10^{-6}	Unit conversion factor (kg/mg)	10^{-6}

RfD_o	Oral reference dose (mg/kg-day)	Chemical-specific
SA_{CI}	Dermal surface area, commercial/industrial (cm^2/day)	3,300
AF_{CI}	Soil adherence factor, commercial/industrial (mg/cm^2)	0.2
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
ABS_d	Skin absorption factor (unitless)	Chemical-specific
ET_{CI}	Exposure time(8 hours/day per 1 day/24 hour)	0.33
RfC	Reference concentration (mg/m^3)	Chemical-specific
VF_s	Volatilization factor for soil (m^3/kg)	See Equation 22
PEF_w	Particulate emission factor (m^3/kg)	See Equation 24

2.3.2 Construction Worker

A construction worker is assumed to be a receptor that is exposed to contaminated soil during the work day for the duration of a single on-site construction project. If multiple construction projects are anticipated, it is assumed that different workers will be employed for each project. The activities for this receptor typically involve substantial exposures to surface and subsurface soils (i.e., at depths of zero to 10 feet below ground surface) during excavation, maintenance and building construction projects (intrusive operations). A construction worker is assumed to be exposed to contaminants via the following pathways: incidental soil ingestion, dermal contact with soil, and inhalation of contaminated outdoor air (volatile and particulate emissions). While a construction worker receptor is assumed to have a higher soil ingestion rate than a commercial/industrial worker due to the type of activities performed during construction projects, the exposure frequency and duration are assumed to be significantly shorter due to the short-term nature of construction projects. However, chronic toxicity information was used when developing screening levels for a construction worker receptor. This approach is significantly more conservative than using sub-chronic toxicity data because it combines the higher soil exposures for construction workers with chronic toxicity criteria. Equations 14 and 15 were used to develop generic SSLs for cumulative exposure to carcinogenic and non-carcinogenic contaminants by all exposure pathways for a construction worker. Default exposure parameters (US EPA 2002a) are provided and were used in calculating the NMED SSLs.

Equation 14
Combined Exposures to Carcinogenic Contaminants in Soil
Construction Worker Scenarios

$$C_{CW-oral} = \frac{TR \times AT_{CW} \times BW_{CW}}{CFS_o \times EF_{CW} \times ED_{CW} \times IR_{CW} \times 10^{-6}}$$

$$C_{CW-inh} = \frac{TR \times AT_{CW}}{IUR \times 1000 \times EF_{CW} \times \left(\frac{1}{VF_{cw}} + \frac{1}{PEF_{cw}}\right) \times ED_{CW} \times ET_{CW}}$$

$$C_{CW-dermal} = \frac{TR \times AT_{CW} \times BW_{CW}}{EF_{CW} \times ED_{CW} \times \frac{CFS_o}{GIABS} \times SA_{CW} \times AF_{CW} \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{CW} = \frac{1}{\frac{1}{C_{CW-oral}} + \frac{1}{C_{CW-inh}} + \frac{1}{C_{CW-dermal}}}$$

Parameter	Definition (units)	Default
$C_{CW\text{-}oral}$	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
$C_{CW\text{-}dermal}$	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
$C_{CW\text{-}inh}$	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{CW}	Contaminant concentration, all pathways (mg/kg)	Chemical-specific
TR	Target Risk	1E-05
BW_{CW}	Body weight, adult (kg)	70
AT_{CW}	Averaging time, carcinogens (days)	365
EF_{CW}	Exposure frequency, construction worker (day/yr)	250
ED_{CW}	Exposure duration, construction worker (years)	1
IR_{CW}	Soil ingestion rate, construction worker (mg/day)	330
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
SA_{CW}	Dermal surface area, construction worker (cm^2/day)	3,300
AF_{CW}	Soil adherence factor, construction worker (mg/cm^2)	0.3
ABS_d	Skin absorption factor (unitless)	Chemical-specific
ET_{CW}	Exposure time, construction worker (8 hours/day per 1 day/24 hours)	0.33
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
1000	Unit conversion (µg/mg)	1000
VF_{cw}	Volatilization factor for soil (m^3/kg)	See Equation 22
PEF_{cw}	Particulate emission factor (m^3/kg)	See Equation 25

Equation 15
Combined Exposures to Noncarcinogenic Contaminants in Soil
Construction Worker Scenario

$$C_{CW-oral} = \frac{THQ \times AT_{CW} \times BW_{CW}}{EF_{CW} \times ED_{CW} \times (1/RfD_o) \times IR_{CW} \times (10^{-6})}$$

$$C_{CW-inh} = \frac{THQ \times AT_{CI}}{EF_{CW} \times ED_{CW} \times ET_{CW} \times (1/RfC) \times [(1/VF_{cw}) + (1/PEF_{cw})]}$$

$$C_{CW-dermal} = \frac{THQ \times AT_{CW} \times BW_{cw}}{EF_{CW} \times ED_{CW} \times [1/(RfD_o \times GIABS)] \times SA_{CW} \times AF_{CW} \times ABS_d \times 10^{-6}}$$

Combined Exposures:

$$SSL_{CW} = \frac{1}{\frac{1}{C_{CW-oral}} + \frac{1}{C_{CW-inh}} + \frac{1}{C_{CW-dermal}}}$$

Parameter	Definition (units)	Default
$C_{CW\text{-}oral}$	Contaminant concentration via oral ingestion (mg/kg)	Chemical-specific
$C_{CW\text{-}dermal}$	Contaminant concentration via dermal adsorption (mg/kg)	Chemical-specific
$C_{CW\text{-}inh}$	Contaminant concentration via inhalation (mg/kg)	Chemical-specific
SSL_{CW}	Soil screening level, all pathways (mg/kg)	Chemical-specific
THQ	Target hazard quotient	1
BW_{cw}	Body weight, adult (kg)	70
AT_{CW}	Averaging time, noncarcinogens (days)	ED x 365
EF_{CW}	Exposure frequency, construction worker (day/yr)	250
ED_{CW}	Exposure duration, construction worker (years)	1
IR_{CW}	Soil ingestion rate, construction worker (mg/day)	330
10^{-6}	Unit conversion factor (kg/mg)	10^{-6}
RfD_o	Oral reference dose (mg/kg-day)	Chemical-specific
SA_{CW}	Dermal surface area, construction worker (cm^2/day)	3,300
AF_{CW}	Soil adherence factor, construction worker (mg/cm^2)	0.3
GIABS	Fraction absorbed in gastrointestinal tract (unitless)	Chemical-specific
ABS_d	Skin absorption factor (unitless)	Chemical-specific
ET_{CW}	Exposure time(8 hours/day per 1 day/24 hour)	0.33
RfC	Reference concentration (mg/m^3)	Chemical-specific
VF_{cw}	Volatilization factor for soil (m^3/kg)	See Equation 22
PEF_{cw}	Particulate emission factor (m^3/kg)	See Equation 25

2.3.3 Alternative Evaluation for Lead

Exposure to lead can result in neurotoxic and developmental effects. The primary receptors of concern are children, whose nervous systems are still undergoing development and who also exhibit behavioral tendencies that increase their likelihood of exposure (e.g., pica). These effects may occur at exposures so low that they may be considered to have no threshold, and are evaluated based on a blood lead level (rather than the external dose as reflected the RfD/RfC methodology). Therefore, US EPA views it to be inappropriate to develop noncarcinogenic "safe" exposure levels (i.e., RfDs) for lead. Instead, US EPA's lead assessment workgroup has recommended the use of the IEUBK model that relates measured lead concentrations in environmental media with an estimated blood-lead level (US EPA 1994 and 1998b). The model is used to calculate a blood lead level in children when evaluating residential land use and in adults (based on a pregnant mother's capacity to contribute to fetal blood lead levels), or when evaluating occupational scenarios at sites where access by children is reliably restricted. The NMED SSLs presented in Appendix A include values for lead that were calculated by using the IEUBK to back-calculate a soil concentration for each receptor that would not result in an estimated blood-lead concentration of 10 micrograms per deciliter (μg/dL) or greater (residential adult of 400 mg/kg and industrial and construction worker of 800 mg/kg).

2.4 Tap Water Screening Levels

Exposure to contaminants can occur through the ingestion of domestic/household water and inhalation of volatiles in domestic/household water. The calculations of the NMED tap water screening levels for domestic water are based upon the methodology presented in RAGS, part B (US EPA 1991). The screening levels are based upon ingestion and inhalation of contaminants in water. Although exposure to contaminants could occur through dermal contact with domestic/household water, exposure to contaminants in water is primarily due to ingestion and inhalation. Therefore, dermal contact with water was not included in the calculation of the tap water screening levels (SLs). If it is determined that dermal exposure to water at the site being evaluated is a significant exposure pathway, then dermal contact with water should be evaluated further using methods outlined in RAGS, Part E (US EPA, 2004). While ingestion is for all chemicals, inhalation of volatiles from water was considered for those chemicals with a minimum Henry's Law constant of 1E-05 atm-m^3/mole and with a maximum molecular weight of 200 g/mole. To address the groundwater-to-air pathways, the tap water screening levels incorporate a volatilization factor (K) of 0.5 L/m^3 for volatile contaminants (US EPA, 1991); this derived value defines the relationship between the concentration of a contaminant in household water and the average concentration of the volatilized contaminant in air as a result of all uses of household water (i.e., showering, laundering, dish washing).

As ingestion and inhalation rates may be different for children and adults, carcinogenic risks were calculated using age-adjusted factors, which were obtained from RAGS, Part B (US EPA 1991). Equations 16 through 18 show how SLs for carcinogenic and non-carcinogenic contaminants were developed. Similar to soil, separate equations are used for vinyl chloride (Equation 19) and carcinogens exhibiting mutagenic toxicity (Equation 20).

Equation 16
Ingestion and Inhalation Exposures to Carcinogenic Contaminants in Tap Water
Residential Scenario

$$C_{oral} = \frac{TR \times AT_r \times 1000}{EF_r \times CSF_o \times IFW_{adj}}$$

$$C_{inh} = \frac{TR \times AT_r}{EF_r \times ED_r \times ET_{rw} \times IUR \times K}$$

Combined Exposures:

$$SSL_{tap} = \frac{1}{\frac{1}{C_{oral}} + \frac{1}{C_{inh}}}$$

Parameter	Definition (units)	Default
C_{oral}	Contaminant concentration, ingestion (µg/L)	Chemical-specific
C_{ihal}	Contaminant concentration, inhalation (µg/L)	Chemical-specific
SSL_{tap}	Tap water screening level (µg/L)	Chemical-specific
TR	Target risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
EF_r	Exposure frequency, resident (day/yr)	350
1000	Unit conversion (µg/mg)	1000
IFW_{adj}	Age-adjusted water ingestion rate, resident (L-yr/kg-day) (See Equation 17)	1.086
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
ED_r	Exposure duration (years)	30
ET_{rw}	Exposure time (24 hours/day per 1day/24 hours)	1
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific
K	Andelman volatilization factor (L/m^3)	0.5

Equation 17
Calculation of Age-Adjusted Tap Water Ingestion Factor

$$IFW_{adj} = \frac{ED_c \times IRW_c}{BW_c} + \frac{ED_{r-c} \times IRW_a}{BW_a}$$

Parameter	Definition (units)	Default
IFW_{adj}	Age-adjusted water ingestion factor for carcinogens [(L-yr)/(kg-day)]	1.086
ED_c	Exposure duration, child (years)	6
IRW_c	Water ingestion rate, child (L/day)	1
BW_c	Body weight, child (kg)	15
ED_{r-c}	Exposure duration, resident minus child (years)	24
IRW_a	Water ingestion rate, adult (L/day)	2
BW_a	Body weight, adult (kg)	70

Equation 18
Ingestion and Inhalation Exposures to Noncarcinogenic Contaminants in Tap Water Residential Scenario

$$C_{oral} = \frac{THQ \times BW_a \times 1000 \times AT_r}{EF_r \times ED_r \times \left(\frac{1}{RfD_o}\right) \times IRW_a}$$

$$C_{inh} = \frac{THQ \times AT_r \times 1000}{EF_r \times ED_r \times ET_{rw} \times \left(\frac{1}{RfC}\right) \times K}$$

Combined Exposures:

$$SSL_{tap} = \frac{1}{\frac{1}{C_{oral}} + \frac{1}{C_{inh}}}$$

Parameter	Definition (units)	Default
C_{oral}	Contaminant concentration, ingestion (µg/L)	Chemical-specific
C_{inl}	Contaminant concentration, inhalation (µg/L)	Chemical-specific
SSL_{tap}	Tap water screening level (µg/L)	Chemical-specific
THQ	Target hazard quotient	1
BW_a	Body weight, adult (kg)	70
AT_r	Averaging time, noncarcinogens (days)	ED_r x 365
1000	Unit conversion (µg/mg)	1000
EF_r	Exposure frequency, resident (day/yr)	350
ED_r	Exposure duration, resident (years)	30

IRW_a	Water ingestion rate, resident (L/day)	2
RfD_o	Oral reference dose(mg/kg-day)	Chemical-specific
ET_{rw}	Exposure time (24 hours/day per 1day/24 hours)	1
RfC	Reference concentration ((mg/m^3)	Chemical-specific
K	Andelman volatilization factor (L/m^3)	0.5

Equation 19
Ingestion and Inhalation Exposures to Vinyl Chloride in Tap Water
Residential Scenario

$$C_{oral} = \frac{TR}{\left(\frac{CSF_o \times EF_r \times IFW_{adj} \times 0.001}{AT} + \frac{CSF_o \times IRW_c \times 0.001}{BW_c}\right)}$$

$$C_{inh} = \frac{TR}{\left(\frac{IUR \times EF_r \times ED_r \times ET_{rw} \times K}{AT} + (IUR \times K)\right)}$$

Combined Exposures:

$$SSL_{tap} = \frac{1}{\frac{1}{C_{oral}} + \frac{1}{C_{inh}}}$$

Parameter	Definition (units)	Default
C_{oral}	Contaminant concentration, ingestion (µg/L)	Chemical-specific
C_{ihal}	Contaminant concentration, inhalation (µg/L)	Chemical-specific
SSL_{tap}	Tap water screening level (µg/L)	Chemical-specific
TR	Target risk	1E-05
AT	Averaging time, carcinogens (days)	25,550
EF_r	Exposure frequency, resident (day/yr)	350
0.001	Unit conversion (mg/µg)	0.001
IFW_{adj}	Age-adjusted water ingestion rate, resident (L-yr/kg-day) (See Equation 17)	1.086
IRW_c	Child water ingestion rate, resident (L/day)	1
CSF_o	Oral cancer slope factor (mg/kg-day)$^{-1}$	Chemical-specific
ED_r	Exposure duration (years)	30
ET_{rw}	Exposure time (24 hours/day per 1day/24 hours)	1
IUR	Inhalation unit risk (µg/m^3)$^{-1}$	Chemical-specific
K	Andelman volatilization factor (L/m^3)	0.5

Equation 20
SL for Tap Water, Residential Exposure – Mutagens

$$C_{mu-oral} = \frac{TR \times AT_r \times 1000}{CFS_o \times EF_r \times IFWM_{adj}}$$

$$C_{mu-inh} = \frac{TR \times AT_r}{(EF_r \times ET_{ra} \times K) \times [(ED_{0-2} \times IUR \times 10) + (ED_{2-6} \times IUR \times 3) + (ED_{6-16} \times IUR \times 3) + (ED_{16-30} \times IUR \times 1)]}$$

Combined Exposures:

$$SSL_{tap-mu} = \frac{1}{\frac{1}{C_{mu-oral}} + \frac{1}{C_{mu-inh}}}$$

Parameter	Definition (units)	Default
$C_{mu\text{-}oral}$	Contaminant concentration, ingestion (µg/kg)	Chemical-specific
$C_{mu\text{-}inh}$	Contaminant concentration, inhalation (µg/kg)	Chemical-specific
$SSL_{tap\text{-}mu}$	Tap water screening level (µg/L)	Chemical-specific
TR	Target cancer risk	1E-05
AT_r	Averaging time, carcinogens (days)	25,550
CSF_o	Oral cancer slope factor $(mg/kg\text{-}day)^{-1}$	Chemical-specific
EF_r	Exposure frequency, resident (day/yr)	350
ET_{rw}	Exposure time (24 hours/day per 1day/24 hours)	1
K	Andelman volatilization factor (L/m^3)	0.5
$IFWM_{adj}$	Age-adjusted water ingestion rate (L-yr/kg-day) (See Equation 21)	3.39
1000	Conversion factor (µg/mg)	1000
$ED_{0\text{-}2}$	Exposure duration, child (years)	2
$ED_{2\text{-}6}$	Exposure duration, child (years)	4
$ED_{6\text{-}16}$	Exposure duration, adult (years)	10
$ED_{16\text{-}30}$	Exposure duration, adult (years)	14
IUR	Inhalation unit risk $(\mu g/m^3)^{-1}$	Chemical-specific

Equation 21
Calculation of Age-Adjusted Tap Water Ingestion Factor, Mutagens

$$IFWM_{adj} = \frac{ED_{0-2} \times IRW_c \times 10}{BW_c} + \frac{ED_{2-6} \times IRW_c \times 3}{BW_c} + \frac{ED_{6-16} \times IRW_a \times 3}{BW_a} + \frac{ED_{16-30} \times IRW_a \times 1}{BW_a}$$

Parameter	Definition (units)	Default
$IFWM_{adj}$	Age-adjusted water ingestion factor for mutagens [(L-yr)/(kg-day)]	3.39
ED_{0-2}	Exposure duration, child (years)	2
ED_{2-6}	Exposure duration, child (years)	4
ED_{6-16}	Exposure duration, adult (years)	10
ED_{16-30}	Exposure duration, adult (years)	14
IRW_c	Water ingestion rate, child (L/day)	1
IRW_a	Water ingestion rate, adult (L/day)	2
BW_c	Body weight, child (kg)	15
BW_a	Body weight, adult (kg)	70

2.5 Site Assessment and Characterization

The Site Assessment/Site Characterization phase is intended to provide additional spatial and contextual information about the site, which may be used to determine if there is any reason to believe that receptors and/or complete exposure pathways may exist at or in the locality of the site where a release of hazardous waste/constituents has occurred. In addition, the site assessment phase serves as the initial information gathering phase to determine whether potential exposures are sufficiently similar to those upon which the NMED SSLs are predicated to support comparison. Finally, this phase can help to identify sites in need of a more detailed assessment of potential risk. A CSM providing a list of the potentially exposed receptors and potentially complete exposure pathways in the scoping report is used to determine whether further assessment (i.e., a screening level assessment) and/or interim measures are required or whether the site poses minimal threat to human and ecological receptors at or near the site.

The ultimate purpose of the site assessment phase is to address the question: Are exposure pathways complete with regard to contaminant contact by receptors? A complete site assessment will consists of several steps:

- Develop data quality objectives and conduct site sampling;
- Identify preliminary COPCs;
- Develop a preliminary site conceptual exposure model (SCEM);
- Determine Exposure Intervals;
- Compare maximum COPC concentrations for consideration of complete exposure pathways with SSLs;
- Assess concentrations of essential nutrients; and
- If the site maximums are above the SSLs, a Tier 2 approach may be deemed appropriate by NMED using the 95% upper confidence limit (UCL) value) for contaminant concentrations (or detection/quantitation limits for non-detect results).

2.5.1 Development of Data Quality Objectives

Before any additional environmental samples are collected, data quality objectives (DQOs) should be developed. The DQOs should address the qualitative and quantitative nature of the sampling data, in terms of relative quality and intent for use, to ensure that any data collected will be appropriate for the intended objective. Development of the DQOs should consider not only precision, accuracy, representativeness, completeness, and comparability of the data, but also the sampling locations, types of laboratory analyses used, sensitivity of detection limits of the analytical techniques, the resulting data quality, and the employment of adequate quality assurance/quality control measures.

2.5.2 Identification of COPCs

COPCs are those substances (including transformation or breakdown compounds and companion products) likely to be present in environmental media affected by a release. Identification of COPCs should begin with existing knowledge of the process, product, or waste from which the release originated. For example, if facility operations deal primarily with pesticide manufacturing then pesticides should be considered COPCs. Contaminants identified during current or previous site investigation activities should also be evaluated as COPCs. A site-specific COPC list for soil may be generated based on maximum detected (or, if deemed appropriate by NMED, the 95% UCL value) concentrations (US EPA 2002b) and a comparison of detection/quantitation limits for non-detect results to the NMED SSLs. This list may be refined through a site-specific risk assessment. Per US EPA guidance (US EPA 1989), if there is site history to indicate a chemical was potentially used/present at a site, and the chemical was detected in at least one sample, this chemical must be included as a COPC and evaluated in the screening assessment.

For inorganics, a comparison of site concentrations to appropriate background concentrations may be conducted prior to evaluation against SSLs. Those inorganics that are present at levels indicative of natural background may be eliminated as a COPC. Comparison to background must be conducted following current US Guidance and outlined in this guidance. The general process is a tiered approach.

Step 1. Compare the maximum detected site concentration to the site-specific background reference values (upper tolerance limit) determined for that site. If the site maximum is less than the background reference value, it is assumed that the site concentrations are representative of background and the metal/inorganic is not retained as a COPC. If there is no background value for a constituent, then it will be retained as a COPC.

Step 2: If the maximum site concentration is greater than the background reference value, then a two-sample hypothesis test should be used to compare the distributions of the site data to the distributions of background data to determine if site concentrations are elevated compared with background. The most recent version of US EPA's ProUCL statistical software will be used for hypothesis testing. ProUCL will also be used to determine the most appropriate test (parametric or nonparametric) based on distribution of the data. Appropriate methods in ProUCL will also be used to

compute site-to-background comparisons based on censored data sets containing non-detect values.

Note that the above two-sample test can only be used for site data-sets that have sufficient number of samples (i.e., $n \geq 8$) and number of detections (i.e, ≥ 5 detected observations). Site-to-background point-by-point comparisons will be conducted for site data sets containing fewer than eight samples and fewer than five detected observations. As stated in the current version of ProUCL User's Guide (US EPA, 2010), hypothesis testing is only considered to be reliable with sufficient sample size ($n \geq 8$) and frequency of detection (≥ 5 detected observations). If there are not at least eight samples in the site data set and at least five detections, then the site maximum detected concentrations will be compared to the corresponding background value (i.e., 95% upper tolerance limit) as noted in Step 1 or additional data must be collected to conduct a two-tailed test.

Step 3: Additional lines of evidence may be used to justify exclusion of an inorganic as being site related, such as site history, number of non-detects, etc. Comparison of site data to regional data (such as US Geological Survey (USGS) databases not specific to the site) is not an acceptable line of evidence.

2.5.3 Development of a Preliminary Conceptual Site Model

A CSM is a graphical representation of three-dimensional site conditions that conveys what is known or suspected, at a discrete point in time, about the site-specific sources, releases, release mechanisms, contaminant fate and transport, exposure routes, and potential receptors. The CSM is generally documented by written descriptions and supported by maps, geological cross-sections, tables, diagrams and other illustrations to communicate site conditions. When preparing a CSM, the facility should decide the scope, quantity, and relevance of information to be included, balancing the need to present as complete a picture as possible to document current site conditions and justify risk management actions, with the need to keep the information focused and exclude extraneous data.

As a final check, the CSM should answer the following questions:

- Are there potential land uses present (now or in the foreseeable future) other than those covered by the SSLs? (refer to US EPA 1989).
- Are there other likely human exposure pathways that were not considered in development of the SSLs (e.g. vapor intrusion, direct exposure to groundwater, local fish consumption, raising homegrown produce, beef, dairy, or other livestock)? (refer to US EPA 1989)
- Are there potential ecological concerns? (*Guidance for Assessing Ecological Risks Posed by Chemicals: Screening Level Ecological Risk Assessment*; NMED 2000)

If any conditions such as these exist, the SSLs may need to be adjusted to reflect this new information.

2.5.4 Determine Exposure Intervals

Based on current and potential land-use scenarios, receptors for completed exposure pathways can be exposed to varying depths of soil, or soil exposure intervals. Per US EPA (US EPA 1989), depth of samples should be considered and surface soils should be evaluated separately from subsurface soils due to possible differences in exposure levels that would be encountered by different receptors. Exposure intervals for each receptor are based on the types of activities in which each receptor is likely to be involved. Default exposure intervals are summarized in Table 2-5.

It is assumed that commercial/industrial workers would only be exposed to surface soils (0-1 ft below ground surface). As stated in Section 2.3.1, this receptor may be involved in moderate digging associated with routine maintenance and grounds keeping activities. Therefore, COPC concentrations in soil in the surface soil interval (0-1 ft bgs) should be considered when evaluating exposure by a commercial/industrial worker receptor.

As stated in Section 2.3.2, a construction worker is assumed to be exposed to surface and subsurface soils up to depths of 0-10 ft below ground surface. Construction workers are involved in digging, excavation, maintenance and building construction projects and could be exposed to surface as well as subsurface soil. Therefore, a soil exposure interval of 0-10 feet below ground surface should be considered when evaluating exposure to soil by a construction worker.

Residents could be exposed to surface and subsurface soils during home maintenance activities, yard work, landscaping, and outdoor play activities. Therefore, an exposure soil interval of 0-10 ft below ground surface should be assumed when evaluating soil exposure by a residential receptor.

Exposure to COPCs in soil by ecological receptors should be addressed separately in a tiered approach as outlined by NMED (NMED 2000). However, a discussion of soil exposure intervals for ecological receptors is warranted here because ecological receptors are considered in the CSM and depending on the types of ecological receptors, there can be a differential in exposure levels due to soil exposure intervals. Burrowing animals would be exposed to deeper soils, whereas all other animals would only be exposed to surface and shallow subsurface soils. Therefore, maximum concentrations of COPCs in soil 0-10 ft below ground surface should be assessed for burrowing animals. Maximum COPC concentrations in soil 0-5 ft below ground surface should be assessed for all other animals.

Table 2-5. Soil Exposure Intervals

Receptor	Exposure Intervals (Soil)
Resident (adult and child)	0 – 10 ft bgs
Commercial/Industrial Worker	0 – 1 ft bgs
Construction Worker	0 – 10 ft bgs
Vapor Intrusion	Depth of maximum detection
Ecological Receptors (non-burrowing)	0 – 5 ft bgs
Ecological Receptors (burrowing)	0 – 10 ft bgs

2.5.5 Compare COPC Maximum Concentrations with SSLs

The final step in the site assessment phase is to compare maximum detected COPC concentrations in soil with SSLs based on the complete exposure pathways identified by the preliminary CSM and assessing total risk/hazard from all constituents (Refer to Section 5). These concentrations should also be compared against the SSL leaching values to determine which contaminants present in soil have the capacity to leach to underlying groundwater and impact these resources adversely. As stated earlier, those contaminants exhibiting concentrations in excess of the SSLs represent the initial soil COPC list for a given site. Refinement of this list may be necessary based on a host of factors, including elevated detection or quantitation limits.

3.0 CHEMICAL-SPECIFIC AND PHYSICAL-CHEMICAL PARAMETERS

Chemical-specific parameters required for calculating SSLs include the organic carbon normalized soil-water partition coefficient for organic compounds (K_{oc}), the soil-water partition coefficient (K_d), water solubility (S), octanol-water partition coefficient (K_{ow}), Henry's Law constant (H), diffusivity in air (D_a), and diffusivity in water (D_w). The following sections describe these values and present methodologies for calculating additional values necessary for calculating the NMED SSLs.

3.1 Volatilization Factor for Soil

Volatile chemicals, defined as those chemicals having a Henry's Law constant greater than 1E-05 atm-m^3/mole and a molecular weight less than 200 g/mole, were screened for inhalation exposures using a volatilization factor (VF_s) for soils. The soil-to-air VF_s is used to define the relationship between the concentration of the contaminant in soil and the flux of the volatilized contaminant to ambient air. The emission terms used in the VF_s are chemical-specific and were calculated from physical-chemical information obtained from several sources including: US EPA's *Soil Screening Guidance: Technical Background Document* (US EPA, 1996a and 2001a), *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA 2002a), US EPA Master Physical and Chemical Parameter table for development US EPA Regional Screening Levels (US EPA 2011), US EPA's *Basics of Pump and Treat Groundwater Remediation Technology* (US EPA 1990), US EPA's *Dermal Exposure Assessment* (US EPA 1992a), *Superfund Public Health Evaluation Manual* (US EPA 1986), US EPA's *Additional Environmental Fate Constants* (US EPA 1995), Hazardous Substance Release/Health Effects Database (ATSDR 2003), the RAIS database (DOE 2005), and the CHEMFACTS database (US

EPA 2000c). The VF_s for the residential and commercial/industrial scenarios is calculated using Equation 22 while the $VF_{s\text{-}cw}$ for the construction worker is calculated using Equation 23.

Equation 22
Derivation of the Volatilization Factor for Residential and Commercial/Industrial Scenarios

$$VF_s = \frac{Q/C_{vol} \times \left(3.14 \times D_A \times T\right)^{0.5} \times 10^{-4}}{\left(2 \times \rho_b \times D_A\right)}$$

Where:

$$D_A = \frac{\left[\frac{\left(\theta_a^{10/3} D_a H' + \theta_w^{10/3} D_w\right)}{n^2}\right]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Parameter	Definition (units)	Default
VF_s	Volatilization factor for soil (m^3/kg)	Chemical-specific
D_A	Apparent diffusivity (cm^2/s)	Chemical-specific
Q/C_{vol}	Inverse of the mean concentration at the center of a 0.5- acre-square source (g/m^2-s per kg/m^3)	68.18
T	Exposure interval (s)	9.5E+08
ρ_b	Dry soil bulk density (g/cm^3)	1.5
n	Total soil porosity 1 - (ρ_b/ρ_s)	0.43
θ_a	Air-filled soil porosity (n - θ_w)	0.17
θ_w	Water-filled soil porosity	0.26
ρ_s	Soil particle density (g/cm^3)	2.65
D_a	Diffusivity in air (cm^2/s)	Chemical-specific
H'	Dimensionless Henry's Law constant	Chemical-specific
D_w	Diffusivity in water (cm^2/s)	Chemical-specific
K_d	Soil-water partition coefficient (cm^3/g) = K_{oc} x f_{oc} (organics)	Chemical-specific
K_{oc}	Soil organic carbon partition coefficient (cm^3/g)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.0015

Equation 23
Derivation of the Volatilization Factor for Construction Worker Scenario

$$VF_{s-cw} = \left(\frac{(3.14 \times D_A \times T)^{0.5}}{2 \times \rho_b \times D_A} \right) \times 10^{-4} \times Q/C \times (1/F_D)$$

Where:

$$D_A = \frac{\left[\frac{\left(\theta_a^{10/3} D_a H' + \theta_w^{10/3} D_w \right)}{n^2} \right]}{\rho_b K_d + \theta_w + \theta_a H'}$$

Parameter	Definition (units)	Default
VF_{s-cw}	Volatilization factor for soil (m^3/kg)	Chemical-specific
D_A	Apparent diffusivity (cm^2/s)	Chemical-specific
Q/C	Inverse of the mean concentration at the center of a 0.5- acre-square source (g/m^2-s per kg/m^3)	14.31
T	Exposure interval (s)	3.15E+07
10^{-4}	Conversion factor (m^2/cm^2)	1E-04
F_D	Dispersion correction factor (unitless)	0.185
ρ_b	Dry soil bulk density (g/cm^3)	1.5
n	Total soil porosity 1 - (ρ_b/ρ_s)	0.43
θ_a	Air-filled soil porosity (n - θ_w)	0.17
θ_w	Water-filled soil porosity	0.26
ρ_s	Soil particle density (g/cm^3)	2.65
D_a	Diffusivity in air (cm^2/s)	Chemical-specific
H'	Dimensionless Henry's Law constant	Chemical-specific
D_w	Diffusivity in water (cm^2/s)	Chemical-specific
K_d	Soil-water partition coefficient (cm^3/g) = K_{oc} x f_{oc} (organics)	Chemical-specific
K_{oc}	Soil organic carbon partition coefficient (cm^3/g)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.0015

While most of the parameters used to calculate apparent diffusivity (D_A) are either chemical-specific or default values, several state-specific values were used which are more representative of soil conditions found in New Mexico. The default values for θ_w, θ_a, and ρ_b in Equations 22 and 23 are 0.26, 0.17 and 1.5 g/cm^3, respectively. These values represent the mean value from a National Resources Conservation Service (NRCS) soil survey database for New Mexico that includes over 1200 sample points (U.S. Department of Agriculture 2000). US EPA guidance (US EPA 2001a) provides additional methodologies for estimating site-specific air-filled soil porosities and water-filled soil porosities.

It should be noted that the basic principle of the VF model (Henry's Law) is applicable only if the soil contaminant concentration is at or below soil saturation, C_{sat}. Above the soil saturation limit, the model cannot predict an accurate VF-based SSL.

3.2 Soil Saturation Limit

C_{sat} describes a chemical-physical soil condition that integrates certain chemical-specific properties with physical attributes of the soil to estimate the contaminant concentration at which the soil pore water, pore air, and surface sorption sites are saturated with contaminants. Above this concentration, the contaminants may be present in free phase within the soil matrix – as non-aqueous phase liquids (NAPLs) for substances that are liquid at ambient soil temperatures, and pure solid phases for compounds that are solids at ambient soil temperatures (US EPA 1996a). Generic C_{sat} concentrations should not be interpreted as confirmation of a saturated soil condition, but as estimates of when this condition may occur. It should be noted that C_{sat} concentrations are not risk-based values. Instead, they correspond to a theoretical threshold above which free phase contaminant may exist. C_{sat} concentrations, therefore, serve to identify an upper limit to the applicability of generic risk-based soil criteria, because certain default assumptions and models used in the generic algorithms are not applicable when free phase contaminant is present in soil. The basic principle of the volatilization model is not applicable when free-phase contaminants are present. How these cases are handled depends on whether the contaminant is liquid or solid at ambient temperatures. Liquid contaminants that have volatilization factor- (VF_s) based screening levels that exceed the "sat" concentration are set equal to "sat" whereas for solids (e.g., polycyclic aromatic hydrocarbons, PAHs), soil screening decisions are based on appropriate other pathways of concern at the site (e.g., ingestion and dermal contact). Equation 24, given below is used to calculate C_{sat} for each volatile contaminant considered within the SSLs.

Equation 24
Derivation of the Soil Saturation Limit

$$C_{sat} = \frac{S}{\rho_b}\left(K_d \rho_b + \theta_w + H'\theta_a\right)$$

Parameter	Definition (units)	Default
C_{sat}	Soil saturation concentration (mg/kg)	Chemical-specific
S	Solubility in water (mg/L-water)	Chemical-specific
ρ_b	Dry soil bulk density (kg/L)	1.5
K_d	Soil-water partition coefficient (L/kg; $K_{oc} \times f_{oc}$)	Chemical-specific
K_{oc}	Soil organic carbon/water partition coefficient (L/kg)	Chemical-specific
f_{oc}	Fraction organic carbon in soil (g/g)	0.0015
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.26
H′	Dimensionless Henry's Law constant	Chemical-specific
θ_a	Air-filled soil porosity (n- θ_w),(L_{air}/L_{soil})	0.17
n	Total soil porosity ($1 - (\rho_b/\rho_s)$), (L_{pore}/L_{soil})	0.43
ρ_s	Soil particle density (kg/L)	2.65

Chemical-specific parameters used in Equation 24 were obtained from physical-chemical information obtained from several sources including: US EPA's *Soil Screening Guidance: Technical Background Document* (US EPA 1996a and US EPA 2002a), the US EPA Regional

Screening Levels (US EPA 2011), US EPA's *Basics of Pump and Treat Groundwater remediation Technology* (US EPA 1990), US EPA's *Dermal Exposure Assessment* (US EPA 1992a), *Superfund Public Health Evaluation Manual* (US EPA 1986), US EPA's *Additional Environmental Fate Constants* (US EPA 1995), Hazardous Substance Release/Health Effects Database (ATSDR 2003), the RAIS, CHEMFACTS, WATER9,and PHYSPROP databases, and EPISUITE.

3.3 Particulate Emission Factor

Inhalation of chemicals adsorbed to suspended respirable particles is assessed using a chemical-specific PEF, which relates the contaminant concentration in soil to the concentration of respirable particles in the air due to fugitive dust emissions from contaminated soils. This guidance addresses dust generated from open sources, which is termed "fugitive" because it is not discharged into the atmosphere in a confined flow stream. For further details on the methodology associated with the PEF model, the reader is referred to US EPA's *Soil Screening Guidance: Technical Background Document* (US EPA 1996a), *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA 2002a) and *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (US EPA 1998a).

It is important to note that the PEF for use in evaluating exposures of the residential and commercial/industrial receptors addresses only windborne dust emissions and does not consider emissions from traffic or other forms of mechanical disturbance, which could lead to a greater level of exposure. The PEF for use in evaluating the construction worker exposures considers windborne dust emissions and emissions from vehicle traffic associated with construction activities. Therefore, the fugitive dust pathway should be considered carefully when developing the CSM at sites where receptors may be exposed to fugitive dusts by other mechanisms. Equation 25 is used to calculate a New-Mexico region-specific PEF value, used for both the residential and commercial/industrial exposure scenarios. A scenario-specific PEF value was calculated for a construction worker receptor (PEF_{cw}) using Equation 26.

Equation 25
Derivation of the Particulate Emission Factor
Residential and Commercial/Industrial Scenarios

$$PEF = Q / C_{wind} \times \frac{3{,}600 \text{ sec / hr}}{0.036 \times (1 - V) \times \left(\frac{U_m}{U_t}\right)^3 \times F(x)}$$

Parameter	Definition (units)	Default
PEF	Particulate emission factor (m^3/kg)	6.61E+09
Q/C_{wind}	Inverse of a mean concentration at center of a 0.5-acre-square source (g/m^2-s per kg/m^3)	81.85
V	Fraction of vegetative cover (unitless)	0.5
U_m	Mean annual windspeed (m/s)	4.02
U_t	Equivalent threshold value of windspeed at 7 m (m/s)	11.32
F(x)	Function dependent on U_m/U_t derived using Cowherd et al. (1985) (unitless)	0.0553

Equation 26
Derivation of the Particulate Emission Factor
Construction Worker Scenario

$$PEF_{CW} = Q / C_{CW} \times \frac{1}{F_D} \left[\frac{T \times A_R}{556 \times \left(\frac{W}{3}\right)^{0.4} \times \frac{(365 \text{ days/yr} - P)}{365 \text{ days/yr}} \times \sum VKT} \right]$$

Parameter	Definition (units)	Default
PEF_{CW}	Particulate emission factor for a construction worker (m^3/kg)	2.1E+06
Q/C_{CW}	Inverse of a mean concentration at center of a 0.5-acre-square source (g/m^2-s per kg/m^3)	23.02
F_D	Dispersion correction factor (unitless)	0.185
T	Total time over which construction occurs (s)	7.2E+06
A_R	Surface area of road segment (m^2)	274.2
W	Mean vehicle weight (tons)	8
P	Number of days with at least 0.01 inches of precipitation (days/yr)	60
ΣVKT	sum of fleet vehicle kilometers traveled during the exposure duration (km)	168.75

3.4 Physical-Chemical Parameters

Several chemical-specific parameters are required for calculating SSLs including the organic carbon normalized soil-organic carbon/water partition coefficients for organic compounds (K_{oc}), the soil-water partition coefficient for organic and inorganic constituents (K_d), the solubility of a compound in water (S), Henry's Law constant (H), air diffusivity (D_a), water diffusivity (D_w),

and the octanol-water partition coefficient (K_{ow}). Prior to calculating site-specific SSLs, each relevant chemical specific parameter value presented in Appendix B should be checked against the most recent version of its source to determine if updated data are available. Tables B-1 and B-2 in Appendix B provides the chemical-specific parameters used in calculating the NMED SSLs.

Chemical-specific values were obtained from US EPA's *Soil Screening Guidance: Technical Background Document* (US EPA 1996a and US EPA 2002a, the US EPA Regional Screening Levels (US EPA 2011), US EPA's *Basics of Pump and Treat Groundwater remediation Technology* (US EPA 1990), US EPA's *Dermal Exposure Assessment* (US EPA 1992a), *Superfund Public Health Evaluation Manual* (US EPA 1986), US EPA's *Additional Environmental Fate Constants* (US EPA 1995), Hazardous Substance Release/Health Effects Database (ATSDR 2003), the RAIS, CHEMFACTS, WATER9,and PHYSPROP databases, and EPISUITE.

3.4.1 Solubility, Henry's Law Constant, and K_{ow}

The solubility of a contaminant refers to the maximum amount that can be dissolved in a fixed volume of solvent, usually pure water, at a specific temperature and pH. A chemical with a high solubility readily dissolves in water, while a low solubility indicates an inability to dissolve. Water solubility is generally predicted based on correlations with the octanol-water partition coefficient (K_{ow}). Solubility is used to calculate soil saturation limits for the NMED SSLs.

The octanol-water partition coefficient (K_{ow}) of a chemical is the ratio of a chemical's solubility in octanol versus its solubility in water at equilibrium. Essentially, this chemical-specific property is used as an indication of a contaminant's propensity to migrate from soil to water. It is an important parameter and is used in the assessment of environmental fate and transport for organic chemicals.

The Henry's Law constant (H) is used when evaluating air exposure pathways. For all chemicals that are capable of exchanging across the air-water interface, there is a point at which the rate of volatilization into the air and dissolution to the water or soil will be equal. The ratio of gas- and liquid-phase concentrations of the chemical at this equilibrium point is represented by H, which is used to determine the rate at which a contaminant will volatilize from soil to air. Values for H may be calculated using the following equation and the values for solubility (S), vapor pressure (VP), and molecular weight (MW).

$$H = \frac{VP \times MW}{S} \qquad \textbf{Equation 27}$$

The dimensionless form of Henry's Law constant (H′) used in calculating soil saturation limits and volatilization factors for the NMED SSLs was calculated by multiplying H by a factor of 41 to convert the Henry's Law constant to a unitless value.

3.4.2 Soil Organic Carbon/Water Partition Coefficients (K_{oc})

The soil organic carbon-water partition coefficient (K_{oc}) is a measure of a chemical's tendency to

adsorb to organic carbon present in soil. High K_{oc} values indicate a tendency for the chemical to adsorb to soil particles rather than remain dissolved in the soil solution. Strongly adsorbed molecules will not unless the soil particle to which they are adsorbed moves (as in erosion). K_{oc} values of less than 500 indicate weak adsorption and a potential for leaching. K_{oc} is calculated using the following equation:

$$K_{oc} = \frac{\text{conc. adsorbed/conc. dissolved}}{\text{\% organic carbon in soil}} \qquad \textbf{Equation 28}$$

K_{oc} can also be calculated by dividing the K_d value by the fraction of organic carbon (f_{oc}) present in the soil or sediment. It should be noted that a strong linear relationship exists between K_{oc} and K_{ow} and that this relationship can be used to predict K_{oc}.

3.4.3 Soil/Water Partition Coefficients (K_d)

Soil-water partition coefficient (K_d) for organic chemicals is the ratio of a contaminant's distribution between soil and water particles. The soil-water partitioning behavior of nonionizing and ionizing organic compounds differs because the partitioning of ionizing organics can be influenced by soil pH. K_d values were used in calculating soil saturation limits and volatilization factors used in developing the NMED SSLs.

For organic compounds, K_d represents the tendency of a chemical to adsorb to the organic carbon fraction in soils, and is represented by:

$$K_d = K_{oc} \times f_{oc} \qquad \textbf{Equation 29}$$

where

K_{oc} = organic carbon partition coefficient (L/kg or cm^3/g); and
f_{oc} = fraction of organic carbon in soil (mg/mg).

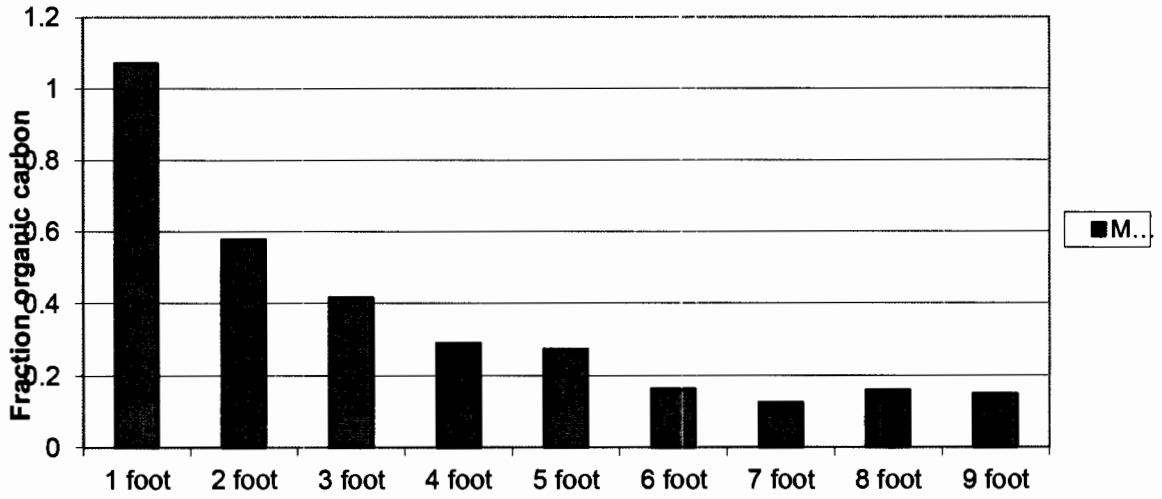
This relationship is generally valid for volatile halogenated hydrocarbons as long as the fraction of organic carbon in soil is above approximately 0.001 (0.1 percent) (Piwoni and Banaerjee, 1989 Schwarzenbach and Westall 1981). For low organic carbon soils ($f_{oc} < 0.001$), Piwoni and Banerjee (1989) developed the following empirical correlation for organic chemicals:

$$\log K_d = 1.01 \log K_{ow} - 0.36 \qquad \textbf{Equation 30}$$

The use of a fixed K_{oc} value in the soil-water partition equation for the migration to groundwater pathway is only valid for hydrophobic non-ionizing organic chemicals. For organic chemicals that ionize in the soil environment, existing in both neutral and ionized forms within the normal soil pH range, K_{oc} values must consider the relative proportions and differences in sorptive properties of these forms. For the equations and applications of developing K_{oc} values for ionizing organic acids as a function of pH, the reader is referred to US EPA 1996. The default

value used for f_{oc} in development of NMED SSLs is 0.0015 (0.15%). This value represents the median value of 212 data points included in the NRCS soil survey database for New Mexico (U.S. Department of Agriculture 2000). Only samples collected from a depth of greater than 5 feet were included in the calculation of the mean f_{oc} value. Shallow soil samples tend to have higher f_{oc} values as shown in Figure 2-1. There is a steady decline in f_{oc} value with depth until approximately 5 feet bgs. Below 5 feet, there is little variability in the f_{oc} value. Because a lower f_{oc} value provides a more conservative calculation of SSL, a value representative of deeper soil conditions is used as the default value.

Figure 2-1 Mean Value - Fraction Organic Carbon (f_{oc})- All counties in New Mexico



As with organic chemicals, development of the NMED SSLs for inorganic constituents (i.e., metals) requires a soil-water partition coefficient (K_d) for each contaminant. K_d values for metals are affected by a variety of soil conditions, most notably pH, oxidation-reduction conditions, iron oxide content, soil organic matter content, cation exchange capacity and major ion chemistry. US EPA developed default K_d values for metals using either an equilibrium geochemical speciation model (MINTEQ2) or from empirical pH-dependent adsorption relationships developed by Environmental Protection Agency's Office of Research and Development (EPA/ORD) (US EPA 1996a).

4.0 MIGRATION OF CONTAMINANTS TO GROUNDWATER

Generic SSLs were developed that address the potential for migration of contaminants from soil to groundwater. The methodology used to calculate generic SSLs addresses the potential leaching of contaminants from the vadose zone to groundwater. This method does not take into account any additional attenuation associated with contaminant transport in groundwater. The SSLs developed from this analysis are risk-based values incorporating NMED-specific tap water SSLs. This methodology is modeled after US EPA's *Soil Screening Guidance: Technical*

Background Document (US EPA 1996a) and the *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (US EPA 2002a).*

4.1 Overview of the SSL Model Approach

Two approaches to developing soil leachate-based SSLs are presented, the generic model and the site-specific model. Both models use the same set of equations to calculate SSLs and are based on leaching to groundwater scenarios that NMED believes are protective of groundwater. The generic model calculates SSLs using default parameter values generally representative of conditions in New Mexico. These values are presented in Tables B-1 and B-2 of Appendix B. The site-specific model provides the flexibility of using site-specific meteorological, soil and hydrological data to calculate SSLs, while retaining the simplicity and ease of use associated with the generic model.

The development of soil leachate SSLs is based upon a two step process. The first step is the development of a Dilution Attenuation Factor (DAF). The DAF accounts for leachate mixing in the aquifer. A leachate concentration that is protective of ground water is back calculated by multiplying the ground water standard for a given constituent by the DAF. That leachate concentration is then used to back calculate an SSL that is protective of groundwater using a simple linear equilibrium soil/water partition equation. For the generic SSL approach, default parameter values are used for all non-chemical specific parameters. At sites that are not adequately represented by the default values and where more site-specific data are available, it may be more appropriate to use the site-specific SSL model. The site-specific model uses the same spreadsheet equations to calculate SSLs as those in the generic look-up table; however, site-specific data are used in the site-specific model.

The following sections of this document provide a general description of the leaching to groundwater pathway SSL model (generic and site-specific) including the assumptions, equations, and input parameters. Justification for the default parameters used in the generic model is also provided. Additionally, a sensitivity analysis was performed on each of the input parameters to provide guidance on when use of the site-specific model may be warranted. Applicability and limitations of the generic and site-specific models are also presented.

4.2 Model Assumptions

Assumptions regarding the release and distribution of contaminants in the subsurface that are incorporated into the SSL methodology include the following.

- The source is infinite (a constant concentration is maintained for the duration of the exposure period).
- Contamination is uniformly distributed from the surface to the water table.
- Soil/water partitioning is instantaneous and follows a linear equilibrium isotherm.
- There is no attenuation of the contaminant in soil or the aquifer (i.e., irreversible adsorption, chemical transformation or biological degradation).
- The potentially impacted aquifer is unconfined and unconsolidated with

homogenous and isotropic hydrologic properties.

- The receptor well (point of exposure) is at the downgradient edge of the source and is screened within the potentially impacted aquifer.
- NAPLs are not present.

4.3 Soil Water Partition Equation

US EPA's *Supplemental Soil Screening Guidance: Technical Background Document* (US EPA 1996a) and *Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites* (US EPA 2002a) developed an equation to estimate contaminant release in soil leachate based on the Freundlich adsorption isotherm. The Freundlich equation was modified to relate the sorbed concentration to the total concentration measured in a soil sample (which includes contaminants associated with solid soil, soil-water and soil-air components) (Feenstra 1991). Equation 31, given below, is used to calculate SSLs corresponding to target soil leachate concentrations (C_w).

Equation 31
Soil Screening Level For Leaching To Groundwater Pathway

$$SSL = C_w \text{ x} \left[K_d + \left(\frac{\theta_w + \theta_a H'}{\rho_b} \right) \right]$$

Parameter	Definition (units)	Default
SSL	Soil Screening Level for migration to groundwater pathway (mg/kg)	Chemical-Specific
C_w	Target soil leachate concentration (mg/L)	Chemical-Specific
K_d	Soil /water partition coefficient (L/kg)	Chemical-Specific
θ_w	Water-filled soil porosity (L_{water}/L_{soil})	0.26
θ_a	Air-filled soil porosity (L_{air}/L_{soil}), n - θ_w	0.17
n	Total soil porosity (L_{pore}/L_{soil}), 1 - (ρ_b/ρ_s)	0.43
ρ_s	Soil particle density (kg/L)	2.65
ρ_b	Dry soil bulk density (kg/L)	1.5
H′	Dimensionless Henry's Law constant	Chemical-Specific

Target soil leachate concentrations (C_w) are equivalent to the NMED-specific tap water screening levels multiplied by a DAF.

$$C_w = \text{Tap Water SSL x DAF} \qquad \textbf{Equation 32}$$

The derivation of the DAF is discussed in subsequent sections of this document.

4.4 Dilution Attenuation Factor

Contaminants transported as a leachate through soil to groundwater are affected by physical, chemical, and biological processes that can significantly reduce their concentration. These processes include adsorption, biological degradation, chemical transformation, and dilution from mixing of the leachate with groundwater. The total reduction in concentration between the source of the contaminant (vadose zone soil) and the point of ground water withdrawal is defined as the ratio of contaminant concentration in soil leachate to the concentration in groundwater at the point of withdrawal. This ratio is termed a dilution/attenuation factor (DAF; US EPA 1996a and 1996b). The higher the DAF value, the greater the degree of dilution and attenuation of contaminants along the migration flowpath. A DAF of 1 implies no reduction in contaminant concentration occurs.

Development of New Mexico SSLs considers only the dilution of contaminant concentration through mixing with groundwater in the aquifer directly beneath the source. This is consistent with the conservative assumptions used in the SSL methodology including an infinite source, soil contamination extending from surface to groundwater and the point of exposure occurring at the downgradient edge of the source. The ratio of contaminant concentration in soil leachate to the concentration in groundwater at the point of withdrawal that considers only dilution processes is calculated from a simple water balance equation (Equation 33), described below.

Equation 33
Dilution/Attenuation Factor (DAF)

$$DAF = 1 + \left(\frac{K \times i \times D}{I \times L} \right)$$

Where:

$$D = \left(0.0112 \times L^2\right)^{0.5} + D_a \left(1 - \exp\left[\frac{-L \times I}{K \times i \times D_a} \right] \right)$$

Parameter	Definition (units)	Default
DAF	Dilution/attenuation factor (unitless)	Site-Specific
K	Aquifer hydraulic conductivity (m/yr)	Site-Specific
i	Hydraulic gradient (m/m)	Site-Specific
D	Mixing zone depth (m)	Site-Specific
I	Infiltration rate (m/yr)	Site-Specific
L	Source length parallel to groundwater flow (m)	Site-Specific
D_a	Aquifer thickness (m)	Site-Specific

Most of these parameters are available from routine environmental site investigations. The mixing zone depth incorporates one additional parameter, the aquifer thickness (D_a).

For the calculation of SSLs, the DAF is used to back calculate the target soil leachate concentration (C_w in Equation 32) from an appropriate groundwater concentration, such as the tap water SL, a Water Quality Control Commission (WQCC) standard, or a Federal Maximum Contaminant Level (MCL). For example, if the WQCC standard for a constituent is 0.1 mg/L and the DAF is 20, the target soil leachate concentration would be 2 mg/L.

The US EPA conducted an extensive evaluation of the range and distribution of DAFs to select a default value to be used for developing generic SSLs that would be reasonably protective of groundwater quality (US EPA 1996a, 1996b, and 2002a). The evaluation included a probabilistic modeling exercise using US EPA's Composite Model for Leachate Migration with Transformation Products (CMTP). A cumulative frequency distribution of DAF values was developed from the model output. Results of the Monte Carlo modeling analysis indicate that for a 0.5 acre source area a DAF of approximately 170 is protective of groundwater at 90 percent of the sites. Groundwater is protected at 95 percent of the sites with a DAF of 7.

US EPA applied the simple SSL water balance dilution model (Equation 31) to 300 sites included in surveys of hydrogeologic investigations to further evaluate the range and distribution of DAF values. Results of this analysis indicated that a DAF of 10 was protective of groundwater for a 30-acre source and that a DAF of 20 was protective of groundwater for a 0.5 acre-source (US EPA 1996a, 1996b, and 2001).

An assessment was performed of US EPA's methodology to determine whether a default DAF value of 20 for a 0.5 acre source, and a DAF of 10 for a 30 acre source, would be appropriate for use as default values for sites in New Mexico. Typical New Mexico conditions may be notably different than conditions represented by areas included in the US EPA analysis of DAFs. For example, infiltration rates across much of New Mexico are substantially less than the average range of 0.15 to 0.24 m/yr reported for many of the hydrogeologic regions used in the US EPA analysis. In addition, effective porosity was assumed to be 0.35, presumably because this value is representative of the most prevalent aquifer type in the databases used (US EPA 1996a). However, the regions included in the US EPA analysis also contain extensive glacial, regolith, lacustrine, swamp and marsh deposits which have high percentages of fine-grained sediments and thus are not representative of typical New Mexico sandy soils. Sandy soils typically have higher hydraulic conductivities than more fine-grained soils and subsequently higher Darcian velocities, under equal hydraulic gradient. According to the DAF equation (Equation 33), soils with relatively greater hydraulic conductivities will tend to result in a higher calculated DAF.

An assessment was made of input parameters to the DAF equation. In order to support a DAF that is protective of the most vulnerable groundwater environments in New Mexico (i.e. areas close to perennial streams or where ground water is very shallow), environmental parameters typical of those areas in New Mexico were used to assess the DAF. This assessment indicated that the DAF is most sensitive to variations in hydraulic conductivity. This is because this value shows such large variations in the natural environment. If a hydraulic conductivity value representative of a fine-grained sand is used in the DAF equation, along with an infiltration rate representative of New Mexico's arid to semi-arid environments, then the result is a DAF of approximately 20. NMED believes that a DAF of 20 for a 0.5 acre source area is protective of groundwater in New Mexico. If the default DAF is not representative of conditions at a specific site, then it is appropriate to calculate a site-specific DAF based upon available site data.

4.5 Limitations on the Use of the Dilution Attenuation Factor

Because of assumptions used in SSL model approach, use of the DAF model may be inappropriate for certain conditions, including sites where:

- Adsorption or degradation processes are expected to significantly attenuate contaminant concentrations in the soil or aquifer media;
- Saturated thickness is significantly less than 12 meters thick;
- Fractured rock or karst aquifer types exist (violates the unconfined, unconsolidated, homogeneous, isotropic assumptions);
- Facilitated transport is significant (colloidal transport, transport via dissolved organic matter, or transport via solvents other than water; and/or
- NAPLs are present.

For sites that have these types of conditions, consideration should be given to application of a more detailed site-specific analysis than either the generic or site-specific models described herein.

4.6 Generic SSLs for Protection of Groundwater

The migration to groundwater pathway model, incorporating the assumptions, soil-water partition equation, and the DAF, was used to develop NMED SSLs. Default values based on conditions predominant in New Mexico were used for the input parameters in the soil-water partition equation. The NMED SSLs are presented for both default DAF values of 1 and 20.

Target soil leachate concentrations (C_w) are equivalent to the appropriate groundwater standards multiplied by a DAF. To maintain an approach that is protective of groundwater quality in the development of generic SSLs, a DAF of 20 is selected as reasonably protective. However SSLs are provided for two DAFs in Appendix A. The use of the SSL listed for a DAF of 20 is advised unless site-specific data on hydrologic conditions are available, and these indicate that the generic DAF is not representative of site conditions. As will be demonstrated in the sensitivity analysis section of this document, calculation of an SSL using the migration to groundwater pathway model is most sensitive to the DAF. The inclusion of the SSL for a DAF of 1 is provided for convenience to the user. If data on hydrologic conditions are readily available, a site specific DAF can be calculated and multiplied by the generic SSL for a DAF of 1 to provide a site-specific SSL.

The generic approach may be inappropriate for use at sites where conditions are substantially different from the default values used to develop the generic soil leachate SSLs.

4.7 Development of Site Specific SSLs for Protection of Groundwater

New Mexico, as with any other state, offers a variety of geologic and hydrologic conditions that may not be readily represented by a single default parameter value.

Site specific conditions may differ considerably from the typical or average conditions represented by the default values used to calculate generic SSLs. The site-specific model can be used to address the variability inherent in environmental conditions across and within the state.

Application of the site-specific model to develop soil leachate SSLs is the same as the generic approach except that site-specific values are used. Use of the site-specific model approach may incorporate replacement of all default values used for the generic SSLs with site-specific values, or may only include substitution of a single key parameter, such as hydraulic conductivity. The decision to use the site-specific model approach instead of the generic approach should be based on consideration of the sensitivity of the calculated SSL to specific parameters and the availability of those parameters as site-specific data. Sufficient site-specific data may be available such that each of the default values used for developing generic SSLs can be readily substituted with a more representative site-derived value. Conversely, limited site-specific data may restrict the number of default values to be replaced.

The NMED SSLs are generally more sensitive to the dilution factor than to other parameters in the soil-water partition equation. Fortunately, information needed to derive the DAF is usually available for sites that have undergone even the most basic levels of environmental investigation. Apart from the dilution factor, SSLs are most sensitive to the soil-water partition coefficient (K_d) as the values for this parameter can range over several orders of magnitude, particularly for metals. Although the K_d term may be critical in developing protective SSLs, information required to evaluate this parameter is more difficult to obtain and less likely to be available. Porosity and bulk density are not particularly sensitive because of the relatively small range of values encountered in subsurface conditions.

Using benzene as a representative contaminant, a sensitivity analysis was performed to compare a generic soil leachate SSL to site-specific model results simulating a range of model input parameters that might be representative of different conditions in New Mexico. The generic soil leachate SSL calculated using the New Mexico default values and a DAF of 1 is 2.8 µg/kg. These results are summarized in Table 4-1. As shown, the resulting SSLs for benzene range from 1.3 to 6.1 µg/kg for the various sensitivity simulations compared to the generic SSL of 2.8 µg/kg. These results indicate that the calculation of SSLs using the site-specific approach is not overly sensitive to the reasonable range of porosity (air and water filled), bulk density and fraction of organic carbon expected for New Mexico or even for a range of values for chemical-specific properties. The generic SSL for benzene of 2.8 µg/kg is representative of values that could be calculated using a spectrum of input parameters, exclusive of the DAF term. Unless there are sufficient data to calculate a site-specific DAF, there is little benefit derived from using the site-specific model approach instead of the generic SSL.

Table 4-1. Input Parameters and Resulting SSLs for the Sensitivity Analysis of the Soil-Water Partition Equation - Migration to Groundwater Pathway Model

Input parameter (NMED default value)	Sensitivity Analysis Values	Resulting SSLs
Bulk density (default value = 1.55 gm/cm)	Lower Limit = 1.20 Upper Limit = 1.90	3.4 2.5
Air filled porosity (default value = 0.18)	Lower Limit = 0.04[a] Upper Limit = 0.25[b]	1.3 3.5
Fraction organic carbon (default value = 0.0015)	Lower Limit = 0.000 5 Upper Limit = 0.007	2.2 6.1
Volume water content (default value = 0.26)	Lower Limit = 0.05[c] Upper Limit = 0.40[c]	1.8 3.5
K_{oc} (default value = 58.9 ml/g)	Lower Limit = 30 Upper Limit = 120	2.4 3.7
Dimensionless Henry's Law constant (default value = 0.228)	Lower Limit = 0.1 Upper Limit = 0.4	2.7 3.0

[a] total porosity was reduced from 0.44 to 0.10 for this simulation
[b] total porosity was increased from 0.44 to 0.6 for this simulation
[c] total porosity remained at 0.44 for this simulation.

As previously stated, calculation of SSLs is most sensitive to the DAF term. The input parameter values and resulting DAFs for the sensitivity analysis are included in Table 4-2. Effects on the DAFs are, from greatest to least, the Darcian velocity (hydraulic conductivity multiplied by the hydraulic gradient), infiltration rates, size of the contaminated area, and the aquifer thickness. Corresponding effects on DAFs for each of these parameters and discussion of the relevance of the use of default values versus site-specific conditions are summarized below:

Table 4-2. Input Parameters and Resulting DAFs for the Sensitivity Analysis of the Dilution Attenuation Factor-Migration to Groundwater Pathway Model

Parameter	Groundwater Velocity (m/yr)	Infiltration Rate (m/yr)	Source Length (m)	Aquifer thickness (m)	Mixing Zone Depth (m)	Dilution Attenuation Factor (DAF)
Groundwater velocity	2.2	0.13	45	12	7.15	3.7
Groundwater velocity	22	0.13	45	12	5.03	19.9
Groundwater velocity	220	0.13	45	12	4.79	181.1
Infiltration Rate	22	0.065	45	12	4.89	37.8
Infiltration Rate	22	0.13	45	12	5.03	19.9
Infiltration Rate	22	0.26	45	12	5.28	10.9
Source Length	22	0.13	22.5	12	2.51	19.9
Source Length	22	0.13	45	12	5.03	19.9
Source Length	22	0.13	348.4	12	38.76*	6.8
Aquifer Thickness	22	0.13	45	3	5.02*	12.3
Aquifer Thickness	22	0.13	45	12	5.03	19.9
Aquifer Thickness	22	0.13	45	48	5.03	19.9

Note: If mixing zone depth calculation is greater than aquifer thickness, then aquifer thickness is used to calculate the DAF.

Higher Darcian velocity results in higher DAFs. Slower mixing of groundwater with soil leachate occurs at lower groundwater velocity. Thus, using a lower velocity will be a more conservative approach. Sandy soils typically have higher hydraulic conductivities than more fine-grained soils and subsequently higher Darcian velocity (under equal hydraulic gradient). Use of a sandy soil type will generally be less conservative (result in higher DAFs) with respect to protection of groundwater quality.

Lower infiltration rates result in higher DAFs. Therefore, using a higher infiltration rate is a more conservative approach (results in a lower DAF).

Larger source sizes result in lower DAFs. The default DAF used to develop SSLs for a 0.5 acre source may not be protective of groundwater at sites larger than 0.5 acre. However, the selection of a second source size is arbitrary. If generic SSLs are developed for a 30 acre source, then those values are considered overly conservative for a 12 acre source. Conversely, SSLs developed for a 30 acre source will be less protective of a 40 acre source. Rather than develop a

separate set of generic SSLs for a second (or third or fourth) source size, the following two approaches are proposed.

- As the size of the source area increases, the assumptions underlying the generic model are less applicable. One of the conservative assumptions in the generic SSL approach is the uniform distribution of contaminants throughout the vadose zone. There are few sites that have relatively uniform soil contamination (both laterally and vertically) of a single constituent in an area of greater than 0.5 acres (22,000 ft^2). Soil contamination at large facilities (such as federal facilities) are usually concentrated in discrete portions of the site. Contamination at large sites is commonly the result of multiple sources. It is advisable to attempt to subdivide the facility by source and contaminant type and then apply generic SSLs to those smaller source areas.

- If this approach is not practical, calculation of site specific DAFs is recommended. Most of the parameters required for these calculations are available from routine environmental site investigations or can be reasonably estimated from general geologic and hydrologic studies.

Thin aquifers will result in lower DAFs. The nominal aquifer thickness used in the sensitivity analysis was 12 meters (m). Reducing the aquifer thickness to 3 m results in a 40 percent reduction in the DAF. Increasing the aquifer thickness beyond the nominal value has very little impact.

The significant effects of the DAF on the calculation of SSLs, coupled with the common availability of site-specific data used to calculate the DAF, suggest that use of the site specific modeling approach should at least incorporate recalculation of the DAF term. If data are available that indicate soil properties significantly different than the default values (such as high or low f_{oc} for organic contaminants, or highly acidic or basic conditions for metal contaminants) the K_d term should also be evaluated and recalculated.

4.8 Detailed Model Analysis for SSL Development

Sites that have complex or heterogeneous subsurface conditions may require more detailed evaluation for development of SSLs that are reasonably, but not overly, protective of groundwater and surface water resources. These types of sites may require more complex models that can address a wide range of variability in environmental site conditions including soil properties, contaminant mass concentration and distribution, contaminant degradation and transformation, recharge rates and recharge concentration, and depth to the water table. Model codes suitable for these types of more detailed analysis range from simple one-dimensional analytical models to complex three-dimensional numerical models. Resource requirements (data, time and cost) increase for the more complex codes. The selection of an appropriate code needs to balance the required accuracy of the output with the level of effort necessary to develop the model.

4.9 Summary of the Migration to Groundwater Pathway SSLs

SSLs for New Mexico have been developed for the migration to groundwater pathway, and are provided in Table A-1 of Appendix A. The NMED SSLs were developed using default parameter values representative of environmental conditions in New Mexico and utilize a DAF of 20. This approach maintains the conservative approach of the SSL methodology and is protective of groundwater quality under a wide range of site conditions. Soil contaminant concentrations can be compared directly to the generic SSLs to determine if additional investigation is necessary to evaluate potential leaching and migration of contaminants from the vadose zone to groundwater in excess of NMED-specific tap water SSLs.

Site-specific SSLs can be developed by substituting site-related data for the default values in the leaching to groundwater pathway model. SSLs developed from this model are most sensitive to the DAF. SSLs are also provided in the lookup table for a DAF of 1. If data on hydrologic conditions are readily available, a site specific DAF can be calculated.

5.0 USE OF THE SSLS

For screening sites with multiple contaminants, the following procedure should be followed: take the site-specific concentration (first step screening assessments should use the maximum reported concentration) and divide by the SSL concentration for each analyte. For multiple contaminants, simply add the ratio for each chemical.

$$\text{Site Risk} = \left(\frac{\text{conc}_x}{\text{SSL}_x} + \frac{\text{conc}_y}{\text{SSL}_y} + \frac{\text{conc}_z}{\text{SSL}_z} + \ldots + \frac{\text{conc}_i}{\text{SSL}_i} \right) \times 10^{-5} \qquad \textbf{Equation 34}$$

$$\text{Site Hazard Index (HI)} = \left(\frac{\text{conc}_x}{\text{SSL}_x} + \frac{\text{conc}_y}{\text{SSL}_y} + \frac{\text{conc}_z}{\text{SSL}_z} + \ldots + \frac{\text{conc}_i}{\text{SSL}_i} \right) \times 1 \qquad \textbf{Equation 35}$$

If the total cancer risk is greater than the target risk level of 1E-05 or if the hazard index is greater than one, concentrations at the site warrant further, site-specific evaluation. Site risk and hazard indices less than the target levels indicate that the concentrations at the site are unlikely to result in adverse health impacts.

As with any risk-based tool, the potential exists for misapplication. In most cases the root cause will be a lack of understanding of the intended use of NMED SSLs. In order to prevent misuse of SSLs, the following should be avoided:

- Applying SSLs to a site without adequately developing a conceptual site model that identifies relevant exposure pathways and exposure scenarios,
- Use of SSLs as cleanup levels without verifying numbers with a toxicologist or risk assessor, and

- Not considering the effects of additivity when screening multiple chemicals.

It is important to note that the generic NMED SSLs were developed assuming distinct soil horizons for each receptor. The soils of interest differ according to the exposure pathway being addressed. For direct ingestion, dermal, and fugitive dust exposure pathways, the primary soil horizon of concern are surface soils. For inhalation of volatiles and migration to groundwater, subsurface soils are of primary concern. Both a residential receptor and a commercial/industrial worker are typically exposed only to surface soil, which may be defined as extending to a depth of approximately two feet below ground surface, depending on site-specific conditions and the amount of intrusive activity that may occur. Construction workers will typically have much greater exposures to subsurface soils. Therefore, when generic SSLs are used for screening level evaluations at a facility, site-specific conditions must be evaluated for each receptor to determine if the assumptions associated with the generic SSLs are appropriate for comparison with the available site data.

6.0 TOTAL PETROLEUM HYDROCABONS (TPH)

In some instances, it may be practical to assess areas of soil contamination that are the result of releases of petroleum products such as jet fuel and diesel, using total petroleum hydrocarbon (TPH) analyses. TPH results may be used to delineate the extent of petroleum-related contamination at these sites and ascertain if the residual level of petroleum products in soil represents an unacceptable risk to future users of the site. Petroleum hydrocarbons represent complex mixtures of compounds, some of which are regulated constituents and some compounds that are not regulated. In addition, the amount and types of the constituent compounds in a petroleum hydrocarbon release differ widely depending on what type of product was spilled and how the spill has weathered. This variability makes it difficult to determine the toxicity of weathered petroleum products in soil solely from TPH results; however, these results can be used to approximate risk in some cases, depending upon the nature of the petroleum product, the release scenario, how well the site has been characterized, and anticipated potential future land uses. In some cases, site cleanup cannot be based solely on the results of TPH sampling. NMED will make these determinations on a case by case basis. If NMED determines that additional data are necessary, these TPH guidelines must be used in conjunction with the SSLs for individual petroleum-related contaminants in Table A-1 and other contaminants, as applicable.

The screening levels for each petroleum carbon range from the Massachusetts Department of Environmental Protection (MADEP) Volatile Petroleum Hydrocarbons/Extractable Petroleum Hydrocarbons (VPH/EPH) approach and the percent composition table below were used to generate screening levels corresponding to total TPH. Except for waste oil, the information in the compositional assumptions table was obtained from the Massachusetts Department of Environmental Protection guidance document *Implementation of the MADEP VPH/EPH Approach* (October 31, 2002). TPH toxicity (MADEP, 2009) was based only on the weighted sum of the toxicity of the hydrocarbon fractions listed in Table 6-1.

Table 6-1. TPH Compositional Assumptions in Soil

Petroleum Product	C11-C22 Aromatics	C9-C18 Aliphatics	C19-C36 Aliphatics
Diesel #2/ new crankcase oil	60%	40%	0%
#3 and #6 Fuel Oil	70%	30%	0%
Kerosene and jet fuel	30%	70%	0%
Mineral oil dielectric fluid	20%	40%	40%
Unknown oil[a]	100%	0%	0%
Waste Oil[b]	0%	0%	100%

[a] Sites with oil from unknown sources must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Tables 6-2 and 6-3 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED SSLs summarized in Table A-1.

[b] Compositional assumption for waste oil developed by NMED is based on review of chromatographs of several types of waste oil. Sites with waste oil must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Tables 6-2 and 6-3 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED SSLs summarized in Table A-1.

A TPH screening guideline was calculated for each of the types of petroleum product based on the assumed composition from Table 6-1 for petroleum products and the direct soil standards incorporating ceiling concentrations given in the MADEP VPH/EPH (December 2009) Excel spreadsheet for each of the carbon fractions (MADEP, 2009). Groundwater concentrations are based on the weighted sum of the noncarcinogenic toxicity of the petroleum fractions.

Method 1 from the MADEP VPH/EPH document and spreadsheet (MADEP, 2009) was applied, which represents generic cleanup standards for soil and groundwater. Method 1 applies if contamination exists in only soil and groundwater. The MADEP VPH/EPH further divides groundwater into standards. Standard GW-1 applies when groundwater may be used for drinking water purposes. GW-1 standards are based upon ingestion and use of groundwater as a potable water supply. The TPH screening guidelines for sites with potable groundwater are presented in Table 6-2. It is noted that the below guidelines are not necessarily risk-based values but may reflect a ceiling level.

Table 6-2. TPH Screening Guidelines for Potable Groundwater (GW-1)

TPH			Concentration in Groundwater (mg/L)
Petroleum Product	Residential Direct Exposure (mg/kg)	Industrial Direct Exposure (mg/kg)	
Diesel #2/crankcase oil	1000	1800	0.4
#3 and #6 Fuel Oil	1000	1600	0.35
Kerosene and jet fuel	1000	2400	0.55
Mineral oil dielectric	1800	3400	5.92

fluid			
Unknown oil[a]	1000	1000	0.02
Waste Oil[b]	3000	5000	See individual contaminants in Appendix A
Gasoline	Not applicable	Not applicable	See individual contaminants in Appendix A

[a] Sites with oil from unknown sources must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Table 6-2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

[b] Compositional assumption for waste oil developed by NMED is based on review of chromatographs of several types of waste oil. Sites with waste oil must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Table 6-2 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED soil screening guidelines.

The second standard is GW-2 (MADEP, 2009), which is applicable for sites where the depth to groundwater is less than 15 feet from the ground surface and within 30 feet of an occupied structure. The structure may be either residential or industrial. GW-2 standards are based upon "inhalation exposures that could occur to occupants of the building impacted by volatile compounds, which partition from the groundwater" (MADEP, 2001). The GW-2 screening guidelines ONLY apply for the evaluation of inhalation exposures. If potential ingestion or contact with contaminated soil and/or groundwater could occur, then the screening guidelines provided in Table 6-2 should be applied. Table 6-3 lists the TPH screening guidelines for the inhalation scenario (MADEP, 2009). It is noted that the below guidelines are not necessarily risk-based values but may reflect a ceiling level.

Table 6-3. TPH Screening Guidelines – Vapor Migration and Inhalation of Groundwater (GW-2)

TPH			Concentration in Groundwater (mg/L)
Petroleum Product	**Residential Direct Exposure (mg/kg)**	**Industrial Direct Exposure (mg/kg)**	
Diesel #2/crankcase oil	1000	3000	32
#3 and #6 Fuel Oil	1000	3000	36.5
Kerosene and jet fuel	1000	3000	18.5
Mineral oil dielectric fluid	1800	3800	12
Unknown oil[a]	1000	3000	50
Waste Oil[b]	3000	5000	See individual contaminants in Appendix A
Gasoline	Not applicable	Not applicable	See individual contaminants in Appendix A

[a] Sites with oil from unknown sources must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Table 6-3 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED SSLs summarized in Table A-1.

[b] Compositional assumption for waste oil developed by NMED is based on review of chromatographs of several types of waste

oil. Sites with waste oil must be tested for VOCs, SVOCs, metals, and PCBs to determine if other potentially toxic constituents are present. The TPH guidelines in Table 6-3 are not designed to be protective of exposure to these constituents therefore they must be tested for, and compared to, their individual NMED SSLs summarized in Table A-1.

Mineral oil based hydraulic fluids can be evaluated for petroleum fraction toxicity using the screening guidelines from Tables 6-2 and 6-3 specified for waste oil, because this type of hydraulic fluid is composed of approximately the same range of carbon fractions as waste oil. However, these hydraulic fluids often contain proprietary additives that may be significantly more toxic than the oil itself; these additives must be considered on a site- and product-specific basis (see ATSDR hydraulic fluids profile reference). **Use of alternate screening guideline values requires prior written approval from the NMED.** The TPH screening guidelines in Tables 6-2 and 6-3 must be used in conjunction with the screening levels for petroleum-related contaminants given in Table A-1 because the TPH screening levels are NOT designed to be protective of exposure to these individual petroleum-related contaminants.

The list of petroleum-related contaminants does not include PAHs with individual screening levels that would exceed the total TPH screening levels (e.g., acenaphthene, anthracene, fluoranthene, fluorine, and pyrene). In addition, these TPH screening guidelines are based solely on human health, not ecological risk considerations, protection of surface water, or potential indoor air impacts from soil vapors. Potential soil vapor impacts to structures or utilities are not addressed by these guidelines. Site-specific investigations for potential soil vapor impacts to structures or utilities must be done to assure that screenings are consistently protective of human health, welfare or use of the property. NMED believes that use of these screening guidelines will allow more efficient screenings of petroleum release sites at sites while protecting human health and the environment. Copies of the references cited below are available on the MADEP website at http://www.mass.gov/dep/cleanup/laws/standard.htm.

7.0 REFERENCES

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. Toxicological Profile for Hydraulic fluids.

Ahlborg UG, Becking GC, Birnbaum LS, Brouwer A, Derks HJGM, Feeley M, Color G, Hanberg A, Larsen JC, Liem AKD, Safe SH, Schlatter C, Wvern F, Younes M, Yrjinheikki E. 1993. *Toxic Equivalency Factors for Dioxin-Like PCBs Report on a WHO-ECEH and IPCS Consultation*. December 1993 http://epa-prgs.ornl.gov/chemicals/help/documents/TEF_PCB170_PCB180.pdf

Center for Disease Control, Agency for Toxic Substances and Disease Registry. 2003. *Hazardous Substances Database*. http://www.atsdr.cdc.gov/hazdat.html

Enfield, C. G., R.F. Carsel, S.E. Cohen, T. Phan, and D.M. Walters. 1982. *Approximating Pollutant Transport to Ground Water*. Groundwater, vol. 20, no. 6, pp. 711-722.

Feenstra, S., D.M. Mackay and J.D. Cherry, 1991. *A method for assessing residual NAPL based on organic chemical concentrations in soil samples*. Groundwater Monitoring Review, vol. 11, no. 2, pp 128-136.

Massachusetts Department of Environmental Protection Bureau of Waste Site Cleanup and Office of Research and Standards (MADEP). 1994. "Background Documentation for the Development of the MCP Numerical Standards."

MADEP, 2002. "Characterizing Risks Posed by Petroleum Contaminated Sites: Implementation of the MADEP VPH/EPH Approach," Policy, October 31, 2002.

MADEP, 2003. "Updated Petroleum Hydrocarbon Fraction Toxicity Values for the VPH/EPH/APH Methodology." November 2003.

MADEP, 2009. Spreadsheets for the Development of the MCP Numerical Standards. December.

New Mexico Environment Department, Hazardous and Radioactive Materials Bureau (NMED). 2000. *Assessing Human Health Risks Posed by Chemicals: Screening-level risk Assessment.* Santa Fe, New Mexico. *R*

New Mexico Administrative Code (NMAC) 20.6.2, New Mexico Water Quality Control Commission Regulations, September 15, 2002.

Piwoni, M.D., and P. Banaerjee. 1989. *Sorption of organic solvents from aqueous solution onto subsurface solids*. Journal of Contaminant Hydrology, vol. 4, no. 2, pp 163-179.

Scharwzenbach, R.P. and J.C. Westall. 1981. *Transport of non-polar organic compounds from surface water to groundwater*. Environmental Science Technology, vol. 15, no.1, pp. 1360-1367.

United States Department of Agriculture, 2000. *National Resources Conservation Service, Soil Survey Laboratory Database-New Mexico-All counties.*

United States Department of Energy, 2004. RAIS, Risk Assessment Information System. http://risk.lsd.ornl.gov/index.shtml

United States Environmental Protection Agency (US EPA). 1986. *Superfund Public Health Evaluation Manual*. Office of Emergency and Remedial Response and Office of Solid Waste and Emergency Response. Washington, D.C.

US EPA. 1988. *Superfund Exposure Assessment Manual* (EPA/540/1-88/001). Office of Emergency and Remedial Response, Washington, D.C.

US EPA. 1989. *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual, Interim Final* (EPA/540/1-89/002). Office of Emergency and Remedial Response, Washington, D.C.

US EPA. 1990. *Basics of Pump and Treat Groundwater remediation Technology* (EPA/600/8-90/003) Office of Research and Development. March.

US EPA. 1991. *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-Based Preliminary Remediation Goals), Interim Final* (EPA 9285.6-03). Office of Emergency and Remedial Response, Washington, D.C.

US EPA. 1992a. *Dermal Exposure Assessment: Principles and Applications* (EPA600/8-91/011B). Office of Health and Environmental Assessment, Washington, D.C.

US EPA. 1992b. *Supplemental Guidance to RAGS: Calculating the Concentration Term* (9285.7-081). Office of Solid Waste and Emergency Response, Washington, D.C.

US EPA. 1994. *Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities* (EPA/540/F-94/043). Office of Solid Waste and Emergency Response. Washington, D.C.

US EPA. 1995. *Additional Environmental Fate Constants*. Office of Emergency and Remedial Response, Washington D.C.

US EPA. 1996a. *Soil Screening Guidance. Technical Background Document* (EPA/540/R95/128). Office of Emergency and Remedial Response, Washington D.C.

US EPA. 1996b. *Soil Screening Guidance. Users Guide, Second Edition* (EPA 9355.4-23). Office of Emergency and Remedial Response, Washington D.C.

US EPA. 1996c. *Recommendations of the Technical Review Workgroup for Lead for an Interim Approach to Assessing Associated with Adult to Lead in Soil.* December.

US EPA. 1997a. *Health Effects Assessment Summary Tables: FY 1997 Update* (HEAST). National Center for Environmental Assessment, Office of Research and Development and Office of Emergency and Remedial Response, Washington, D.C.

US EPA. 1997b. *Exposure Factors Handbook*, (EPA/600/P-95/002Fa). Office of Research and Development, Washington, D.C.

US EPA. 1998a. *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities, Peer Review Draft* (EPA/530/D-98/001a). Office of Solid Waste and Emergency Response, Washington, D.C.

US EPA. 1998b. *Clarification to the 1994 Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities*. OWSER Directive 9200.4-27, EPA/540/F-98/030. August.

US EPA. 2000. *CHEMFACT Database*. http://www.epa.gov/chemfact/. Office of Pollution Prevention and Toxics. Washington, D.C.

US EPA. 2002a. *Supplemental Guidance for Developing Soil Screening Levels for Superfund*

Sites. Office of Emergency and Remedial Response, Washington, D.C. OSWER 9355.4-24. December. http://www.epa.gov/superfund/health/conmedia/soil/pdfs/ssg_main.pdf

US EPA. 2002b. *Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites*. Office of Solid Waste and Emergency Response, OSWER 9285.6-10. December 2002.

US EPA. 2002c. Current Drinking Water Standards. http://www.epa.gov/safewater/mcl.html.

US EPA. 2003. Memorandum: Human Health Toxicity Values in Superfund Risk Assessments, OSWER Directive 9285.7-53. December 3. http://www.epa.gov/oswer/riskassessment/pdf/hhmemo.pdf

US EPA. 2004. *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Interim Guidance*. Office of Solid Waste and Emergency Response, Washington, D.C. http://www.epa.gov/oswer/riskassessment/ragse/index.htm

US EPA. 2005. *Supplemental Guidance for Assessing Susceptibility from Early-life Exposure to Carcinogens*. EPA/630/R-03/003F. Washington, D.C.

US EPA. 2009a. *Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment), Final*. Office of Solid Waste and Emergency Response, Washington, D.C. http://www.epa.gov/oswer/riskassessment/ragsf/pdf/partf_200901_final.pdf

US EPA. 2011. *Integrated Risk Information System* (IRIS). http://www.epa.gov/iris.

US EPA. 2011. Regional Screening Levels for Chemical Contaminants at Superfund Sites. June. http://www.epa.gov/region9/superfund//prg/index.html

Van den Berg, et. al, 2006. *The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency factors for Dioxin and Dioxin-like Compounds*. ToxiSci Advance Access, July 7, 2006.

APPENDIX A

NMED SOIL SCREENING LEVELS (SSLs)

Appendix A

State of New Mexico Soil Screening Levels

Table A-1 provides State of New Mexico Soil Screening Levels (SSLs), as developed by the New Mexico Environment Department (NMED) Hazardous Waste Bureau (HWB) and the Ground Water Quality Bureau Voluntary Remediation Program for 220 chemicals most commonly associated with environmental releases within the state. These NMED SSLs are derived using default exposure parameter values (refer to Equations in Volume I) and chemical- and State of New Mexico-specific physical parameters (as presented in Tables B-1 and B-2 of Appendix B). These default values are assumed to be appropriately conservative in the face of uncertainty and are likely to be protective for the majority of site conditions relevant to soil exposures within New Mexico.

However, the NMED SSLs are not necessarily protective of all known human exposure pathways, reasonable land uses or ecological threats. Thus, before applying NMED SSLs at a site, it is extremely important to compare the conceptual site model (CSM) with the assumptions upon which the NMED SSLs are predicated to ensure that the site conditions and exposure pathways match those used to develop the NMED SSLs. If this comparison indicates that the site at issue is more complex than the corresponding SSL scenarios, or that there are significant exposure pathways not accounted for by the NMED SSLs, then the NMED SSLs are insufficient for use in a defensible assessment of the site. A more detailed site-specific approach will be necessary to evaluate the additional pathways or site conditions.

TABLE A-1

Column 1: The first column in Table A-1 presents the names of the chemicals for which NMED has developed SSLs.

Column 2: The second column presents NMED SSLs predicated on residential soil exposures.

Column 3, 5, 7, and 9: These columns present indicator categories for the NMED SSL residential, industrial, construction, and tap water basis, whether predicated on carcinogenic (c) and noncarcinogenic (n) effects. In some cases, the risk-based SSL is greater than the soil saturation limit, and in these cases, the SSL is denoted as either "cs" or "ns" depending on carcinogenicity or non-carcinogenicity, respectively. In the case where a noncarcinogenic SSL is greater than the ceiling limit (1E+05), the SSL is denoted as "nl" and in a few cases, "nls" is used to indicate the SSL is both above the saturation level and the ceiling limit. NMED SSLs predicated on a carcinogenic endpoint reflect age-adjusted child-to-adult exposures. NMED SSLs predicated on a noncarcinogenic endpoint reflect child-only exposures. Detected concentrations above a saturation value ("cs", "ns", or "nsl") may indicate the presence of nonaqueous phase liquid (NAPL).

Columns 4 and 6: The fourth and sixth columns present NMED SSLs analogous to Column 1, with the exception that these values correspond to Industrial/Occupational

and Construction worker (adult-only) exposures, respectively.

Column 8: Presents the tap water SL for the residential scenario.

Columns 10 and 11: The tenth column presents NMED SSLs for the migration to groundwater pathway developed using a default dilution attenuation factor (DAF) of 1, which assume no effective dilution or attenuation. These values can be considered at sites where little or no dilution or attenuation of soil leachate concentrations is expected (e.g., shallow water tables, karst topography). Column 11 presents NMED SSLs for the migration to groundwater pathway developed using a DAF of 20 to account for natural processes that reduce contaminant concentrations in the subsurface. The SSLs based on a DAF of 20 are default SSLs that should be applicable at most sites.

As noted above, separate NMED SSLs are presented for use in evaluating three discrete potential receptor populations: Residential, Industrial/Occupational, and Construction. Each NMED SSL considers incidental ingestion of soil, inhalation of volatiles from soil (limited to those chemicals noted as volatile organic compounds [VOCs] within Table B-2) and/or particulate emissions from impacted soil, and dermal contact with soil.

Generally, if a contaminant is detected at a level in soil exceeding the most relevant NMED SSL, and the site-specific CSM is in general agreement with the underlying assumptions upon which the NMED SSLs are predicated, this result indicates the potential for adverse human health effects to occur. Conversely, if no contaminants are detected above the most relevant NMED SSL, this tends to indicate to the user that environmental conditions may not necessitate remedial action of the surface soil or the vadose zone.

A detection above a NMED SSL does not indicate that unacceptable exposures are, in fact, occurring. The NMED SSLs are predicated on relatively conservative exposure assumptions and an exceedance only tends to indicate the potential for adverse effects. The NMED SSLs do not account for additive exposures, whether for carcinogenic or noncarcinogenic endpoints. Section 5 of Volume I addresses a methodology by which an environmental manager may determine whether further site-evaluation is warranted, however, this methodology does not replace the need for defensible risk assessment where indicated. The SSLs also do not account for ingestion of homegrown produce/animals or the vapor intrusion pathway. If these or other exposure pathways are complete, additional analyses may be warranted.

The NMED SSLs address a basic subset of exposures fundamental to the widest array of environmentally-impacted sites within the State of New Mexico. The NMED SSLs cannot address all relevant exposure pathways associated with all sites. The utility of the NMED SSLs depends heavily upon the understanding of site conditions as accurately reflected in the CSM and nature and extent of contamination determinations. Consideration of the NMED SSLs does not preclude the need for site-specific risk assessment in all instances.

Table A-1: NMED Soil Screening Levels

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (µg/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
Acenaphthene	3.44E+03	n	3.67E+04	n	1.86E+04	n	2.19E+03	n	1.71E+01	3.43E+02
Acetaldehyde	2.45E+02	n	1.16E+03	n	2.14E+02	n	1.88E+01	n	3.77E-03	7.54E-02
Acetone	6.66E+04	n	8.68E+05	nls	2.21E+05	nls	2.18E+04	n	3.85E+00	7.71E+01
Acrylonitrile	4.55E+00	c	2.43E+01	c	3.76E+01	n	4.54E-01	c	8.46E-05	1.69E-03
Acetophenone	7.82E+03	ns	1.14E+05	nls	3.10E+04	ns	3.65E+03	n	9.17E-01	1.83E+01
Acrolein	4.04E-01	n	1.92E+00	n	3.56E-01	n	4.16E-02	n	7.28E-06	1.46E-04
Aldrin	2.84E-01	c	1.12E+00	c	7.15E+00	n	3.92E-02	c	4.83E-03	9.66E-02
Aluminum	7.80E+04	n	1.13E+06	nl	4.07E+04	n	3.65E+04	n	5.48E+04	1.10E+06
Anthracene	1.72E+04	n	1.83E+05	nl	6.68E+04	n	1.10E+04	n	2.71E+02	5.41E+03
Antimony	3.13E+01	n	4.54E+02	n	1.24E+02	n	1.46E+01	n	6.60E-01	1.32E+01
Arsenic	3.90E+00	c	1.77E+01	c	5.30E+01	n	4.48E-01	c	1.31E-02	2.61E-01
Barium	1.56E+04	n	2.23E+05	nl	4.35E+03	n	7.30E+03	n	3.01E+02	6.01E+03
Benzene	1.54E+01	c	8.47E+01	c	1.38E+02	n	4.13E+00	c	1.62E-03	3.24E-02
Benzidine	5.01E-03	c	8.33E-02	c	7.20E-01	c	9.36E-04	c	1.83E-06	3.67E-05
Benzo(a)anthracene	1.48E+00	c	2.34E+01	c	2.13E+02	c	2.95E-01	c	7.83E-02	1.57E+00
Benzo(a)pyrene	1.48E-01	c	2.34E+00	c	2.13E+01	c	2.95E-02	c	2.60E-02	5.20E-01
Benzo(b)fluoranthene	1.48E+00	c	2.34E+01	c	2.13E+02	c	2.95E-01	c	2.65E-01	5.31E+00
Benzo(k)fluoranthene	1.48E+01	c	2.34E+02	c	2.06E+03	c	2.95E+00	c	2.60E+00	5.20E+01
Beryllium	1.56E+02	n	2.26E+03	n	1.44E+02	n	7.30E+01	n	5.77E+01	1.15E+03
a-BHC (a-Hexachlorocyclohexane, a-HCH)	7.72E-01	c	3.04E+00	c	2.63E+01	c	1.07E-01	c	5.04E-04	1.01E-02
b-BHC (b-Hexachlorocyclohexane, b-HCH)	2.70E+00	c	1.06E+01	c	9.19E+01	c	3.73E-01	c	1.64E-03	3.27E-02
g-BHC (Lindane)	5.17E+00	c	2.29E+01	c	8.30E+01	n	6.11E-01	c	2.68E-03	5.36E-02
1,1-Biphenyl	5.71E+01	ns	2.72E+02	ns	1.55E+04	ns	8.34E-01	n	6.65E-03	1.33E-01
Bis(2-chloroethyl) ether	2.68E+00	c	1.42E+01	c	7.78E+01	c	1.19E-01	c	3.41E-05	6.81E-04
Bis(2-chloroisopropyl) ether	9.15E+01	c	4.54E+02	cs	3.10E+03	cs	9.60E+00	c	3.53E-03	7.06E-02
Bis(2-ethylhexyl) phthalate	3.47E+02	cs	1.37E+03	cs	4.76E+03	n	4.80E+01	c	8.62E+00	1.72E+02
Bis(chloromethyl) ether	6.48E-03	c	3.53E-02	c	1.78E-01	c	6.24E-04	c	1.17E-07	2.35E-06
Boron	1.56E+04	n	2.27E+05	nl	4.65E+04	n	7.30E+03	n	2.51E+01	5.01E+02
Bromodichloromethane	5.41E+00	c	3.01E+01	c	1.43E+02	c	1.17E+00	c	5.81E-04	1.16E-02

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (µg/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
Bromomethane	1.65E+01	n	8.65E+01	n	1.64E+01	n	8.66E+00	n	1.80E-03	3.60E-02
1,3-Butadiene	8.08E-01	c	4.29E+00	c	3.19E+00	n	1.76E-01	c	5.49E-05	1.10E-03
2-Butanone (Methyl ethyl ketone, MEK)	3.71E+04	n	3.75E+05	nls	8.43E+04	nls	7.06E+03	n	2.61E+00	5.21E+01
tert-Butyl methyl ether (MTBE)	9.01E+02	c	4.89E+03	c	2.49E+04	cs	1.25E+02	c	2.59E-02	5.18E-01
Cadmium	7.03E+01	n	8.97E+02	n	2.77E+02	n	1.83E+01	n	1.37E+00	2.75E+01
Carbon disulfide	1.53E+03	ns	8.33E+03	ns	1.58E+03	ns	1.04E+03	n	2.16E-01	4.33E+00
Carbon tetrachloride	1.08E+01	c	5.98E+01	c	2.26E+02	ns	4.40E+00	c	1.05E-03	2.10E-02
Chlordane	1.62E+01	c	7.19E+01	c	1.35E+02	n	1.35E+00	n	6.87E-02	1.37E+00
2-Chloroacetophenone	1.72E+05	nl	8.12E+05	nl	2.81E+02	n				
2-Chloro-1,3-butadiene	1.69E-01	c	2.03E+02	n	4.39E+00	c	1.62E-01	c	4.29E-05	1.70E-03
1-Chloro-1,1-difluoroethane	1.07E+05	nls	5.05E+05	nls	9.38E+04	nls	1.04E+05	n	2.67E+01	1.07E+03
Chlorobenzene	3.76E+02	ns	2.12E+03	ns	4.06E+02	ns	9.13E+01	n	5.82E-02	9.84E-01
1-Chlorobutane	3.13E+03	ns	4.54E+04	ns	1.24E+04	ns	1.46E+03	n	5.77E-01	1.05E+01
Chlorodifluoromethane	1.03E+05	nls	4.86E+05	nls	9.04E+04	nls	1.04E+05	n	2.31E+01	8.55E+02
Chloroform	5.86E+00	c	3.27E+01	c	1.54E+02	c	1.93E+00	c	6.45E-04	9.18E-03
Chloromethane	2.75E+02	n	1.29E+03	cs	2.41E+02	n	1.88E+02	n	3.63E-02	8.79E-01
b-Chloronaphthalene	6.26E+03	ns	9.08E+04	ns	2.48E+04	ns	2.92E+03	n	1.15E+01	2.27E+02
o-Chloronitrobenzene	1.62E+01	c	1.06E+02	n	8.51E+01	n	2.24E+00	c	1.63E-03	3.27E-02
p-Chloronitrobenzene	6.11E+01	n	1.49E+02	n	2.94E+02	n	1.21E+00	n	8.99E-04	1.74E-02
2-Chlorophenol	3.91E+02	n	5.68E+03	n	1.55E+03	n	1.83E+02	n	1.36E-01	2.31E+00
2-Chloropropane	6.63E+03	ns	3.13E+04	ns	5.78E+03	ns	2.09E+02	n	4.80E-02	9.22E-01
o-Chlorotoluene	1.56E+03	ns	2.27E+04	ns	6.19E+03	ns	7.30E+02	n	5.46E-01	1.12E+01
Chromium III	1.17E+05	nl	1.70E+06	nl	4.65E+05	nl	5.48E+04	n	9.86E+07	1.97E+09
Chromium VI	2.97E+00	c	6.31E+01	n	6.56E+01	c	4.31E-01	c	8.26E-03	1.66E-01
Chrysene	1.48E+02	c	2.34E+03	c	2.06E+04	c	2.95E+01	c	7.99E+00	1.60E+02
Copper	3.13E+03	n	4.54E+04	n	1.24E+04	n	1.46E+03	n	5.14E+01	1.03E+03
Crotonaldehyde	3.37E+00	c	1.14E+03	c	1.14E+02	c	3.54E-01	c	6.35E-05	1.25E-03
Cumene (isopropylbenzene)	2.43E+03	ns	1.45E+04	ns	2.81E+03	ns	6.79E+02	n	8.31E-01	1.73E+01
Cyanide	4.69E+01	n	6.81E+02	n	1.86E+02	n	2.19E+01	n	2.21E-01	4.41E+00
Cyanogen	3.13E+03	ns	4.54E+04	n	1.24E+04	n	1.46E+03	n	2.66E-01	5.79E+00
Cyanogen bromide	7.04E+03	n	1.02E+05	nl	2.79E+04	n	3.29E+03	n	6.06E-01	1.88E+01

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (µg/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
Cyanogen chloride	3.91E+03	n	5.68E+04	n	1.55E+04	n	1.83E+03	n	3.16E-01	6.66E+00
DDD	2.03E+01	c	7.98E+01	c	6.90E+02	c	2.80E+00	c	4.98E-01	9.88E+00
DDE	1.43E+01	c	5.63E+01	c	4.87E+02	c	1.98E+00	c	3.49E-01	6.97E+00
DDT	1.72E+01	c	7.81E+01	c	1.42E+02	n	1.98E+00	c	5.00E-01	1.00E+01
Dibenz(a,h)anthracene	1.48E-01	c	2.34E+00	c	2.13E+01	c	2.95E-02	c	8.46E-02	1.69E+00
1,2-Dibromo-3-chloropropane	1.86E+00	c	1.08E+00	c	5.07E+00	c	3.16E-03	c	1.16E-06	2.20E-05
Dibromochloromethane	1.21E+01	c	6.24E+01	c	3.32E+02	cs	1.47E+00	c	5.04E-04	6.61E-03
1,2-Dibromoethane	5.88E-01	c	3.22E+00	c	1.60E+01	c	6.53E-02	c	1.52E-05	3.08E-04
1,4-Dichloro-2-butene	9.73E-02	c	5.45E-01	c	2.53E+00	c	1.16E-02	c	4.45E-06	8.66E-05
1,2-Dichlorobenzene	2.31E+03	ns	1.40E+04	ns	2.71E+03	ns	3.70E+02	n	2.78E-01	5.60E+00
1,4-Dichlorobenzene	3.17E+01	c	1.77E+02	c	8.31E+02	cs	4.27E+00	c	4.39E-03	6.39E-02
3,3-Dichlorobenzidine	1.08E+01	c	4.26E+01	c	3.64E+02	c	1.49E+00	c	7.40E-03	1.48E-01
Dichlorodifluoromethane	1.68E+02	n	7.98E+02	ns	1.49E+02	ns	2.03E+02	n	4.85E-02	7.43E+00
1,1-Dichloroethane	6.45E+01	c	3.59E+02	c	1.70E+03	cs	2.42E+01	c	5.34E-03	1.20E-01
1,2-Dichloroethane	7.89E+00	c	4.35E+01	c	5.87E+01	n	1.49E+00	c	3.48E-04	7.11E-03
cis-1,2-Dichloroethene	1.56E+02	n	2.27E+03	ns	6.19E+02	c	7.30E+01	n	1.70E-02	3.67E-01
trans-1,2-Dichloroethene	2.70E+02	n	1.44E+03	ns	2.73E+02	ns	1.07E+02	n	2.49E-02	5.38E-01
1,1-Dichloroethene	4.49E+02	n	2.29E+03	ns	4.32E+02	ns	3.40E+02	n	7.51E-02	2.32E+00
2,4-Dichlorophenol	1.83E+02	n	2.05E+03	n	7.15E+02	n	1.10E+02	n	9.98E-02	2.00E+00
1,2-Dichloropropane	1.52E+01	c	8.44E+01	c	2.50E+01	n	3.86E+00	c	1.02E-03	2.14E-02
1,3-Dichloropropene	3.37E+01	c	1.77E+02	c	2.09E+02	ns	4.33E+00	c	1.22E-03	2.48E-02
Dicyclopentadiene	3.33E+01	n	1.63E+02	ns	3.04E+01	n	1.39E+01	n	3.40E-02	7.60E-01
Dieldrin	3.04E-01	c	1.20E+00	c	1.03E+01	c	4.20E-02	c	1.27E-03	2.55E-02
Diethyl phthalate	4.89E+04	n	5.47E+05	nl	1.91E+05	nl	2.92E+04	n	9.66E+00	1.93E+02
Dimethyl phthalate	6.11E+05	nl	6.84E+06	nl	2.38E+06	nl	3.65E+05	n	8.06E+01	1.61E+03
Di-n-butyl phthalate (Dibutyl phthalate)	6.11E+03	n	6.84E+04	n	2.38E+04	n	3.65E+03	n	6.97E+00	1.39E+02
2,4-Dimethylphenol	1.22E+03	n	1.37E+04	n	4.76E+03	n	7.30E+02	n	6.66E-01	1.33E+01
4,6-Dinitro-o-cresol	4.89E+00	n	5.47E+01	n	1.91E+01	n	2.92E+00	n	3.82E-03	7.62E-02
2,4-Dinitrophenol	1.22E+02	n	1.37E+03	n	4.76E+02	n	7.30E+01	n	6.69E-02	1.26E+00
2,4-Dinitrotoluene	1.57E+01	c	6.18E+01	c	4.76E+02	n	2.17E+00	c	2.26E-03	4.49E-02
2,6-Dintitrotoluene	6.11E+01	n	6.84E+02	n	2.38E+02	n	3.65E+01	n	3.85E-02	7.70E-01

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (µg/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
2,4/2,6-Dintrotoluene Mixture	7.15E+00	c	2.82E+01	c	2.45E+02	c	9.88E-01	c	1.08E-03	2.08E-02
1,4-Dioxane	4.86E+01	c	1.92E+02	c	1.66E+03	c	6.72E+00	c	1.20E-03	2.38E-02
1,2-Diphenylhydrazine	6.08E+00	c	2.39E+01	c	2.07E+02	c	8.40E-01	c	2.04E-03	4.08E-02
Endosulfan	3.67E+02	n	4.10E+03	n	1.43E+03	n	2.19E+02	n	2.26E+00	4.52E+01
Endrin	1.83E+01	n	2.05E+02	n	7.15E+01	n	1.10E+01	n	3.33E-01	6.64E+00
Epichlorohydrin	4.10E+01	n	2.06E+02	n	3.84E+01	n	2.07E+00	n	4.41E-04	7.78E-03
Ethyl acetate	7.04E+04	ns	1.02E+06	nls	2.79E+05	nls	3.29E+04	n	6.01E+00	1.20E+02
Ethyl acrylate	1.33E+02	c	6.62E+02	c	4.52E+03	cs	1.40E+01	c	2.76E-03	5.34E-02
Ethyl chloride	2.98E+04	ns	1.41E+05	nls	2.61E+04	nls	2.09E+04	n	5.29E+00	1.07E+02
Ethyl ether	1.56E+04	ns	2.27E+05	nls	6.19E+04	ns	7.30E+03	n	2.29E+00	2.83E+01
Ethyl methacrylate	4.55E+03	ns	3.80E+04	ns	2.79E+04	ns	5.26E+02	n	1.14E-01	2.09E+00
Ethylbenzene	6.84E+01	c	3.78E+02	cs	1.83E+03	cs	1.48E+01	c	1.36E-01	2.60E-01
Ethylene oxide	4.06E+00	c	2.22E+01	c	1.11E+02	c	4.41E-01	c	7.85E-05	1.58E-03
Fluoranthene	2.29E+03	n	2.44E+04	n	8.91E+03	n	1.46E+03	n	1.22E+02	2.43E+03
Fluorene	2.29E+03	n	2.44E+04	ns	8.91E+03	ns	1.46E+03	n	2.03E+01	4.06E+02
Fluoride	3.13E+03	n	4.54E+04	n	1.24E+04	n	1.46E+03	n	2.53E-01	8.37E+00
Furan	7.82E+01	n	1.14E+03	n	3.10E+02	n	3.65E+01	n	1.48E-02	2.32E-01
Heptachlor	1.08E+00	c	4.26E+00	c	3.68E+01	c	1.49E-01	c	9.27E-03	1.85E-01
Hexachlorobenzene	3.04E+00	c	1.20E+01	c	1.03E+02	c	4.20E-01	c	3.98E-03	7.96E-02
Hexachloro-1,3-butadiene	6.11E+01	n	2.46E+02	c	2.38E+02	n	8.62E+00	c	1.24E-02	2.57E-01
Hexachlorocyclopentadiene	3.67E+02	n	4.10E+03	n	8.11E+02	n	2.19E+02	n	1.08E+00	1.05E+01
Hexachloroethane	4.28E+01	n	4.79E+02	n	1.67E+02	n	1.68E+01	c	7.87E-03	1.64E-01
n-Hexane	9.38E+02	ns	5.11E+03	ns	9.73E+02	ns	8.76E+02	n	4.24E-01	1.53E+02
HMX	3.91E+03	n	5.68E+04	n	1.55E+04	n	1.83E+03	n	1.87E+00	3.54E+01
Hydrazine anhydride	2.13E+00	c	1.06E+01	c	6.85E+01	c	2.24E-01	c	5.08E-04	1.02E-02
Hydrogen cyanide	1.07E+01	n	5.98E+01	n	1.14E+01	n	1.55E+00	n	4.44E-04	5.39E-03
Indeno(1,2,3-c,d)pyrene	1.48E+00	c	2.34E+01	c	2.13E+02	c	2.95E-01	c	8.63E-01	1.73E+01
Iron	5.48E+04	n	7.95E+05	nl	2.17E+05	nl	2.56E+04	n	6.43E+02	1.29E+04
Isobutanol (Isobutyl alcohol)	2.35E+04	ns	3.41E+05	nls	9.29E+04	ns	1.10E+04	n	1.95E+00	3.89E+01
Isophorone	5.12E+03	c	1.37E+05	cs	4.75E+04	n	7.07E+02	c	1.92E-01	3.84E+00
Lead	4.00E+02	IEUB	8.00E+02	IEUB	8.00E+02	IEU				

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (µg/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
		K		K		BK				
Lead (tetraethyl-)	6.11E-03	n	6.84E-02	n	2.38E-02	n	3.65E-03	n	4.19E-06	2.76E-04
Maleic hydrazide	3.06E+04	n	3.42E+05	nl	1.19E+05	nl	1.83E+04	n	3.45E+00	6.51E+01
Manganese	1.86E+03	n	2.67E+04	nl	4.40E+02	n	8.76E+02	n	5.71E+01	1.14E+03
Mercury (elemental)	1.56E+01	ns	7.36E+01	ns	1.36E+01	ns	6.26E-01	n	3.39E-02	6.54E-01
Mercury (methyl)	7.82E+00	n	1.14E+02	n	3.10E+01	n	3.65E+00	n	6.47E-04	2.09E-02
Mercury (salts)	2.35E+01	n	3.41E+02	ns	9.29E+01	n	1.10E+01	n	5.71E-01	1.15E+01
Methacrylonitrile	4.84E+00	n	3.92E+01	n	8.18E+00	n	1.04E+00	n	3.19E-04	4.05E-03
Methomyl	1.53E+03	n	1.71E+04	n	5.96E+03	n	9.13E+02	n	1.74E-01	3.44E+00
Methyl acetate	7.82E+04	ns	1.14E+06	nls	3.10E+05	nls	3.65E+04	n	1.06E+01	1.30E+02
Methyl acrylate	2.35E+03	n	3.41E+04	ns	9.29E+03	ns	1.10E+03	n	3.23E-01	4.01E+00
Methyl isobutyl ketone	5.82E+03	ns	7.38E+04	ns	1.85E+04	ns	1.99E+03	n	6.08E-01	7.68E+00
Methyl methacrylate	1.12E+04	ns	5.69E+04	ns	1.07E+04	ns	1.42E+03	n	2.66E-01	5.35E+00
Methyl styrene (alpha)	5.48E+03	ns	7.95E+04	ns	2.17E+04	ns	2.56E+03	n	3.12E+00	6.29E+01
Methyl styrene (mixture)	2.72E+02	ns	2.11E+03	ns	4.34E+02	ns	6.04E+01	n	7.53E-02	1.52E+00
Methylcyclohexane	5.63E+03	ns	2.65E+04	ns	4.93E+03	ns	6.26E+03	n	3.28E+00	3.21E+02
Methylene bromide (Dibromomethane)	5.16E+01	n	2.54E+02	n	3.10E+03	ns	8.16E+00	n	1.68E-03	3.42E-02
Methylene chloride	4.09E+02	n	4.70E+03	c	1.12E+03	ns	1.86E+02	n	3.84E-02	8.24E-01
Molybdenum	3.91E+02	n	5.68E+03	n	1.55E+03	n	1.83E+02	n	3.68E+00	7.40E+01
Naphthalene	4.30E+01	c	2.41E+02	c	1.58E+02	n	1.43E+00	c	3.56E-03	7.13E-02
Nickel	1.56E+03	n	2.25E+04	n	6.19E+03	n	7.30E+02	n	4.76E+01	9.53E+02
Nitrate	1.25E+05	nl	1.82E+06	nl	4.96E+05	nl	5.84E+04	n	1.01E+01	3.35E+02
Nitrite	7.82E+03	n	1.14E+05	nl	3.10E+04	n	3.65E+03	n	6.45E-01	2.09E+01
Nitrobenzene	5.35E+01	c	3.00E+02	c	3.32E+02	n	1.22E+00	c	6.24E-04	1.25E-02
Nitroglycerin	6.11E+00	n	6.84E+01	n	2.38E+01	n	3.65E+00	n	1.68E-03	2.53E-02
N-Nitrosodiethylamine	7.68E-03	c	1.28E-01	c	1.10E+00	c	1.44E-03	c	1.68E-06	8.55E-06
N-Nitrosodimethylamine	2.26E-02	c	3.76E-01	c	1.91E+00	n	4.22E-03	c	8.76E-07	1.75E-05
N-Nitrosodi-*n*-butylamine	6.89E-01	c	2.92E+00	c	2.19E+01	c	2.44E-02	c	3.78E-05	7.55E-04
N-Nitrosodiphenylamine	9.93E+02	c	3.91E+03	c	3.36E+04	c	1.37E+02	c	5.65E-01	1.13E+01
N-Nitrosopyrrolidine	2.32E+00	c	9.12E+00	c	7.88E+01	c	3.20E-01	c	1.01E-04	1.99E-03
m-Nitrotoluene	7.82E+00	n	1.14E+02	n	3.10E+01	n	3.65E+00	n	2.63E-03	5.24E-02

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (µg/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
o-Nitrotoluene	2.91E+01	c	1.02E+03	cs	2.79E+02	n	3.05E+00	c	2.23E-03	4.46E-02
p-Nitrotoluene	2.44E+02	n	2.74E+03	c	9.53E+02	n	4.20E+01	c	3.02E-02	6.03E-01
Pentachlorobenzene	4.89E+01	n	5.47E+02	n	1.91E+02	n	2.92E+01	n	1.68E-01	3.35E+00
Pentachlorophenol	8.94E+00	c	3.00E+01	c	3.10E+02	c	1.68E+00	c	1.28E-02	2.56E-01
Perchlorate	5.48E+01	n	7.95E+02	ns	2.17E+02	n	2.56E+01	n	4.43E-03	1.46E-01
Phenanthrene	1.83E+03	ns	2.05E+04	n	7.15E+03	n	1.10E+03	n	2.76E+01	5.71E+02
Phenol	1.83E+04	n	2.05E+05	nl	6.88E+04	n	1.10E+04	n	4.98E+00	9.95E+01
Polychlorinatedbiphenyls (PCBs)										
Aroclor 1016	3.93E+00	n	4.13E+01	n	1.53E+01	n	2.56E+00	n	1.83E-01	3.67E+00
Aroclor 1221	1.49E+00	c	6.24E+00	c	4.63E+01	cs	6.81E-02	c	8.69E-04	1.74E-02
Aroclor 1232	1.49E+00	c	6.24E+00	c	4.63E+01	cs	6.81E-02	c	8.69E-04	1.74E-02
Aroclor 1242	2.22E+00	c	8.26E+00	c	7.58E+01	c	3.36E-01	c	3.94E-02	7.88E-01
Aroclor 1248	2.22E+00	c	8.26E+00	c	7.58E+01	c	3.36E-01	c	3.86E-02	7.73E-01
Aroclor 1254	1.12E+00	n	8.26E+00	c	4.36E+00	n	3.36E-01	c	6.58E-02	1.32E+00
Aroclor 1260	2.22E+00	c	8.26E+00	c	7.58E+01	c	3.36E-01	c	1.76E-01	3.53E+00
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	3.41E-01	c	1.27E+00	c	1.17E+01	c	5.17E-02	c	2.77E-02	5.53E-01
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	3.41E+00	c	1.27E+01	c	1.17E+02	c	5.17E-01	c	2.71E-01	5.42E+00
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	1.14E+00	c	4.24E+00	c	3.89E+01	c	1.72E-01	c	9.04E-02	1.81E+00
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	1.14E+00	c	4.24E+00	c	3.89E+01	c	1.72E-01	c	5.41E-02	1.08E+00
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)	1.14E+00	c	4.24E+00	c	3.89E+01	c	1.72E-01	c	5.52E-02	1.10E+00
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	1.14E+00	c	4.24E+00	c	3.89E+01	c	1.72E-01	c	5.52E-02	1.10E+00
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	1.14E-03	c	4.24E-03	c	3.89E-02	c	1.72E-04	c	5.41E-05	1.08E-03
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	1.14E+00	c	4.24E+00	c	3.89E+01	c	1.72E-01	c	3.38E-02	6.75E-01
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	1.14E+00	c	4.24E+00	c	3.89E+01	c	1.72E-01	c	3.31E-02	6.62E-01
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	1.14E+00	c	4.24E+00	c	3.89E+01	c	1.72E-01	c	3.38E-02	6.75E-01
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	1.14E+00	c	4.24E+00	c	3.89E+01	c	1.72E-01	c	3.38E-02	6.75E-01
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	3.41E-04	c	1.27E-03	c	1.17E-02	c	5.17E-05	c	9.93E-06	1.99E-04
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	3.41E-01	c	1.27E+00	c	1.17E+01	c	5.17E-02	c	6.06E-03	1.21E-01
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	1.14E-01	c	4.24E-01	c	3.89E+00	c	1.72E-02	c	2.02E-03	4.04E-02
Propylene oxide	2.31E+01	c	1.16E+02	c	7.06E+02	n	2.31E+00	c	4.19E-04	8.38E-03
Pyrene	1.72E+03	n	1.83E+04	n	6.68E+03	n	1.10E+03	n	8.94E+01	1.79E+03

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (µg/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
RDX (Hexahydro-1,3,5-trinitro-1,3,5-triazine	5.82E+01	c	3.41E+03	c	9.29E+02	n	6.11E+00	c	1.88E-03	3.75E-02
Selenium	3.91E+02	n	5.68E+03	n	1.55E+03	n	1.83E+02	n	9.65E-01	1.93E+01
Silver	3.91E+02	n	5.68E+03	n	1.55E+03	n	1.83E+02	n	1.57E+00	3.13E+01
Strontium	4.69E+04	n	6.81E+05	nl	1.86E+05	nl	2.19E+04	n	7.73E+02	1.55E+04
Styrene	7.28E+03	ns	5.00E+04	ns	9.99E+03	ns	1.62E+03	n	1.39E+00	2.77E+01
2,3,7,8-TCDD	4.50E-05	c	2.04E-04	c	2.84E-04	n	5.17E-06	c	1.93E-06	3.86E-05
2,3,7,8-TCDF	4.50E-04	c	2.04E-03	c	1.52E-02	c	5.17E-05	c	1.08E-05	2.17E-04
1,2,4,5-Tetrachlorobenzene	1.83E+01	n	2.05E+02	n	7.15E+01	n	1.10E+01	n	3.84E-02	7.68E-01
1,1,1,2-Tetrachloroethane	2.91E+01	c	1.61E+02	c	7.79E+02	cs	5.24E+00	c	1.65E-03	3.29E-02
1,1,2,2-Tetrachloroethane	8.02E+00	c	4.35E+01	c	2.21E+02	c	6.71E-01	c	2.13E-04	4.26E-03
Tetrachloroethene	7.02E+00	c	3.66E+01	c	2.12E+02	cs	1.08E+00	c	4.30E-04	8.61E-03
Tetryl (Trinitrophenylmethylnitramine)	2.44E+02	n	2.74E+03	n	9.53E+02	n	1.46E+02	n	1.03E+00	2.07E+01
Thallium	7.82E-01	n	1.14E+01	n	3.10E+00	n	3.65E-01	n	2.60E-02	5.20E-01
Toluene	5.27E+03	ns	5.77E+04	ns	1.34E+04	ns	2.28E+03	n	1.27E+00	2.53E+01
Toxaphene	4.42E+00	c	1.74E+01	c	1.50E+02	c	6.11E-01	c	7.08E-02	1.42E+00
Tribromomethane (Bromoform)	6.16E+02	c	2.42E+03	c	4.76E+03	n	8.51E+01	c	6.04E-01	1.21E+01
1,1,2-Trichloro-1,2,2-trifluoroethane	7.21E+04	nls	3.47E+05	nls	6.47E+04	nls	5.92E+04	n	1.72E+02	3.45E+03
1,2,4-Trichlorobenzene	7.30E+01	n	3.67E+02	ns	6.87E+01	ns	4.12E+00	n	9.13E-03	1.83E-01
1,1,1-Trichloroethane	1.56E+04	ns	7.89E+04	ns	1.48E+04	ns	9.13E+03	n	2.91E+00	5.82E+01
1,1,2-Trichloroethane	2.81E+00	n	1.33E+01	c	4.72E+02	ns	4.16E-01	n	1.12E-04	2.23E-03
Trichloroethylene	8.77E+00	n	4.13E+01	c	7.68E+00	cs	3.40E+00	n	1.05E-03	2.11E-02
Trichlorofluoromethane	1.41E+03	ns	6.94E+03	ns	1.30E+03	ns	1.29E+03	n	8.89E-01	1.78E+01
2,4,5-Trichlorophenol	6.11E+03	n	6.84E+04	n	2.38E+04	n	3.65E+03	n	1.04E+01	2.07E+02
2,4,6-Trichlorophenol	6.11E+01	n	6.84E+02	n	2.38E+02	n	3.65E+01	n	1.04E-01	2.07E+00
1,1,2-Trichloropropane	3.91E+02	n	5.68E+03	ns	1.55E+03	ns	1.83E+02	n	5.79E-02	1.16E+00
1,2,3-Trichloropropane	4.97E-02	c	3.76E+01	c	7.23E+00	c	7.18E-03	c	2.50E-06	5.00E-05
Triethylamine	2.21E+02	n	1.04E+03	n	1.93E+02	n	1.46E+01	n	3.65E-03	7.31E-02
2,4,6-Trinitrotoluene	3.91E+01	n	5.68E+02	n	1.55E+02	n	1.83E+01	n	8.01E-02	1.60E+00
Uranium (soluable salts)	2.35E+02	n	3.41E+03	n	9.29E+02	ns	1.10E+02	n	4.93E+01	9.86E+02
Vanadium	3.91E+02	n	5.68E+03	n	1.55E+03	n	1.83E+02	n	1.83E+02	3.65E+03
Vinyl acetate	2.56E+03	n	1.23E+04	ns	2.30E+03	ns	4.12E+02	n	7.59E-02	1.52E+00

Chemical	Residential Soil (mg/kg)	End-point	Industrial/ Occupational Soil (mg/kg)	End-point	Construction Worker Soil (mg/kg)	End-point	Tap Water (µg/L)	End-point	Risk-based SSL for a DAF of 1 (mg/kg)	Risk-based SSL for a DAF of 20 (mg/kg)
Vinyl bromide	2.36E+00	c	1.32E+01	n	8.51E+00	n	1.52E+00	c	4.00E-04	8.00E-03
Vinyl chloride	7.28E-01	c	2.61E+01	c	1.49E+02	c	1.62E-01	c	5.42E-05	1.08E-03
m-Xylene	7.74E+02	ns	3.78E+03	ns	7.05E+02	ns	2.03E+02	n	1.56E-01	3.12E+00
o-Xylene	8.98E+02	ns	4.41E+03	ns	8.23E+02	ns	2.03E+02	n	1.56E-01	3.13E+00
Xylenes	8.14E+02	ns	3.98E+03	ns	7.43E+02	ns	2.03E+02	n	1.56E-01	3.13E+00
Zinc	2.35E+04	n	3.41E+05	nl	9.29E+04	n	1.10E+04	n	6.82E+02	1.36E+04

c – carcinogen
cs - carcinogenic, SSL may exceed saturation
n – noncarcinogenic
nl - noncarcinogen, SSL may exceed ceiling limit
ns - noncarcinogen, SSL may exceed saturation
nls - noncarcinogen, SSL may exceed both saturation and ceiling limit

APPENDIX B

CHEMICAL AND PHYSICAL PROPERTIES

Table B-1: Chemical CAS and Molecular Weight

Chemical	Chemical Abstract Service (CAS) Number	Molecular Weight (g/mole)
Acenaphthene	83-32-9	154.21
Acetaldehyde	75-07-0	44.05
Acetone	67-64-1	58.08
Acrylonitrile	107-13-1	41.05
Acetophenone	98-86-2	120.15
Acrolein	107-02-8	56.06
Aldrin	309-00-2	364.92
Aluminum	7429-90-5	26.98
Anthracene	120-12-7	178.24
Antimony	7440-36-0	121.75
Arsenic	7440-38-2	74.92
Barium	7440-39-3	137.33
Benzene	71-43-2	78.1
Benzidine	92-87-5	184.23
Benzo(a)anthracene	56-55-3	228
Benzo(a)pyrene	50-32-8	250
Benzo(b)fluoranthene	205-99-2	252.3
Benzo(k)fluoranthene	207-08-9	252.3
Beryllium	7440-41-7	9.01
a-BHC (HCH)	319-84-6	290.85
b-BHC (HCH)	319-85-7	290.85
g-BHC	58-89-9	290.85
1,1-Biphenyl	92-52-4	150
Bis(2-chloroethyl) ether	111-44-4	140
Bis(2-chloroisopropyl) ether	39638-32-9	170
Bis(2-ethylhexyl) phthalate	117-81-7	390.54
Bis(chloromethyl) ether	542-88-1	120
Boron	7440-42-8	10.81
Bromodichloromethane	75-27-4	164
Bromomethane	74-83-9	94.95
1,3-Butadiene	106-99-0	54
2-Butanone (Methyl ethyl ketone, MEK)	78-93-3	72
tert-Butyl methyl ether (MTBE)	1634-04-4	88.2
Cadmium	7440-43-9	112.41
Carbon disulfide	75-15-0	76
Carbon tetrachloride	56-23-5	154
Chlordane	12789-03-6	409.8
2-Chloroacetophenone	532-27-4	154.59
2-Chloro-1,3-butadiene	126-99-8	88
1-Chloro-1,1-difluoroethane	75-68-3	100.5
Chlorobenzene	108-90-7	113
1-Chlorobutane	109-69-3	92.57
Chlorodifluoromethane	75-45-6	86.47

Chemical	Chemical Abstract Service (CAS) Number	Molecular Weight (g/mole)
Chloroform	67-66-3	120
Chloromethane	74-87-3	51
b-Chloronaphthalene	91-58-7	160
o-Chloronitrobenzene	88-73-3	153.33
p-Chloronitrobenzene	100-00-5	153.33
2-Chlorophenol	95-57-8	130
2-Chloropropane	75-29-6	78.54
o-Chlorotoluene	95-49-8	172.57
Chromium III	16065-83-1	52
Chromium VI	18540-29-9	52
Chrysene	218-01-9	228.28
Copper	7440-50-8	63.55
Crotonaldehyde	123-73-9	70.09
Cumene (isopropylbenzene)	98-82-8	120
Cyanide	57-12-5	27.03
Cyanogen	460-19-5	52
Cyanogen bromide	506-68-3	52
Cyanogen chloride	506-77-4	52
DDD	72-54-8	320
DDE	72-55-9	318
DDT	50-29-3	354.5
Dibenz(a,h)anthracene	53-70-3	278.3
1,2-Dibromo-3-chloropropane	96-12-8	240
Dibromochloromethane	124-48-1	210
1,2-Dibromoethane	106-93-4	188
1,4-Dichloro-2-butene	764-41-0	130
1,2-Dichlorobenzene	95-50-1	147
1,4-Dichlorobenzene	106-46-7	147
3,3-Dichlorobenzidine	91-94-1	253.13
Dichlorodifluoromethane	75-71-8	120
1,1-Dichloroethane	75-34-3	99
1,2-Dichloroethane	107-06-2	99
cis-1,2-Dichloroethene	156-59-2	97
trans-1,2-Dichloroethene	156-60-5	97
1,1-Dichloroethene	75-35-4	97
2,4-Dichlorophenol	120-83-2	163
1,2-Dichloropropane	78-87-5	110
1,3-Dichloropropene	542-75-6	111
Dicyclopentadiene	77-73-6	130
Dieldrin	60-57-1	381
Diethyl phthalate	84-66-2	222.2
Dimethyl phthalate	131-11-3	194.19
Di-n-butyl phthalate (Dibutyl phthalate)	84-74-2	278.34
2,4-Dimethylphenol	105-67-9	122.16
4,6-Dinitro-o-cresol	534-52-1	198.14

Chemical	Chemical Abstract Service (CAS) Number	Molecular Weight (g/mole)
2,4-Dinitrophenol	51-28-5	184.11
2,4-Dinitrotoluene	121-14-2	182.14
2,6-Dintitrotoluene	606-20-2	182.14
2,4/2,6-Dintrotoluene Mixture	25321-14-6	182.14
1,4-Dioxane	123-91-1	88.11
1,2-Diphenylhydrazine	122-66-7	184.24
Endosulfan	115-29-7	406.95
Endrin	72-20-8	381
Epichlorohydrin	106-89-8	93
Ethyl acetate	141-78-6	88
Ethyl acrylate	140-88-5	100.1
Ethyl chloride	75-00-3	65
Ethyl ether	60-29-7	74.12
Ethyl methacrylate	97-63-2	114.12
Ethylbenzene	100-41-4	106.2
Ethylene oxide	75-21-8	44
Fluoranthene	206-44-0	202.3
Fluorene	86-73-7	166.21
Fluoride	7782-41-4	38
Furan	110-00-9	68
Heptachlor	76-44-8	373.5
Hexachlorobenzene	118-74-1	284.8
Hexachloro-1,3-butadiene	87-68-3	260.76
Hexachlorocyclopentadiene	77-47-4	272.75
Hexachloroethane	67-72-1	236.74
n-Hexane	110-54-3	86
HMX	2691-41-0	296.2
Hydrazine anhydride	302-01-2	32.05
Hydrogen cyanide	74-90-8	27
Indeno(1,2,3-c,d)pyrene	193-39-5	276.3
Iron	7439-89-6	55.84
Isobutanol (Isobutyl alcohol)	78-83-1	74
Isophorone	78-59-1	138.21
Lead	7439-92-1	207.2
Lead (tetraethyl-)	78-00-2	64.52
Maleic hydrazide	123-33-1	110
Manganese	7439-96-5	54.94
Mercury (elemental)	7439-97-6	200
Mercury (methyl)	22967-92-6	215.62
Mercury Chloride (Mercury Salts)	7487-94-7	271.5
Methacrylonitrile	126-98-7	67.09
Methomyl	16752-77-5	160
Methyl acetate	79-20-9	74.08
Methyl acrylate	96-33-3	86.09
Methyl isobutyl ketone	108-10-1	100

Chemical	Chemical Abstract Service (CAS) Number	Molecular Weight (g/mole)
Methyl methacrylate	80-62-6	100
Methyl styrene (alpha)	98-83-9	118.18
Methyl styrene (mixture)	25013-15-4	118.18
Methylcyclohexane	108-87-2	98
Methylene bromide (Dibromomethane)	74-95-3	170
Methylene chloride	75-09-2	85
Molybdenum	7439-98-7	95.94
Naphthalene	91-20-3	128.16
Nickel	7440-02-0	58.71
Nitrate	14797-55-8	101.1
Nitrite	14797-65-0	46
Nitrobenzene	98-95-3	120
Nitroglycerin	55-63-0	227.08
N-Nitrosodiethylamine	55-18-5	102.14
N-Nitrosodimethylamine	62-75-9	74.08
N-Nitrosodi-*n*-butylamine	924-16-3	158.2
N-Nitrosodiphenylamine	86-30-6	198.23
N-Nitrosopyrrolidine	930-55-2	100.2
m-Nitrotoluene	99-08-1	137.1
o-Nitrotoluene	88-72-2	137.13
p-Nitrotoluene	99-99-0	137.1
Pentachlorobenzene	608-93-5	250.32
Pentachlorophenol	87-86-5	266.34
Perchlorate	14797-73-0	117.49
Phenanthrene	85-01-8	178.2
Phenol	108-95-2	94
Polychlorinatedbiphenyls		
Aroclor 1016	12674-11-2	257.55
Aroclor 1221	11104-28-2	262
Aroclor 1232	11141-16-5	262
Aroclor 1242	53469-21-9	291.99
Aroclor 1248	12672-29-6	291.99
Aroclor 1254	11097-69-1	326.44
Aroclor 1260	11096-82-5	395.33
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	35065-30-6	395.33
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	35065-29-3	395.33
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	39635-31-9	395.33
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	52663-72-6	360.88
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)	69782-90-7	360.88
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	38380-08-4	360.88
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	32774-16-6	360.88
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	65510-44-3	326.44
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	31508-00-6	326.44
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	32598-14-4	326.44
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	74472-37-0	326.44

Chemical	Chemical Abstract Service (CAS) Number	Molecular Weight (g/mole)
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	57465-28-8	326.44
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	32598-13-3	291.99
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	70362-50-4	291.99
Propylene oxide	75-56-9	58
Pyrene	129-00-0	200
RDX	121-82-4	222.12
Selenium	7782-49-2	78.96
Silver	7440-22-4	107.87
Strontium	7440-24-6	87.62
Styrene	100-42-5	100
2,3,7,8-TCDD	1746-01-6	321.98
2,3,7,8-TCDF	51207-31-9	305.98
1,2,4,5-Tetrachlorobenzene	95-94-3	215.89
1,1,1,2-Tetrachloroethane	630-20-6	167.85
1,1,2,2-Tetrachloroethane	79-34-5	169.86
Tetrachloroethene	127-18-4	170
Tetryl (Trinitrophenylmethylnitramine)	479-45-8	287.15
Thallium	7440-28-0	204.37
Toluene	108-88-3	92
Toxaphene	8001-35-2	414
Tribromomethane (Bromoform)	75-25-2	252.73
1,1,2-Trichloro-1,2,2-trifluoroethane	76-13-1	187.38
1,2,4-Trichlorobenzene	120-82-1	181
1,1,1-Trichloroethane	71-55-6	130
1,1,2-Trichloroethane	79-00-5	133
Trichloroethylene	79-01-6	131
Trichlorofluoromethane	75-69-4	140
2,4,5-Trichlorophenol	95-95-4	197.46
2,4,6-Trichlorophenol	88-06-2	197.46
1,1,2-Trichloropropane	598-77-6	147.43
1,2,3-Trichloropropane	96-18-4	147.43
Triethylamine	121-44-8	101.19
2,4,6-Trinitrotoluene	118-96-7	227.13
Uranium (soluble salts)	--	
Vanadium	7440-62-2	50.94
Vinyl acetate	108-05-4	86
Vinyl bromide	593-60-2	106.95
Vinyl chloride	75-01-4	63
m-Xylene	108-38-3	106
o-Xylene	95-47-6	106
Xylenes	1330-20-7	106
Zinc	7440-66-6	65.38

Table B-2: Physical and Chemical Properties

Chemical	H (atm-m^3/mole)	H' (dimensio n-less)	D_a (cm^2/s)	D_w (cm^2/s)	K_{oc} (cm^3/g)	K_d (cm^3/g)	S (mg/L-water)	D_A (cm^2/s)	Res./Indus VF (m^3/kg)	Comm VF (mg^3/kg)	SAT (mg/kg)	VOC?
Acenaphthene	1.8E-04	7.54E-03	5.06E-02	8.30E-06	5.03E+03	7.54E+00	3.90E+00	5.22E-07	1.72E+05	3.55E+04		✓
Acetaldehyde	6.7E-05	2.73E-03	1.28E-01	1.40E-05	1.00E+00	1.50E-03	1.00E+06	2.25E-05	2.61E+04	5.40E+03	1.75E+05	✓
Acetone	3.5E-05	1.44E-03	1.06E-01	1.10E-05	2.36E+00	3.55E-03	1.00E+06	1.08E-05	3.78E+04	7.80E+03	1.77E+05	✓
Acrylonitrile	1.4E-04	5.66E-03	1.14E-01	1.23E-05	8.51E+00	1.28E-02	7.54E+04	3.61E-05	2.07E+04	4.27E+03	1.41E+04	✓
Acetophenone	1.0E-05	4.26E-04	6.50E-02	8.70E-06	5.19E+01	7.78E-02	6.13E+03	2.45E-06	7.94E+04	1.64E+04	1.54E+03	✓
Acrolein	1.2E-04	5.00E-03	1.34E-01	1.41E-05	1.00E+00	1.50E-03	1.00E+06	4.02E-05	1.96E+04	4.04E+03	1.75E+05	✓
Aldrin	4.4E-05	1.80E-03	3.72E-02	4.35E-06	8.20E+04	1.23E+02	1.70E-02	6.68E-09				
Aluminum						1.50E+03						
Anthracene	5.6E-05	2.30E-03	3.90E-02	7.90E-06	1.64E+04	2.45E+01	4.34E-02	4.78E-08	5.68E+05	1.17E+05		✓
Antimony						4.50E+01						
Arsenic						2.90E+01						
Barium						4.10E+01						
Benzene	5.6E-03	2.30E-01	8.95E-02	1.03E-05	1.46E+02	2.19E-01	1.79E+03	4.77E-04	5.68E+03	1.17E+03	7.51E+02	✓
Benzidine	7.0E-11	2.87E-09	5.87E-02	6.86E-06	1.19E+03	1.79E+00	3.22E+02	1.39E-07				
Benzo(a)anthracene	1.2E-05	4.92E-04	5.09E-02	5.94E-06	1.77E+05	2.65E+02	9.40E-03	1.80E-09				
Benzo(a)pyrene	4.6E-07	1.89E-05	4.76E-02	5.56E-06	5.87E+05	8.81E+02	1.62E-03	2.61E-10				
Benzo(b)fluoranthene	6.6E-07	2.71E-05	4.76E-02	5.56E-06	5.99E+05	8.99E+02	1.50E-03	2.60E-10				
Benzo(k)fluoranthene	5.9E-07	2.42E-05	4.76E-02	5.56E-06	5.87E+05	8.81E+02	8.00E-04	2.63E-10				
Beryllium						7.90E+02						
α-BHC (HCH)	1.2E-05	4.92E-04	4.33E-02	5.06E-06	2.81E+03	4.21E+00	8.00E+00	9.29E-08				
ß-BHC (HCH)	4.4E-07	1.80E-05	2.77E-02	7.40E-06	2.81E+03	4.21E+00	8.00E+00	6.81E-08				
γ-BHC	5.1E-06	2.09E-04	4.33E-02	5.06E-06	2.81E+03	4.21E+00	8.00E+00	6.58E-08				
1,1-Biphenyl	3.2E-04	1.31E-02	4.70E-02	7.60E-06	5.13E+03	7.69E+00	6.94E+00	7.98E-07	1.39E+05	2.87E+04	5.46E+01	✓
Bis(2-chloroethyl) ether	1.8E-05	7.38E-04	5.70E-02	8.70E-06	3.22E+01	4.83E-02	1.72E+04	3.40E-06	6.73E+04	1.39E+04	3.81E+03	✓
Bis(2-chloroisopropyl) ether	1.1E-04	4.51E-03	6.30E-02	6.40E-06	4.58E+01	6.87E-02	1.70E+03	1.24E-05	3.52E+04	7.28E+03	4.12E+02	✓
Bis(2-ethylhexyl) phthalate	2.7E-07	1.11E-05	1.73E-02	4.18E-06	1.20E+05	1.79E+02	2.70E-01	9.35E-10				
Bis(chloromethyl) ether	2.0E-04	8.20E-03	7.60E-02	1.00E-05	9.70E+00	1.45E-02	2.20E+04	3.41E-05	2.13E+04	4.39E+03	4.16E+03	✓
Boron						3.00E+00						
Bromodichloromethane	2.1E-03	8.61E-02	5.60E-02	1.10E-05	3.18E+01	4.77E-02	3.03E+03	2.04E-04	8.68E+03	1.79E+03	7.01E+02	✓
Bromomethane	6.2E-03	2.54E-01	1.00E-01	1.30E-05	1.32E+01	1.98E-02	1.52E+04	1.11E-03	3.72E+03	7.69E+02	3.40E+03	✓
1,3-Butadiene	7.3E-02	2.99E+00	1.00E-01	1.10E-05	3.96E+01	5.94E-02	7.35E+02	5.07E-03	1.74E+03	3.60E+02	4.35E+02	✓
2-Butanone (Methyl ethyl ketone, MEK)	5.6E-05	2.30E-03	9.10E-02	1.00E-05	4.51E+00	6.77E-03	2.23E+05	1.34E-05	3.39E+04	7.00E+03	4.02E+04	✓
tert-Butyl methyl ether (MTBE)	5.9E-04	2.42E-02	7.50E-02	8.60E-06	1.16E+01	1.73E-02	5.10E+04	9.27E-05	1.29E+04	2.66E+03	9.87E+03	✓
Cadmium						7.50E+01						

Chemical	H (atm-m^3/mole)	H' (dimensio n-less)	D_a (cm^2/s)	D_w (cm^2/s)	K_{oc} (cm^3/g)	K_d (cm^3/g)	S (mg/L-water)	D_A (cm^2/s)	Res./Indus VF (m^3/kg)	Comm VF (mg^3/kg)	SAT (mg/kg)	VOC?
Carbon disulfide	1.4E-02	5.74E-01	1.10E-01	1.30E-05	2.17E+01	3.26E-02	1.18E+03	2.26E-03	2.61E+03	5.39E+02	3.24E+02	✓
Carbon tetrachloride	2.7E-02	1.11E+00	5.70E-02	9.80E-06	4.39E+01	6.58E-02	7.93E+02	1.68E-03	3.03E+03	6.26E+02	2.95E+02	✓
Chlordane	4.9E-05	2.01E-03	3.44E-02	4.02E-06	3.38E+04	5.07E+01	5.60E-02	1.63E-08				
2-Chloroacetophenone	3.2E-06	1.31E-04	5.20E-02	8.70E-06	9.89E+01	1.48E-01	1.64E+03	1.28E-06				
2-Chloro-1,3-butadiene	5.6E-02	2.30E+00	8.40E-02	1.10E-05	6.07E+01	9.11E-02	8.75E+02	3.56E-03	2.08E+03	4.30E+02	4.72E+02	✓
1-Chloro-1,1-difluoroethane	5.9E-02	2.42E+00	8.00E-02	1.00E-05	4.39E+01	6.58E-02	1.40E+03	3.65E-03	2.05E+03	4.24E+02	7.41E+02	✓
Chlorobenzene	3.2E-03	1.31E-01	7.20E-02	9.50E-06	2.34E+02	3.51E-01	4.98E+02	1.71E-04	9.50E+03	1.96E+03	2.69E+02	✓
1-Chlorobutane	1.7E-02	6.97E-01	7.80E-02	9.30E-06	7.22E+01	1.08E-01	1.10E+03	1.46E-03	3.25E+03	6.71E+02	4.02E+02	✓
Chlorodifluoromethane	4.1E-02	1.66E+00	1.00E-01	1.30E-05	3.18E+01	4.77E-02	2.77E+03	3.94E-03	1.98E+03	4.09E+02	1.17E+03	✓
Chloroform	3.7E-03	1.50E-01	7.70E-02	1.10E-05	3.18E+01	4.77E-02	7.95E+03	4.73E-04	5.70E+03	1.18E+03	1.90E+03	✓
Chloromethane	8.8E-03	3.62E-01	1.20E-01	1.40E-05	1.32E+01	1.98E-02	5.32E+03	1.80E-03	2.93E+03	6.05E+02	1.26E+03	✓
□-Chloronaphthalene	3.2E-04	1.31E-02	4.50E-02	7.70E-06	2.48E+03	3.72E+00	1.17E+01	1.55E-06	9.97E+04	2.06E+04	4.55E+01	✓
o-Chloronitrobenzene	9.3E-06	3.81E-04	5.10E-02	8.80E-06	3.71E+02	5.56E-01	4.41E+02	7.38E-07				
p-Chloronitrobenzene	4.9E-06	2.00E-04	5.00E-02	8.50E-06	3.63E+02	5.45E-01	2.25E+02	6.06E-07				
2-Chlorophenol	1.1E-05	4.59E-04	6.60E-02	9.50E-06	3.07E+02	4.60E-01	2.85E+04	1.06E-06	1.21E+05	2.49E+04	1.80E+04	✓
2-Chloropropane	1.4E-05	5.74E-04	8.00E-02	1.00E-05	3.18E+01	4.77E-02	2.70E+03	3.81E-06	6.36E+04	1.31E+04	5.97E+02	✓
o-Chlorotoluene	3.6E-03	1.46E-01	6.30E-02	8.70E-06	3.83E+02	5.74E-01	3.74E+02	1.17E-04	1.15E+04	2.37E+03	2.86E+02	✓
Chromium III						1.80E+06						
Chromium VI						1.90E+01	1.69E+06					
Chrysene	5.2E-06	2.14E-04	2.61E-02	6.75E-06	1.81E+05	2.71E+02	2.00E-03	1.19E-09				
Copper						3.50E+01						
Crotonaldehyde	1.9E-05	7.95E-04	9.60E-02	1.10E-05	1.79E+00	2.69E-03	1.81E+05	6.68E-06	4.80E+04	9.92E+03	3.19E+04	✓
Cumene (isopropylbenzene)	1.2E-02	4.72E-01	6.00E-02	7.90E-06	6.98E+02	1.05E+00	6.13E+01	2.16E-04	8.45E+03	1.75E+03	7.83E+01	✓
Cyanide	1.3E-04	5.45E-03	1.24E-01	1.38E-05		9.90E+00	1.00E+06	7.05E-07	1.48E+05	3.05E+04	1.01E+07	✓
Cyanogen	5.4E-03	2.21E-01	1.20E-01	1.40E-05			1.05E+04	1.30E-03	3.44E+03	7.11E+02		✓
Cyanogen bromide			9.80E-02	1.40E-05				3.21E-06	6.93E+04	1.43E+04		✓
Cyanogen chloride	1.9E-03	7.96E-02	1.20E-01	1.40E-05			2.50E+07	5.11E-04	5.49E+03	1.13E+03		✓
DDD	6.6E-06	2.71E-04	4.06E-02	4.74E-06	1.18E+05	1.76E+02	9.00E-02	1.67E-09				
DDE	4.2E-05	1.71E-03	4.08E-02	4.76E-06	1.18E+05	1.76E+02	4.00E-02	4.89E-09				
DDT	8.3E-06	3.41E-04	3.79E-02	4.43E-06	1.69E+05	2.53E+02	5.50E-03	1.19E-09				
Dibenz(a,h)anthracene	1.4E-07	5.78E-06	4.71E-02	5.50E-06	1.91E+06	2.87E+03	1.03E-03	7.71E-11				
1,2-Dibromo-3-chloropropane	1.5E-04	6.03E-03	3.20E-02	8.90E-06	1.16E+02	1.74E-01	1.23E+03	6.39E-06	4.91E+04	1.01E+04	4.28E+02	✓
Dibromochloromethane	7.8E-04	3.21E-02	3.70E-02	1.10E-05	3.18E+01	4.77E-02	2.70E+03	5.32E-05	1.70E+04	3.52E+03	6.07E+02	✓
1,2-Dibromoethane	6.5E-04	2.67E-02	4.30E-02	1.00E-05	3.96E+01	5.94E-02	3.91E+03	4.88E-05	1.78E+04	3.67E+03	9.22E+02	✓
1,4-Dichloro-2-butene	6.6E-04	2.72E-02	7.60E-02	8.90E-06	1.32E+02	1.97E-01	5.80E+02	5.46E-05	1.68E+04	3.47E+03	2.17E+02	✓
1,2-Dichlorobenzene	1.9E-03	7.87E-02	5.60E-02	8.90E-06	3.83E+02	5.74E-01	8.00E+01	5.69E-05	1.65E+04	3.40E+03	6.06E+01	✓

Chemical	H (atm-m^3/mole)	H' (dimensio n-less)	D_a (cm^2/s)	D_w (cm^2/s)	K_{oc} (cm^3/g)	K_d (cm^3/g)	S (mg/L-water)	D_A (cm^2/s)	Res./Indus VF (m^3/kg)	Comm VF (mg^3/kg)	SAT (mg/kg)	VOC?
1,4-Dichlorobenzene	2.4E-03	9.88E-02	5.50E-02	8.70E-06	3.75E+02	5.63E-01	8.13E+01	7.09E-05	1.47E+04	3.04E+03		✓
3,3-Dichlorobenzidine	4.0E-09	1.64E-07	4.75E-02	5.55E-06	3.19E+03	4.79E+00	3.10E+00	4.45E-08				
Dichlorodifluoromethane	3.4E-01	1.41E+01	7.80E-02	9.10E-06	4.39E+01	6.58E-02	2.80E+02	5.80E-03	1.63E+03	3.37E+02	5.39E+02	✓
1,1-Dichloroethane	5.6E-03	2.30E-01	8.40E-02	1.10E-05	3.18E+01	4.77E-02	5.04E+03	7.61E-04	4.50E+03	9.30E+02	1.25E+03	✓
1,2-Dichloroethane	1.2E-03	4.84E-02	8.60E-02	1.10E-05	3.96E+01	5.94E-02	5.10E+03	1.71E-04	9.49E+03	1.96E+03	1.22E+03	✓
cis-1,2-Dichloroethene	4.1E-03	1.67E-01	8.80E-02	1.10E-05	3.96E+01	5.94E-02	3.50E+03	5.69E-04	5.21E+03	1.08E+03	8.85E+02	✓
trans-1,2-Dichloroethene	4.1E-03	1.67E-01	8.80E-02	1.10E-05	3.96E+01	5.94E-02	3.50E+03	5.69E-04	5.21E+03	1.08E+03	8.85E+02	✓
1,1-Dichloroethene	2.6E-02	1.07E+00	8.60E-02	1.10E-05	3.18E+01	4.77E-02	2.42E+03	2.61E-03	2.43E+03	5.02E+02	8.46E+02	✓
2,4-Dichlorophenol	4.3E-06	1.76E-04	6.40E-02	7.40E-06	4.92E+02	7.38E-01	4.50E+03	4.42E-07				
1,2-Dichloropropane	2.8E-03	1.16E-01	8.10E-02	9.50E-06	6.07E+01	9.11E-02	2.80E+03	3.28E-04	6.85E+03	1.41E+03	7.79E+02	✓
1,3-Dichloropropene	9.8E-04	4.00E-02	8.20E-02	9.60E-06	7.22E+01	1.08E-01	2.80E+03	1.12E-04	1.17E+04	2.42E+03	8.02E+02	✓
Dicyclopentadiene	6.3E-02	2.56E+00	7.30E-02	8.60E-06	1.51E+03	2.27E+00	5.19E+01	6.63E-04	4.82E+03	9.95E+02	1.43E+02	✓
Dieldrin	1.0E-05	4.10E-04	2.33E-02	6.01E-06	2.01E+04	3.01E+01	2.50E-01	1.09E-08				
Diethyl phthalate	6.1E-07	2.50E-05	2.61E-02	6.72E-06	1.05E+02	1.57E-01	1.08E+03	8.27E-07				
Dimethyl phthalate	4.1E-07	1.68E-05	5.68E-02	6.29E-06	3.16E+01	4.74E-02	4.00E+03	1.17E-06				
Di-n-butyl phthalate (Dibutyl phthalate)	1.8E-06	7.38E-05	2.14E-02	5.33E-06	1.16E+03	1.74E+00	1.12E+01	1.19E-07				
2,4-Dimethylphenol	9.5E-07	3.90E-05	6.20E-02	8.30E-06	4.92E+02	7.38E-01	7.87E+03	3.88E-07				
4,6-Dinitro-o-cresol	1.4E-06	5.74E-05	5.60E-02	6.50E-06	7.54E+02	1.13E+00	1.98E+02	2.22E-07				
2,4-Dinitrophenol	8.6E-08	3.53E-06	4.07E-02	9.08E-06	4.61E+02	6.91E-01	2.79E+03	4.19E-07				
2,4-Dinitrotoluene	5.4E-08	2.21E-06	3.75E-02	7.90E-06	5.76E+02	8.63E-01	2.70E+02	3.03E-07				
2,6-Dintitrotoluene	7.5E-07	3.06E-05	3.70E-02	7.80E-08	5.87E+02	8.81E-01	3.52E+02	1.34E-08				
2,4/2,6-Dintrotoluene Mixture	4.0E-07	1.63E-05	5.90E-02	6.90E-06	5.87E+02	8.81E-01	2.70E+02	2.69E-07				
1,4-Dioxane	4.8E-06	1.97E-04	8.70E-02	1.10E-05	2.63E+00	3.95E-03	1.00E+06	3.40E-06				
1,2-Diphenylhydrazine	4.8E-07	1.96E-05	3.43E-02	7.25E-06	1.51E+03	2.26E+00	2.21E+02	1.21E-07				
Endosulfan	6.5E-05	2.67E-03	2.25E-02	5.76E-06	6.76E+03	1.01E+01	4.50E-01	7.85E-08				
Endrin	1.0E-05	4.10E-04	3.62E-02	4.22E-06	2.01E+04	3.01E+01	2.50E-01	1.03E-08				
Epichlorohydrin	3.0E-05	1.25E-03	9.30E-02	1.10E-05	9.91E+00	1.49E-02	6.59E+04	8.29E-06	4.31E+04	8.91E+03	1.24E+04	✓
Ethyl acetate	1.3E-04	5.49E-03	8.20E-02	9.70E-06	5.58E+00	8.37E-03	8.00E+04	2.61E-05	2.43E+04	5.02E+03	1.46E+04	✓
Ethyl acrylate	3.4E-04	1.39E-02	7.50E-02	9.10E-06	1.07E+01	1.60E-02	1.50E+04	5.48E-05	1.68E+04	3.46E+03	2.86E+03	✓
Ethyl chloride	1.1E-02	4.55E-01	1.10E-01	1.20E-05	2.17E+01	3.26E-02	6.71E+03	1.89E-03	2.86E+03	5.90E+02	1.75E+03	✓
Ethyl ether	1.2E-03	5.04E-02	8.50E-02	9.40E-06	9.70E+00	1.45E-02	6.04E+04	2.17E-04	8.44E+03	1.74E+03	1.17E+04	✓
Ethyl methacrylate	5.7E-05	2.35E-03	6.50E-02	8.40E-06	1.67E+01	2.50E-02	5.40E+03	9.13E-06	4.11E+04	8.48E+03	1.07E+03	✓
Ethylbenzene	7.9E-03	3.23E-01	6.80E-02	8.50E-06	4.46E+02	6.69E-01	1.69E+02	2.43E-04	7.97E+03	1.65E+03	1.49E+02	✓
Ethylene oxide	1.5E-04	6.07E-03	1.30E-01	1.50E-05	3.24E+00	4.86E-03	1.00E+06	4.61E-05	1.83E+04	3.78E+03	1.79E+05	✓
Fluoranthene	8.9E-06	3.63E-04	2.76E-02	7.18E-06	5.55E+04	8.32E+01	2.60E-01	4.59E-09				
Fluorene	9.6E-05	3.94E-03	4.40E-02	7.88E-06	9.16E+03	1.37E+01	1.89E+00	1.43E-07	3.28E+05	6.77E+04		✓

Chemical	H (atm-m^3/mole)	H' (dimensio n-less)	D_a (cm^2/s)	D_w (cm^2/s)	K_{oc} (cm^3/g)	K_d (cm^3/g)	S (mg/L-water)	D_A (cm^2/s)	Res./Indus VF (m^3/kg)	Comm VF (mg^3/kg)	SAT (mg/kg)	VOC?
Fluoride							4.13E+04					
Furan	5.4E-03	2.21E-01	1.00E-01	1.20E-05	8.00E+01	1.20E-01	1.00E+04	6.75E-04	4.78E+03	9.87E+02	3.20E+03	✓
Heptachlor	2.9E-04	1.21E-02	2.23E-02	5.70E-06	4.13E+04	6.19E+01	1.80E-01	4.57E-08				
Hexachlorobenzene	1.7E-03	6.97E-02	2.90E-02	7.85E-06	6.20E+03	9.29E+00	6.20E-03	2.10E-06				
Hexachloro-1,3-butadiene	1.0E-02	4.22E-01	2.67E-02	7.03E-06	8.45E+02	1.27E+00	3.23E+00	7.37E-05				
Hexachlorocyclopentadiene	2.7E-02	1.11E+00	2.72E-02	7.22E-06	1.40E+03	2.11E+00	1.80E+00	1.22E-04				
Hexachloroethane	3.9E-03	1.59E-01	3.21E-02	8.89E-06	1.97E+02	2.95E-01	5.00E+01	1.03E-04				
n-Hexane	1.8E+00	7.38E+01	7.30E-02	8.20E-06	1.32E+02	1.97E-01	9.50E+00	5.98E-03	1.61E+03	3.32E+02	8.77E+01	✓
HMX	8.7E-10	3.55E-08	4.28E-02	5.00E-06	5.32E+02	7.97E-01	9.44E+03	2.05E-07				
Hydrazine anhydride					1.32E+03	1.98E+00	1.00E+06					
Hydrogen cyanide	1.3E-04	5.45E-03	1.70E-01	1.70E-05			1.00E+06	5.55E-05	1.67E+04	3.44E+03		1
Indeno(1,2,3-c,d)pyrene	3.5E-07	1.43E-05	4.48E-02	5.23E-06	1.95E+06	2.93E+03	1.90E-04	7.31E-11				
Iron						2.50E+01						
Isobutanol (Isobutyl alcohol)	9.8E-06	4.01E-04	9.00E-02	1.00E-05	2.92E+00	4.38E-03	8.50E+04	4.20E-06	6.05E+04	1.25E+04	1.51E+04	✓
Isophorone	6.6E-06	2.72E-04	5.30E-02	7.50E-06	6.52E+01	9.77E-02	1.20E+04	1.61E-06				
Lead						9.00E+02						
Lead (tetraethyl-)	5.7E-01	2.33E+01	2.45E-02	6.40E-06	6.48E+02	9.72E-01	2.90E-01	1.46E-03				
Maleic hydrazide	2.7E-11	1.09E-09	8.20E-02	9.50E-06	3.30E+00	4.95E-03	4.51E+03	2.12E-06				
Manganese						6.50E+01						
Mercury (elemental)	1.1E-02	4.67E-01	7.10E-02	3.00E-05		5.20E+01	6.00E-02	6.18E-06	4.99E+04	1.03E+04	3.13E+00	✓
Mercury (methyl)												
Mercury Chloride (Mercury Salts)						5.20E+01	6.90E+04					
Methacrylonitrile	2.5E-04	1.01E-02	9.60E-02	1.10E-05	1.31E+01	1.96E-02	2.54E+04	5.08E-05	1.74E+04	3.60E+03	4.93E+03	✓
Methomyl	2.0E-11	8.08E-10	4.80E-02	8.40E-06	1.00E+01	1.50E-02	5.80E+04	1.77E-06				
Methyl acetate	1.2E-04	4.72E-03	9.60E-02	1.10E-05	3.06E+00	4.60E-03	2.43E+05	2.70E-05	2.39E+04	4.93E+03	4.34E+04	✓
Methyl acrylate	2.0E-04	8.16E-03	8.60E-02	1.00E-05	5.84E+00	8.77E-03	4.94E+04	3.93E-05	1.98E+04	4.09E+03	9.04E+03	✓
Methyl isobutyl ketone	1.4E-04	5.66E-03	7.00E-02	8.30E-06	1.26E+01	1.89E-02	1.90E+04	2.16E-05	2.67E+04	5.52E+03	3.67E+03	✓
Methyl methacrylate	3.2E-04	1.31E-02	7.50E-02	9.20E-06	9.14E+00	1.37E-02	1.50E+04	5.24E-05	1.72E+04	3.54E+03	2.83E+03	✓
Methyl styrene (alpha)	2.3E-03	9.43E-02	7.10E-02	8.00E-06	6.98E+02	1.05E+00	3.00E+02	5.30E-05	1.71E+04	3.52E+03	3.69E+02	✓
Methyl styrene (mixture)	2.6E-03	1.05E-01	7.90E-02	9.20E-06	7.16E+02	1.07E+00	8.90E+01	6.39E-05	1.55E+04	3.21E+03	1.12E+02	✓
Methylcyclohexane	4.4E-01	1.80E+01	7.00E-02	9.00E-06	2.34E+02	3.51E-01	1.40E+01	4.76E-03	1.80E+03	3.71E+02	3.76E+01	✓
Methylene bromide (Dibromomethane)	8.2E-04	3.37E-02	5.50E-02	1.20E-05	2.17E+01	3.26E-02	1.19E+04	8.79E-05	1.32E+04	2.73E+03	2.50E+03	✓
Methylene chloride	3.3E-03	1.33E-01	1.00E-01	1.30E-05	2.17E+01	3.26E-02	1.30E+04	5.87E-04	5.12E+03	1.06E+03	2.88E+03	✓
Molybdenum						2.00E+01						
Naphthalene	4.4E-04	1.80E-02	5.90E-02	8.40E-06	1.54E+03	2.32E+00	3.10E+01	4.27E-06	6.00E+04	1.24E+04		✓
Nickel						6.50E+01						

Chemical	H (atm-m^3/mole)	H' (dimensio n-less)	D_a (cm^2/s)	D_w (cm^2/s)	K_{oc} (cm^3/g)	K_d (cm^3/g)	S (mg/L-water)	D_A (cm^2/s)	Res./indus VF (m^3/kg)	Comm VF (mg^3/kg)	SAT (mg/kg)	VOC?
Nitrate												
Nitrite												
Nitrobenzene	2.4E-05	9.84E-04	6.80E-02	9.40E-06	2.26E+02	3.40E-01	2.09E+03	1.99E-06	8.79E+04	1.82E+04	1.07E+03	✓
Nitroglycerin	8.7E-08	3.55E-06	2.90E-02	7.74E-06	1.16E+02	1.74E-01	1.38E+03	8.89E-07				
N-Nitrosodiethylamine	3.6E-06	1.49E-04	7.40E-02	9.13E-06	8.29E+01	1.24E-01	1.06E+05	1.58E-06				
N-Nitrosodimethylamine	1.8E-06	7.46E-05	9.90E-02	1.20E-05	2.28E+01	3.42E-02	1.00E+06	2.64E-06				
N-Nitrosodi-*n*-butylamine	1.3E-05	5.41E-04	6.50E-02	7.60E-06	9.15E+02	1.37E+00	1.27E+03	4.16E-07	1.92E+05	3.98E+04	1.96E+03	✓
N-Nitrosodiphenylamine	5.0E-06	2.05E-04	5.60E-02	6.50E-06	2.63E+03	3.95E+00	3.50E+01	8.97E-08				
N-Nitrosopyrrolidine	4.9E-08	2.00E-06	8.00E-01	1.01E-05	9.19E+01	1.38E-01	1.00E+06	1.34E-06				
m-Nitrotoluene	9.3E-06	3.81E-04	5.90E-02	8.70E-06	3.63E+02	5.45E-01	5.00E+02	7.85E-07				
o-Nitrotoluene	1.3E-05	5.13E-04	5.90E-02	8.70E-06	3.71E+02	5.56E-01	6.50E+02	8.76E-07	1.33E+05	2.74E+04	4.74E+02	✓
p-Nitrotoluene	5.6E-06	2.31E-04	5.70E-02	8.40E-06	3.63E+02	5.45E-01	4.42E+02	6.42E-07				
Pentachlorobenzene	7.0E-04	2.88E-02	2.94E-02	7.97E-06	3.71E+03	5.56E+00	8.31E-01	1.49E-06				
Pentachlorophenol	2.5E-08	1.00E-06	2.95E-02	8.01E-06	4.96E+03	7.44E+00	1.40E+01	4.19E-08				
Perchlorate							2.45E+05					
Phenanthrene	1.9E-01	7.71E+00	3.33E-02	7.47E-06	1.67E+04	2.50E+01	1.15E+00	9.54E-05	1.27E+04	2.63E+03		✓
Phenol	3.3E-07	1.37E-05	8.30E-02	1.00E-05	1.87E+02	2.81E-01	8.28E+04	8.99E-07				
Polychlorinatedbiphenyls												
Aroclor 1016	2.0E-04	8.20E-03	4.69E-02	5.48E-06	4.77E+04	7.16E+01	2.77E-01	5.50E-08				
Aroclor 1221	7.4E-04	3.02E-02	5.80E-02	6.70E-06	8.40E+03	1.26E+01	4.83E+00	1.35E-06	1.07E+05	2.21E+04	6.17E+01	✓
Aroclor 1232	7.4E-04	3.02E-02	5.80E-02	6.70E-06	8.40E+03	1.26E+01	4.83E+00	1.35E-06	1.07E+05	2.21E+04	6.17E+01	✓
Aroclor 1242	1.9E-04	7.79E-03	4.32E-02	5.01E-02	7.81E+04	1.17E+02	2.77E-01	1.70E-05				
Aroclor 1248	4.4E-04	1.80E-02	4.32E-02	5.01E-02	7.65E+04	1.15E+02	5.32E-02	1.74E-05				
Aroclor 1254	2.8E-04	1.16E-02	4.01E-02	4.68E-06	1.31E+05	1.96E+02	3.40E-03	2.40E-08				
Aroclor 1260	3.4E-04	1.38E-02	3.53E-02	4.14E-06	3.50E+05	5.25E+02	2.84E-04	9.29E-09				
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	3.0E-06	1.23E-04			3.57E+05	5.35E+02	3.47E-03					
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	2.4E-07	9.84E-06			3.50E+05	5.25E+02	3.85E-03					
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	1.4E-04	5.66E-03	3.53E-02	4.12E-06	3.50E+05	5.25E+02	7.53E-04	4.00E-09				
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	1.6E-04	6.64E-03	3.75E-02	4.38E-06	2.09E+05	3.14E+02	2.23E-03	8.24E-09				
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 157)	1.6E-04	6.64E-03	3.75E-02	4.38E-06	2.14E+05	3.20E+02	1.64E-03	8.07E-09				
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	1.4E-04	5.86E-03	3.75E-02	4.38E-06	2.14E+05	3.20E+02	5.33E-03	7.19E-09				
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	1.6E-04	6.64E-03	3.75E-02	4.38E-06	2.09E+05	3.14E+02	5.10E-04	8.24E-09				
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	1.9E-04	7.79E-03	4.01E-02	4.68E-06	1.31E+05	1.96E+02	1.60E-02	1.64E-08				
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	2.9E-04	1.18E-02	4.01E-02	4.68E-06	1.28E+05	1.92E+02	1.34E-02	2.49E-08				
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	2.8E-04	1.16E-02	4.01E-02	4.68E-06	1.31E+05	1.96E+02	3.40E-03	2.40E-08				
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	1.9E-04	7.79E-03	4.01E-02	4.68E-06	1.31E+05	1.96E+02	1.60E-02	1.64E-08				

Chemical	H (atm-m^3/mole)	H' (dimensio n-less)	D_a (cm^2/s)	D_w (cm^2/s)	K_{oc} (cm^3/g)	K_d (cm^3/g)	S (mg/L-water)	D_A (cm^2/s)	Res./Indus VF (m^3/kg)	Comm VF (mg^3/kg)	SAT (mg/kg)	VOC?
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	1.9E-04	7.79E-03	4.01E-02	4.68E-06	1.28E+05	1.92E+02	9.39E-03	1.67E-08				
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	9.4E-06	3.85E-04	4.32E-02	5.04E-06	7.81E+04	1.17E+02	5.69E-04	3.08E-09				
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	2.2E-04	9.14E-03	4.32E-02	5.04E-06	7.81E+04	1.17E+02	5.32E-02	3.43E-08				
Propylene oxide	7.0E-05	2.85E-03	1.30E-01	1.50E-05	5.19E+00	7.79E-03	5.90E+05	2.31E-05	2.58E+04	5.34E+03	1.07E+05	✓
Pyrene	1.2E-05	4.88E-04	2.72E-02	7.24E-06	5.43E+04	8.15E+01	1.35E-01	5.10E-09	1.74E+06	3.59E+05		✓
RDX	2.0E-11	8.20E-10	3.12E-02	8.50E-06	8.91E+01	1.34E-01	5.97E+01	1.10E-06				
Selenium						5.00E+00						
Silver						8.30E+00						
Strontium						3.50E+01						
Styrene	2.7E-03	1.12E-01	7.10E-02	8.80E-06	4.46E+02	6.69E-01	3.10E+02	9.05E-05	1.30E+04	2.70E+03	2.65E+02	✓
2,3,7,8-TCDD	5.0E-05	2.05E-03	4.70E-02	4.73E-06	2.49E+05	3.74E+02	2.00E-04	3.00E-09				
2,3,7,8-TCDF	1.5E-05	6.15E-04			1.40E+05	2.09E+02	6.92E-04					
1,2,4,5-Tetrachlorobenzene	1.0E-03	4.10E-02	3.19E-02	8.75E-06	2.22E+03	3.33E+00	5.95E-01	3.71E-06				
1,1,1,2-Tetrachloroethane	2.5E-03	1.03E-01	4.80E-02	9.10E-06	8.60E+01	1.29E-01	1.07E+03	1.53E-04	1.00E+04	2.07E+03	3.37E+02	✓
1,1,2,2-Tetrachloroethane	3.7E-04	1.50E-02	4.90E-02	9.30E-06	9.49E+01	1.42E-01	2.87E+03	2.37E-05	2.55E+04	5.27E+03	9.11E+02	✓
Tetrachloroethene	1.8E-02	7.26E-01	5.00E-02	9.50E-06	9.49E+01	1.42E-01	2.06E+02	8.85E-04	4.17E+03	8.62E+02	8.30E+01	✓
Tetryl (Trinitrophenylmethylnitramine)	2.7E-09	1.11E-07	2.56E-02	6.67E-06	4.61E+03	6.91E+00	7.40E+01	3.74E-08				
Thallium						7.10E+01						
Toluene	6.6E-03	2.72E-01	7.80E-02	9.20E-06	2.34E+02	3.51E-01	5.26E+02	3.71E-04	6.44E+03	1.33E+03	2.93E+02	✓
Toxaphene	6.0E-06	2.46E-04	3.42E-02	4.00E-06	7.72E+04	1.16E+02	5.50E-01	2.07E-09				
Tribromomethane (Bromoform)	5.4E-04	2.19E-02	3.57E-02	1.04E-05	3.18E+01	6.92E+00	3.10E+03	1.13E-06				
1,1,2-Trichloro-1,2,2-trifluoroethane	5.3E-01	2.16E+01	3.80E-02	8.60E-06	1.97E+02	2.95E-01	1.70E+02	2.73E-03	2.38E+03	4.91E+02	5.20E+02	✓
1,2,4-Trichlorobenzene	1.4E-03	5.82E-02	4.00E-02	8.40E-06	1.36E+03	2.03E+00	4.90E+01	1.03E-05	3.86E+04	7.97E+03	1.09E+02	✓
1,1,1-Trichloroethane	1.7E-02	7.05E-01	6.50E-02	9.60E-06	4.39E+01	6.58E-02	1.29E+03	1.39E-03	3.33E+03	6.87E+02	4.18E+02	✓
1,1,2-Trichloroethane	8.2E-04	3.38E-02	6.70E-02	1.00E-05	6.07E+01	9.11E-02	1.10E+03	8.33E-05	1.36E+04	2.81E+03	2.95E+02	✓
Trichloroethylene	9.9E-03	4.04E-01	6.90E-02	1.00E-05	6.07E+01	9.11E-02	1.28E+03	8.72E-04	4.20E+03	8.68E+02	4.00E+02	✓
Trichlorofluoromethane	9.7E-02	3.98E+00	6.50E-02	1.00E-05	4.39E+01	6.58E-02	1.10E+03	3.63E-03	2.06E+03	4.25E+02	7.88E+02	✓
2,4,5-Trichlorophenol	1.6E-06	6.64E-05	5.60E-02	6.50E-06	1.78E+03	2.67E+00	1.20E+03	1.04E-07				
2,4,6-Trichlorophenol	2.6E-06	1.07E-04	3.10E-02	8.10E-06	1.78E+03	2.67E+00	8.00E+02	1.25E-07				
1,1,2-Trichloropropane	3.2E-04	1.30E-02	5.70E-02	9.30E-06	9.49E+01	1.42E-01	1.90E+03	2.38E-05	2.54E+04	5.26E+03	6.03E+02	✓
1,2,3-Trichloropropane	3.4E-04	1.41E-02	5.70E-02	9.20E-06	1.16E+02	1.74E-01	1.75E+03	2.33E-05	2.57E+04	5.31E+03	6.10E+02	✓
Triethylamine	1.5E-04	6.11E-03	6.60E-02	7.90E-06	5.08E+01	7.62E-02	7.37E+04	1.69E-05	3.02E+04	6.24E+03	1.84E+04	✓
2,4,6-Trinitrotoluene	2.1E-08	8.53E-07	2.95E-02	7.92E-06	2.81E+03	4.22E+00	1.30E+02	7.17E-08				
Uranium (soluble salts)						4.50E+02						
Vanadium						1.00E+03						
Vinyl acetate	5.1E-04	2.10E-02	8.50E-02	1.00E-05	5.58E+00	8.37E-03	2.00E+04	9.59E-05	1.27E+04	2.62E+03	3.68E+03	✓

Chemical	H (atm-m^3/mole)	H' (dimensio n-less)	D_a (cm^2/s)	D_w (cm^2/s)	K_{oc} (cm^3/g)	K_d (cm^3/g)	S (mg/L-water)	D_A (cm^2/s)	Res./Indus VF (m^3/kg)	Comm VF (mg^3/kg)	SAT (mg/kg)	VOC?
Vinyl bromide	1.2E-02	5.04E-01	8.60E-02	1.20E-05	2.17E+01	3.26E-02	5.08E+03	1.60E-03	3.10E+03	6.41E+02	1.35E+03	✓
Vinyl chloride	2.8E-02	1.14E+00	1.10E-01	1.20E-05	2.17E+01	3.26E-02	8.80E+03	3.63E-03	2.06E+03	4.26E+02	3.02E+03	✓
m-Xylene	7.2E-03	2.94E-01	6.80E-02	8.40E-06	3.75E+02	5.63E-01	1.61E+02	2.53E-04	7.81E+03	1.61E+03	1.24E+02	✓
o-Xylene	5.2E-03	2.12E-01	6.90E-02	8.50E-06	3.83E+02	5.74E-01	1.06E+02	1.84E-04	9.14E+03	1.89E+03	8.20E+01	✓
Xylenes	5.2E-03	2.12E-01	8.50E-02	9.90E-06	3.83E+02	5.74E-01	1.06E+02	2.27E-04	8.23E+03	1.70E+03	8.20E+01	✓
Zinc						6.20E+01				3.55E+04		

Notes:
MW – Molecular weight
H' – Dimensionless Henry's Law Constant
D_w – Diffusivity in water
K_d – Soil-water partition coefficient
D_A – Apparent diffusivity (calculated for VOCs only)
SAT – Soil saturation limit (calculated for VOCs only)
H – Henry's Law Constant
D_a – Diffusivity in air
K_{oc} – Soil organic carbon partition coefficient
S - Solubility in water
VF – Volatilization factor (calculated for VOCs only)
VOC – Volatile organic compound

APPENDIX C

TOXICITY DATA

Table C-1: Human Health Benchmarks Used for Calculating SSLs

Chemical	CSF_o $(mg/kg\text{-}day)^{-1}$	Reference	IUR $(\mu g/m^3)^{-1}$	Reference	RfD_o (mg/kg-day)	Reference	RfC (mg/m^3)	Reference	Mutagen	GIABS	ABS
Acenaphthene					6.00E-02	IRIS				1	0.13
Acetaldehyde			2.20E-06	IRIS			9.00E-03	IRIS		1	
Acetone					9.00E-01	IRIS	3.10E+01	ATSDR		1	
Acrylonitrile	5.40E-01	IRIS	6.80E-05	IRIS	4.00E-02	ATSDR	2.00E-03	IRIS		1	
Acetophenone					1.00E-01	IRIS				1	
Acrolein					5.00E-04	IRIS	2.00E-05	IRIS		1	
Aldrin	1.72E+01	IRIS	4.90E-03	IRIS	3.00E-05	IRIS				1	0.1
Aluminum					1.00E+00	PPTRV	5.00E-03	PPTRV		1	
Anthracene					3.00E-01	IRIS				1	0.13
Antimony					4.00E-04	IRIS				0.15	
Arsenic	1.50E+00	IRIS	4.30E-03	IRIS	3.00E-04	IRIS	1.50E-05	CalEPA		1	0.03
Barium					2.00E-01	IRIS	5.00E-04	HEAST		0.07	
Benzene	5.50E-02	IRIS	7.80E-06	IRIS	4.00E-03	IRIS	3.00E-02	IRIS		1	
Benzidine	2.30E+02	IRIS	6.70E-02	IRIS	3.00E-03	IRIS			M	1	0.1
Benzo(a)anthracene	7.30E-01	NCEA	1.10E-04	CalEPA					M	1	0.13
Benzo(a)pyrene	7.30E+00	IRIS	1.10E-03	CalEPA					M	1	0.13
Benzo(b)fluoranthene	7.30E-01	NCEA	1.10E-04	CalEPA					M	1	0.13
Benzo(k)fluoranthene	7.30E-02	NCEA	1.10E-04	CalEPA					M	1	0.13
Beryllium			2.40E-03	IRIS	2.00E-03	IRIS	2.00E-05	IRIS		0.007	
a-BHC (HCH)	6.30E+00	IRIS	1.80E-03	IRIS	8.00E-03	ATSDR				1	0.1
b-BHC (HCH)	1.80E+00	IRIS	5.30E-04	IRIS						1	0.1
g-BHC	1.10E+00	CalEPA	3.10E-04	CalEPA	3.00E-04	IRIS				1	0.04
1,1-Biphenyl	8.00E-03	PPTRV			5.00E-02	IRIS	4.00E-04	PPTRV		1	
Bis(2-chloroethyl) ether	1.10E+00	IRIS	3.30E-04	IRIS						1	
Bis(2-chloroisopropyl) ether	7.00E-02	HEAST									
Bis(2-ethylhexyl) phthalate	1.40E-02	IRIS	2.40E-06	CalEPA	2.00E-02	IRIS				1	0.1
Bis(chloromethyl) ether	2.20E+02	IRIS	6.20E-02	IRIS						1	
Boron					2.00E-01	IRIS	2.00E-02	HEAST		1	
Bromodichloromethane	6.20E-02	IRIS	3.70E-05	CalEPA	2.00E-02	IRIS				1	
Bromomethane					1.40E-03	IRIS	5.00E-03	IRIS		1	
1,3-Butadiene	3.40E+00	CalEPA	3.00E-05	IRIS			2.00E-03	IRIS		1	
2-Butanone (Methyl ethyl ketone, MEK)					6.00E-01	IRIS	5.00E+00	IRIS		1	
tert-Butyl methyl ether (MTBE)	1.80E-03	CalEPA	2.60E-07	CalEPA			3.00E+00	IRIS		1	

Chemical	CSF_o $(mg/kg\text{-}day)^{-1}$	Reference	IUR $(\mu g/m^3)^{-1}$	Reference	RfD_o (mg/kg-day)	Reference	RfC (mg/m^3)	Reference	Mutagen	GIABS	ABS
Cadmium			1.80E-03	IRIS	1.00E-03	IRIS	2.00E-05	CalEPA		0.025	0.001
Carbon disulfide					1.00E-01	IRIS	7.00E-01	IRIS		1	
Carbon tetrachloride	7.00E-02	IRIS	6.00E-06	IRIS	4.00E-03	IRIS	1.00E-01	IRIS		1	
Chlordane	3.50E-01	IRIS	1.00E-04	IRIS	5.00E-04	IRIS	7.00E-04	IRIS		1	0.04
2-Chloroacetophenone							3.00E-05	IRIS		1	0.1
2-Chloro-1,3-butadiene			3.00E-04	IRIS	2.00E-02	HEAST	2.00E-02	IRIS		1	
1-Chloro-1,1-difluoroethane							5.00E+01	IRIS		1	
Chlorobenzene					2.00E-02	IRIS	5.00E-02	PPTRV		1	
1-Chlorobutane					4.00E-02	PPTRV				1	
Chlorodifluoromethane							5.00E+01	IRIS		1	
Chloroform	3.10E-02	CalEPA	2.30E-05	IRIS	1.00E-02	IRIS	9.80E-02	ATSDR		1	
Chloromethane							9.00E-02	IRIS		1	
b-Chloronaphthalene					8.00E-02	IRIS				1	
o-Chloronitrobenzene	3.00E-01	PPTRV			3.00E-03	PPTRV	1.00E-05	PPTRV		1	0.1
p-Chloronitrobenzene	6.30E-03	PPTRV			1.00E-03	PPTRV	6.00E-04	PPTRV		1	0.1
2-Chlorophenol					5.00E-03	IRIS					
2-Chloropropane							1.00E-01	HEAST			
o-Chlorotoluene					2.00E-02	IRIS					
Chromium III					1.50E+00	IRIS				0.013	
Chromium VI	5.00E-01	NJ	8.40E-02	IRIS	3.00E-03	IRIS	1.00E-04	IRIS	M	0.025	
Chrysene	7.30E-03	NCEA	1.10E-05	CalEPA					M	1	0.13
Copper					4.00E-02	HEAST				1	
Crotonaldehyde	1.90E+00	HEAST			1.00E-03	PPTRV				1	
Cumene (isopropylbenzene)					1.00E-01	IRIS	4.00E-01	IRIS		1	
Cyanide					6.00E-04	IRIS				1	
Cyanogen					4.00E-02	IRIS				1	
Cyanogen bromide					9.00E-02	IRIS				1	
Cyanogen chloride					5.00E-02	IRIS				1	
DDD	2.40E-01	IRIS	6.90E-05	CalEPA						1	0.1
DDE	3.40E-01	IRIS	9.70E-05	CalEPA						1	0.1
DDT	3.40E-01	IRIS	9.70E-05	IRIS	5.00E-04	IRIS				1	0.03
Dibenz(a,h)anthracene	7.30E+00	NCEA	1.20E-03	CalEPA					M	1	0.13
1,2-Dibromo-3-chloropropane	8.00E-01	PPTRV	6.00E-03	PPTRV	2.00E-04	PPTRV	2.00E-04	IRIS	M	1	
Dibromochloromethane	8.40E-02	IRIS	2.70E-05	CalEPA	2.00E-02	IRIS				1	0.1
1,2-Dibromoethane	2.00E+00	IRIS	6.00E-04	IRIS	9.00E-03	IRIS	9.00E-03	IRIS		1	
1,4-Dichloro-2-butene			4.20E-03	PPTRV						1	
1,2-Dichlorobenzene					9.00E-02	IRIS	2.00E-01	HEAST		1	

Chemical	CSF_o $(mg/kg\text{-}day)^{-1}$	Reference	IUR $(\mu g/m^3)^{-1}$	Reference	RfD_o (mg/kg-day)	Reference	RfC (mg/m^3)	Reference	Mutagen	GIABS	ABS
1,4-Dichlorobenzene	5.40E-03	CalEPA	1.10E-05	CalEPA	7.00E-02	ATSDR	8.00E-01	IRIS		1	
3,3-Dichlorobenzidine	**4.50E-01**	**IRIS**	**3.40E-04**	**CalEPA**						1	0.1
Dichlorodifluoromethane					2.00E-01	IRIS	1.00E-01	PPTRV		1	
1,1-Dichloroethane	**5.70E-03**	**CalEPA**	**1.60E-06**	**CalEPA**	**2.00E-01**	**PPTRV**				1	
1,2-Dichloroethane	9.10E-02	IRIS	2.60E-05	IRIS	6.00E-03	PPTRV	7.00E-03	PPTRV		1	
***cis*-1,2-Dichloroethene**					**2.00E-03**	**IRIS**				1	
trans-1,2-Dichloroethene					2.00E-02	IRIS	6.00E-02	PPTRV		1	
1,1-Dichloroethene					**5.00E-02**	**IRIS**	**2.00E-01**	**IRIS**		1	
2,4-Dichlorophenol					3.00E-03	IRIS				1	0.1
1,2-Dichloropropane	**3.60E-02**	**CalEPA**	**1.00E-05**	**CalEPA**	**9.00E-02**	**ATSDR**	**4.00E-03**	**IRIS**		1	
1,3-Dichloropropene	1.00E-01	IRIS	4.00E-06	IRIS	3.00E-02	IRIS	2.00E-02	IRIS		1	
Dicyclopentadiene					**8.00E-03**	**PPTRV**	**7.00E-03**	**PPTRV**		1	
Dieldrin	1.60E+01	IRIS	4.60E-03	IRIS	5.00E-05	IRIS				1	0.1
Diethyl phthalate					**8.00E-01**	**IRIS**				1	0.1
Dimethyl phthalate					1.00E+01	HEAST				1	0.1
Di-n-butyl phthalate (Dibutyl phthalate)					**1.00E-01**	**IRIS**				1	0.1
2,4-Dimethylphenol					2.00E-02	IRIS				1	0.1
4,6-Dinitro-o-cresol					**8.00E-05**	**PPTRV**				1	0.1
2,4-Dinitrophenol					2.00E-03	IRIS				1	0.1
2,4-Dinitrotoluene	**3.10E-01**	**CalEPA**	**8.90E-05**	**CalEPA**	**2.00E-03**	**IRIS**				1	0.1
2,6-Dintitrotoluene					1.00E-03	PPTRV				1	0.1
2,4/2,6-Dintrotoluene Mixture	**6.80E-01**	**IRIS**								1	0.1
1,4-Dioxane	1.00E-01	IRIS	7.70E-06	CalEPA	3.00E-02	IRIS	3.00E+00	CalEPA		1	0.1
1,2-Diphenylhydrazine	**8.00E-01**	**IRIS**	**2.20E-04**	**IRIS**						1	0.1
Endosulfan					6.00E-03	IRIS				1	0.1
Endrin					**3.00E-04**	**IRIS**				1	0.1
Epichlorohydrin	9.90E-03	IRIS	1.20E-06	IRIS	6.00E-03	PPTRV	1.00E-03	IRIS		1	
Ethyl acetate					**9.00E-01**	**IRIS**				1	
Ethyl acrylate	4.80E-02	HEAST								1	
Ethyl chloride							**1.00E+01**	**IRIS**		1	
Ethyl ether					2.00E-01	IRIS				1	
Ethyl methacrylate					**9.00E-02**	**HEAST**	**3.00E-01**	**PPTRV**		1	
Ethylbenzene	1.10E-02	CalEPA	2.50E-06	CalEPA	1.00E-01	IRIS	1.00E+00	IRIS		1	
Ethylene oxide	**3.10E-01**	**CalEPA**	**8.80E-05**	**CalEPA**			**3.00E-02**	**CalEPA**		1	
Fluoranthene					4.00E-02	IRIS				1	0.13
Fluorene					**4.00E-02**	**IRIS**				1	0.13
Fluoride					4.00E-02	CalEPA	1.30E-02	CalEPA		1	

Chemical	CSF_o $(mg/kg\text{-}day)^{-1}$	Reference	IUR $(\mu g/m^3)^{-1}$	Reference	RfD_o (mg/kg-day)	Reference	RfC (mg/m^3)	Reference	Mutagen	GIABS	ABS
Furan					1.00E-03	IRIS				1	
Heptachlor	4.50E+00	IRIS	1.30E-03	IRIS	5.00E-04	IRIS				1	0.1
Hexachlorobenzene	1.60E+00	IRIS	4.60E-04	IRIS	8.00E-04	IRIS				1	0.1
Hexachloro-1,3-butadiene	7.80E-02	IRIS	2.20E-05	IRIS	1.00E-03	PPTRV				1	0.1
Hexachlorocyclopentadiene					6.00E-03	IRIS	2.00E-04	IRIS		1	0.1
Hexachloroethane	4.00E-02	IRIS	4.00E-06	IRIS	7.00E-04	IRIS				1	0.1
n-Hexane					6.00E-02	HEAST	7.00E-01	IRIS		1	
HMX					5.00E-02	IRIS				1	
Hydrazine anhydride	3.00E+00	IRIS	4.90E-03	IRIS			3.00E-05	PPTRV		1	
Hydrogen cyanide					6.00E-04	IRIS	8.00E-04	IRIS		1	
Indeno(1,2,3-c,d)pyrene	7.30E-01	NCEA	1.10E-04	CalEPA					M	1	0.13
Iron					7.00E-01	PPTRV				1	
Isobutanol (Isobutyl alcohol)					3.00E-01	IRIS				1	
Isophorone	9.50E-04	IRIS			2.00E-01	IRIS	2.00E+00	CalEPA		1	0.1
Lead											
Lead (tetraethyl-)					1.00E-07	IRIS				1	0.1
Maleic hydrazide					5.00E-01	IRIS				1	0.1
Manganese					2.40E-02	IRIS	5.00E-05	IRIS		0.04	
Mercury (elemental)							3.00E-04	IRIS		1	
Mercury (methyl)					1.00E-04	IRIS				1	
Mercuric Chloride (Mercury Salts)					3.00E-04	IRIS	3.00E-05	CalEPA		0.07	
Methacrylonitrile					1.00E-04	IRIS	7.00E-04	HEAST		1	
Methomyl					2.50E-02	IRIS				1	0.1
Methyl acetate					1.00E+00	PPTRV				1	
Methyl acrylate					3.00E-02	HEAST				1	
Methyl isobutyl ketone					8.00E-02	HEAST	3.00E+00	IRIS		1	
Methyl methacrylate					1.40E+00	IRIS	7.00E-01	IRIS		1	
Methyl styrene (alpha)					7.00E-02	HEAST				1	
Methyl styrene (mixture)					6.00E-03	HEAST	4.00E-02	HEAST		1	
Methylcyclohexane							3.00E+00	HEAST			
Methylene bromide (Dibromomethane)					1.00E-02	HEAST	4.00E-03	PPTRV		1	
Methylene chloride	2.00E-03	IRIS	1.00E-08	IRIS	6.00E-03	IRIS	6.00E-01	IRIS		1	
Molybdenum					5.00E-03	IRIS				1	
Naphthalene			3.40E-05	CalEPA	2.00E-02	IRIS	3.00E-03	IRIS		1	0.13
Nickel (soluble salts)			2.60E-04	CalEPA	2.00E-02	IRIS	9.00E-05	ATSDR		0.04	
Nitrate					1.60E+00	IRIS				1	
Nitrite					1.00E-01	IRIS				1	

Chemical	CSF_o $(mg/kg\text{-}day)^{-1}$	Reference	IUR $(\mu g/m^3)^{-1}$	Reference	RfD_o (mg/kg-day)	Reference	RfC (mg/m^3)	Reference	Mutagen	GIABS	ABS
Nitrobenzene			4.00E-05	IRIS	2.00E-03	IRIS	9.00E-03	IRIS		1	
Nitroglycerin	1.70E-02	PPTRV			1.00E-04	PPTRV				1	0.1
N-Nitrosodiethylamine	1.50E+02	IRIS	4.30E-02	IRIS					M	1	0.1
N-Nitrosodimethylamine	5.10E+01	IRIS	1.40E-02	IRIS	8.00E-06	PPTRV	4.00E-05	PPTRV	M	1	0.1
N-Nitrosodi-*n*-butylamine	5.40E+00	IRIS	1.60E-03	IRIS						1	0.1
N-Nitrosodiphenylamine	4.90E-03	IRIS	2.60E-06	CalEPA						1	0.1
N-Nitrosopyrrolidine	2.10E+00	IRIS	6.10E-04	IRIS						1	0.1
m-Nitrotoluene					1.00E-04	PPTRV				1	
o-Nitrotoluene	2.20E-01	PPTRV			9.00E-04	PPTRV				1	
p-Nitrotoluene	1.60E-02	PPTRV			4.00E-03	PPTRV				1	0.1
Pentachlorobenzene					8.00E-04	IRIS				1	0.1
Pentachlorophenol	4.00E-01	IRIS	5.10E-06	CalEPA	5.00E-03	IRIS				1	0.25
Perchlorate					7.00E-04	IRIS				1	
Phenanthrene					3.00E-02	IRIS				1	0.1
Phenol					3.00E-01	IRIS	2.00E-01	CalEPA		1	0.1
Polychlorinatedbiphenyls											
Aroclor 1016	7.00E-02	IRIS	2.00E-05	IRIS	7.00E-05	IRIS				1	0.14
Aroclor 1221	2.00E+00	IRIS	5.70E-04	IRIS						1	0.14
Aroclor 1232	2.00E+00	IRIS	5.70E-04	IRIS						1	0.14
Aroclor 1242	2.00E+00	IRIS	5.70E-04	IRIS						1	0.14
Aroclor 1248	2.00E+00	IRIS	5.70E-04	IRIS						1	0.14
Aroclor 1254	2.00E+00	IRIS	5.70E-04	IRIS	2.00E-05	IRIS				1	0.14
Aroclor 1260	2.00E+00	IRIS	5.70E-04	IRIS						1	0.14
2,2',3,3',4,4',5-Heptachlorobiphenyl (PCB 170)	1.30E+01	WHO TEF	3.80E-03	WHO TEF						1	0.14
2,2',3,4,4',5,5'-Heptachlorobiphenyl (PCB 180)	1.30E+00	WHO TEF	3.80E-04	WHO TEF						1	0.14
2,3,3',4,4',5,5'-Heptachlorobiphenyl (PCB 189)	3.90E+00	WHO TEF	1.14E-03	WHO TEF						1	0.14
2,3',4,4',5,5'-Hexachlorobiphenyl (PCB 167)	3.90E+00	WHO TEF	1.14E-03	WHO TEF						1	0.14
2,3,3',4,4',5'-Hexachlorobiphenyl (PCB 157)	3.90E+00	WHO TEF	1.14E-03	WHO TEF						1	0.14
2,3,3',4,4',5-Hexachlorobiphenyl (PCB 156)	3.90E+00	WHO TEF	1.14E-03	WHO TEF						1	0.14
3,3',4,4',5,5'-Hexachlorobiphenyl (PCB 169)	3.90E+03	WHO TEF	1.14E+00	WHO TEF						1	0.14
2',3,4,4',5-Pentachlorobiphenyl (PCB 123)	3.90E+00	WHO TEF	1.14E-03	WHO TEF						1	0.14
2',3',4,4',5-Pentachlorobiphenyl (PCB 118)	3.90E+00	WHO TEF	1.14E-03	WHO TEF						1	0.14
2',3,3',4,4'-Pentachlorobiphenyl (PCB 105)	3.90E+00	WHO TEF	1.14E-03	WHO TEF						1	0.14
2,3,4,4',5-Pentachlorobiphenyl (PCB 114)	3.90E+00	WHO TEF	1.14E-03	WHO TEF						1	0.14
3,3',4,4',5-Pentachlorobiphenyl (PCB 126)	1.30E+04	WHO TEF	3.80E+00	WHO TEF						1	0.14
3,3',4,4'-Tetrachlorobiphenyl (PCB 77)	1.30E+01	WHO TEF	3.80E-03	WHO TEF						1	0.14
3,4,4',5-Tetrachlorobiphenyl (PCB 81)	3.90E+01	WHO TEF	1.14E-02	WHO TEF						1	0.14

Chemical	CSF_o $(mg/kg\text{-}day)^{-1}$	Reference	IUR $(\mu g/m^3)^{-1}$	Reference	RfD_o (mg/kg-day)	Reference	RfC (mg/m^3)	Reference	Mutagen	GIABS	ABS
Propylene oxide	2.40E-01	IRIS	3.70E-06	IRIS			3.00E-02	IRIS		1	
Pyrene					3.00E-02	IRIS				1	0.13
RDX	1.10E-01	IRIS			3.00E-03	IRIS				1	
Selenium					5.00E-03	IRIS	2.00E-02	CalEPA		1	
Silver					5.00E-03	IRIS				0.04	
Strontium					6.00E-01	IRIS				1	
Styrene					2.00E-01	IRIS	1.00E+00	IRIS		1	
2,3,7,8-TCDD	1.30E+05	CalEPA	3.80E+01	CalEPA	1.00E-09	ATSDR	4.00E-08	CalEPA		1	0.03
2,3,7,8-TCDF	1.30E+04	WHO TEF	3.80E+00	WHO TEF						1	0.03
1,2,4,5-Tetrachlorobenzene					3.00E-04	IRIS				1	0.1
1,1,1,2-Tetrachloroethane	2.60E-02	IRIS	7.40E-06	IRIS	3.00E-02	IRIS				1	
1,1,2,2-Tetrachloroethane	2.00E-01	IRIS	5.80E-05	IRIS	2.00E-02	IRIS				1	
Tetrachloroethene	5.40E-01	CalEPA	5.90E-06	CalEPA	1.00E-02	IRIS	2.70E-01	ATSDR		1	
Tetryl (Trinitrophenylmethylnitramine)					4.00E-03	PPTRV				1	0.1
Thallium					1.00E-05	PPTRV				1	
Toluene					8.00E-02	IRIS	5.00E+00	IRIS		1	
Toxaphene	1.10E+00	IRIS	3.20E-04	IRIS						1	0.1
Tribromomethane (Bromoform)	7.90E-03	IRIS	1.10E-06	IRIS	2.00E-02	IRIS				1	0.1
1,1,2-Trichloro-1,2,2-trifluoroethane					3.00E+01	IRIS	3.00E+01	HEAST		1	
1,2,4-Trichlorobenzene	2.90E-02	PPTRV			1.00E-02	IRIS	2.00E-03	PPTRV		1	
1,1,1-Trichloroethane					2.00E+00	IRIS	5.00E+00	IRIS		1	
1,1,2-Trichloroethane	5.70E-02	IRIS	1.60E-05	IRIS	4.00E-03	IRIS	2.00E-04	PPTRV		1	
Trichloroethylene	4.6E-02	IRIS	4.10E-06	IRIS	5.00E-04	IRIS	2.00E-03	IRIS		1	
Trichlorofluoromethane					3.00E-01	IRIS	7.00E-01	HEAST		1	
2,4,5-Trichlorophenol					1.00E-01	IRIS				1	0.1
2,4,6-Trichlorophenol	1.10E-02	IRIS	3.10E-06	IRIS	1.00E-03	PPTRV				1	0.1
1,1,2-Trichloropropane					5.00E-03	IRIS				1	
1,2,3-Trichloropropane	3.00E+01	IRIS			4.00E-03	IRIS	3.00E-04	IRIS	M	1	
Triethylamine							7.00E-03	IRIS		1	
2,4,6-Trinitrotoluene	3.00E-02	IRIS			5.00E-04	IRIS				1	
Uranium (soluble salts)					3.00E-03	IRIS	3.00E-04	ATSDR		1	
Vanadium					5.00E-03	IRIS				1	
Vinyl acetate					1.00E+00	HEAST	2.00E-01	IRIS		1	
Vinyl bromide			3.20E-05	HEAST			3.00E-03	IRIS		1	
Vinyl chloride	7.20E-01	IRIS	4.40E-06	IRIS	3.00E-03	IRIS	1.00E-01	IRIS	M	1	
m-Xylene					2.00E-01	IRIS	1.00E-01	IRIS		1	
o-Xylene					2.00E-01	IRIS	1.00E-01	IRIS		1	

Chemical	CSF_o $(mg/kg\text{-}day)^{-1}$	Reference	IUR $(\mu g/m^3)^{-1}$	Reference	RfD_o (mg/kg-day)	Reference	RfC (mg/m^3)	Reference	Mutagen	GIABS	ABS
Xylenes					2.00E-01	IRIS	1.00E-01	IRIS		1	
Zinc					3.00E-01	IRIS				1	

Notes:
CSF_o – Oral Cancer Slope Factor
IUR– Inhalation Unit Risk
RfD_o – Oral Reference Dose
RfC – Inhalation Reference Concentration
ABS – Dermal absorption coefficient

ATSDR – Agency for Toxic Substances and Disease Registry
Cal EPA – California Environmental Protection Agency
HEAST – Health Effects Assessment Summary Tables
IRIS – Integrated Risk Information System
PPTRV – Provisional Peer Reviewed Toxicity Value
WHO TEF – World Health Organization Toxicity Equivalency Factor

APPENDIX D
New Mexico Environment Department
Hazardous Waste Bureau

Guidance for Risk-based Remediation of Polychlorinated Biphenyls (PCBs) at RCRA Corrective Action Sites

New Mexico Environment Department
Hazardous Waste Bureau

Guidance for Risk-based Remediation of Polychlorinated Biphenyls (PCBs) at RCRA Corrective Action Sites[1]

February 2012

[1]This document is intended as guidance for employees of the New Mexico Environment Department's (NMED) Hazardous Waste Bureau (HWB) and Resource Conservation and Recovery Act (RCRA)-regulated facilities within the State of New Mexico. This guidance does not constitute rule-making and may not be relied upon to create a right or benefit, substantive or procedural, enforceable at law or in equity, by any person. HWB may take action at variance to this guidance and reserves the right to modify this guidance at any time without public notice.

Guidance for Risk-based Remediation of Polychlorinated Biphenyls (PCBs) at RCRA Corrective Action Sites

Table of Contents

List of Tables

ACRONYMNS AND ABBREVIATIONS

µg/g	microgram per gram
µg/L	microgram per liter
AOC	Area of Concern
AT	Averaging Time
BMP	Best Management Practices
BW	Body Weight
CSF	Cancer Slope Factor
CWA	Clean Water Act
DD	Daily Dose
ECD	Electron Capture Detector
ED	Exposure Duration
EF	Exposure Frequency
ELCD	Electrolytic Conductivity Detector
GC/MS	Gas Chromatography/Mass Spectral Detector
HR	High Resolution
HRGC	High Resolution Gas Chromatography
HRMS	High Resolution Mass Spectral Detector
HWB	Hazardous Waste Bureau
IR	Ingestion Rate
IRIS	Integrated Risk Information System
LADD	Lifetime Average Daily Dose
mg/m^3	milligram per cubic meter
mg/kg	milligram per kilogram
mg/L	milligram per liter
ng/L	nanogram per liter
NMED	New Mexico Environment Department
PCB	Polychlorinated Biphenyl
PCDD	Polychlorinated Dibenzo-dioxins
PCDF	Polychlorinated Dibenzo-furans
pg/L	picogram per liter
ppb	parts per billion
ppm	parts per million
RCRA	Resource Conservation and Recovery Act
RfD	Reference Dose
SWMU	Solid Waste Management Unit
TCDD	2,3,7,8-tetrachloro-dibenzo-dioxin
TCDF	2,3,7,8-tetrachloro-dibenzo-furan
TEF	Toxicity Equivalency Factor
TEQ	Toxicity Equivalency Quotient

TRV	Toxicity Reference Value
TSS	Total Suspended Solids
US EPA	United States Environmental Protection Agency

Guidance for Risk-based Remediation of Polychlorinated Biphenyls at RCRA Corrective Action Sites

1.0 SCOPE

This document focuses on remedial activities at sites where polychlorinated biphenyls (**PCBs**) have been identified or are suspected of being present as one of the contaminants of potential concern. The intent of this document is to expedite the remedial action process and provide a cost-effective and consistent method for the evaluation and reduction of the risk posed to human health and the environment by PCBs.

This document **does not** discuss the complex regulations governing PCBs or the sampling methodologies for PCBs or other associated contaminants. This document **does** assume that the nature and extent of PCB contamination have been defined using a site conceptual model and **does** discuss and recommend analytical methods applicable to evaluating the risk to human and ecological health for PCBs in environmental media.

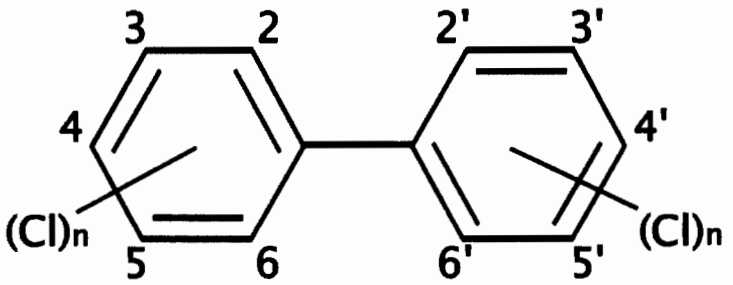
This paper **does not** discuss the risk posed to ground water quality by PCB contamination; state ground water standards and federal drinking water standards[2] exist for the protection of ground water. No state or federal soil/sediment standards exist to protect ground water from the transport of PCBs from contaminated soil/sediments; however, the risk associated with the transport of PCBs from contaminated soil/sediments to ground water should be evaluated to ensure that state and federal standards for ground water are not exceeded. Methods for the evaluation of this threat to ground water are **not**, at this time, specifically addressed in this document.

2.0 BACKGROUND INFORMATION

PCBs are a class of chlorinated organic compounds which found widespread application since their introduction into commerce in 1923. Their properties include thermal stability; resistance to acids, bases and oxidation; and resistance to direct electrical current. They were commonly used in transformers and capacitors, hydraulic and heat transfer equipment, compressors and vacuum pumps, plasticizers (surface coatings and sealants), and some paints and inks. Domestic production of commercial PCBs ceased in 1977; however, PCBs in existence at that time are still in use today.

The general chemical structure of chlorinated biphenyls is as follows:

[2]PCBs in ground water may not exceed the Safe Drinking Water Act's maximum contaminant level of 0.5 micrograms per liter (µg/L) in drinking water (Title 40 Code of Federal Regulations Parts 141-147 and 149) or the State of New Mexico's Water Quality Control Commission Regulations' standard of 1 µg/L in ground water with 10,000 milligrams per liter (mg/L) or less total dissolved solids (Title 20 New Mexico Annotated Code Chapter 6.2).



The number and position of chlorines in the biphenyl molecule determine the physical and chemical properties of the PCB molecule. There are a total of 209 possible *congeners*[3] of PCBs, each one resulting from the chlorination of different substitution positions and varying degrees of chlorination. In general, PCB molecules with higher degrees of chlorination are more resistant to biodegradation and are more persistent in the environment.

PCB congeners may be found in commercial preparations or complex mixtures known by the names Askarel, Aroclor, Clophen, Phenoclor, Kanechlor, and Pyralène. In the United States, PCB mixtures were marketed under the trade name of Aroclor. Each Aroclor has a four-digit numeric designation: the first two digits are "12" (indicating the biphenyl parent molecule) followed by two more digits indicating the percent chlorine content by weight in the mixture. For example, Aroclor 1254 has 54% chlorine by weight. Aroclor 1016 is the exception: it contains 41% chlorine by weight (ATSDR, 1995).

PCBs are a group of environmentally persistent organic chemicals that possess the inherent properties of compounds that bioaccumulate (i.e., high octanol/water partition coefficient and low water solubility). PCBs also have the following properties of environmental relevance: low vapor pressure and low flammability.

PCBs are toxic to humans and other animals (Eisler, 1986; ATSDR, 1995; and US EPA, 1996 and 1997a). PCBs adversely impact reproduction in wildlife and in experimental animals. Other common toxic effects in mammals and birds include thymic atrophy (a wasting syndrome), microsomal enzyme induction, porphyria (manifestations include intermittent nervous system dysfunction and/or sensitivity of skin to sunlight) and related liver damage, chloracne, estrogenic activity, immunosuppression, and tumor promotion. PCBs can be transferred to young mammals (including humans) transplacentally and in breast milk.

The United States Environmental Protection Agency (**US EPA**) and International Agency for Research on Cancer classified PCBs as Group B2; probable human carcinogens, based on sufficient evidence of carcinogenicity (manifested as hepatocellular carcinomas) in experimental animals and inadequate (due to confounding exposures to other potential carcinogens or lack of exposure quantification), yet suggestive evidence of excess risk of liver cancer in humans (US EPA, 2010). Recent studies have indicated that all PCB mixtures can cause cancer; however,

[3]*Congener* means any single, unique, well-defined chemical compound in the PCB category.

different mixtures exhibit different carcinogenic potencies (Cogliano, 1998). In addition, environmental processes may alter the PCB mixtures affecting its carcinogenic potency (see *Environmental Processes*).

The stability and lipophilicity of PCBs promote their biomagnification (i.e., the uptake of a chemical through ingestion resulting in the concentration of the chemical in tissue being greater than that of its food) once they enter the aquatic and terrestrial food chains. Through the food chain, living organisms selectively bioaccumulate persistent congeners of PCBs. Environmentally-aged PCB mixtures appear to be more toxic and persistent in the organism than commercial PCB mixtures. Biomagnification through trophic transfer governs PCB levels in animals, especially those occupying the top of the food web. Therefore, PCBs in food sources represent the most important exposure source to humans and wildlife.

In certain situations, PCBs can become contaminated with the far more toxic polychlorinated dibenzofurans (**PCDFs**) and chlorinated dibenzo-dioxins (**PCDDs**). Therefore, the presence of PCDFs and PCDDs should always be investigated if any of the following processes existed or are suspected of existing:

- combustion or incineration of PCB-contaminated waste or waste oils, or highly variable waste streams (such as municipal and commercial waste for which PCB contamination is suspected);
- manufacture of PCBs[4];
- pyrolysis of PCBs;
- photolysis of PCBs;
- incidental fire of transformers and capacitors containing PCBs; or
- treatment with chlorinating compounds (e.g., hydrochloric acid, chlorine, etc.).

3.0 ENVIRONMENTAL PROCESSES

PCBs occur as mixtures of congeners in the environment. *Partitioning*[5], chemical and biological transformation, and preferential bioaccumulation may change the composition of the PCB mixture over time: the environmentally-aged PCB mixture may vary considerably from the original congener composition (US EPA, 1996b and ATSDR, 1995). Altered PCB mixtures have been known to persist in the environment for many years.

PCBs adsorb to organic matter, sediments, and soil. Their affinity to adsorb increases with the chlorine content of the PCBs and the amount of organic matter present. PCBs can volatilize or disperse as aerosols providing an effective means of transport in the environment. Congeners with low chlorine content tend to be more volatile and more water soluble.

[4]The concentration of PCDFs in commercial PCB samples ranged from 0.2 micrograms per gram (µg/g) to 13.6 µg/g (ATSDR, 1993). Eisler (1986) reported PCDFs impurities ranging from 0.8 to 33 milligrams per kilogram (mg/kg) in some domestic and foreign PCB mixtures.

[5]*Partitioning* includes environmental processes by which different fractions of a mixture separate into air, water, sediment, and soil.

The highly chlorinated Aroclors (Aroclor 1248, 1254, and 1260) resist both chemical and biological transformation (i.e., degradation) in the environment. Biological degradation of highly chlorinated Aroclors to lower chlorinated PCBs can occur under anaerobic conditions[6]. The extent of this dechlorination[7] is limited by the PCB chlorine content and soil/sediment PCB concentrations. Anaerobic bacteria in soil/sediments remove chlorines from low chlorinated PCBs (1 to 4 chlorines) and open the carbon rings through oxidation. PCBs with higher chlorine content are extremely resistant to oxidation and hydrolysis. Photolysis can also slowly break down highly chlorinated PCB congeners.

PCBs bioaccumulate and biomagnify through the food chain because they are highly lipid-soluble. The mixture of congeners found in biotic tissue will differ dramatically from the mixture of congeners originally released to the environment because bioaccumulation and biomagnification concentrate PCB congeners of higher chlorine content up through the food chain. This is because different congeners can exhibit different rates of metabolism and elimination in living organisms (Van den Berg, et al., 1998 and Cogliano, 1998).

By altering the congener composition of PCB mixtures, these environmental processes can substantially increase or decrease the toxicity of environmental PCBs mixture (Cogliano, 1998). Therefore, information on these environmental processes along with the results of congener-specific analyses of environmental and biota samples should be used to substantiate modeling of exposure to and health risks resulting from environmental PCBs.

4.0 PCB CLEANUP LEVELS

PCB-contaminated soil/sediments should be remediated to either 1) a default concentration of 1 mg/kg or part per million (**ppm**) *total PCBs* (defined as the sum of congeners, Aroclors or *homologues*[8]), 2) a risk-based generic screening level (see media-specific screening levels in Appendix A of Volume 1) or 3) a *site-specific risk-based PCB concentration level*[9] established through performing a health risk evaluation. Site-specific risk-based PCB concentrations may be calculated from equations presented in *Risk Evaluation*. Once the calculations have been completed for all receptors, the lowest computed risk-based PCB concentration in a medium would represent the PCB remediation goal for that medium. These PCB remediation goals may be refined, if necessary, in the higher-level, site-specific risk assessment.

Table D-1 presents the corrective action cleanup options for the remediation of PCB-contaminated soil/sediments and data quality recommendations regarding the PCB analyses of environmental media samples.

---

[6]However, certain fungi have been demonstrated to degrade PCBs under aerobic conditions.

[7]Note that dechlorination is not synonymous with detoxification because it may result in the formation of carcinogenic congeners.

[8]A *homologue* is a subcategory of PCBs having an equal number of chlorine substituents. *Substituent* means an atom or group that replaces another atom or group in a molecule. PCB homologues can be quantified using EPA Method 680 or estimated using regression equations such as those found in NOAA, 1993.

[9]A *risk-based PCB concentration level* means the PCB concentration above which some adverse health effects may be produced in human and/or ecological receptors, and below which adverse health effects are unlikely to occur.

Table D-1. PCB Cleanup Options In Soil/Sediment and Data Quality Recommendations[10]

Cleanup Option	Corrective Action Steps		Data Quality Recommendations
Default Option 1	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 parts per billion [ppb] or 1 ppb, respectively) in environmental media
	2	Remediate to 1 ppm	
	3	Conduct post-remediation monitoring, as necessary	
Default Option 2	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 parts per billion [ppb] or 1 ppb, respectively) in environmental media
	2	Remediate to generic risk-based screening level (See Appendix A of Volume 1))	
	3	Conduct post-remediation monitoring, as necessary	
Site-Specific, Risk-Based	1	Delineate the nature and horizontal and vertical extent of contamination	Estimate total PCBs as the sum of Aroclors or homologues (using a quantitation limit of 50 ppb or 1 ppb, respectively) and/or congener-specific environmental and biota concentrations (using a quantitation limit in the low parts per trillion)
	2	Perform health risk evaluation	
	3	Establish risk-based concentrations for all human and environmental receptors	
	4	Remediate to the lowest risk-based concentration	
	5	Conduct post-remediation monitoring, as necessary	

The following is a listing of potential PCB target analytes[11]. The 12 PCB congeners indicated in boldface italics are those which are recommended for quantitation as potential target analytes when performing a risk-based cleanup. The 16 additional congeners listed in plain text may provide valuable information, but are not required for the evaluation of risk. The analyses of all 209 congeners would greatly improve the estimate of total PCB concentrations.

[10]Modified from Valoppi, et al., 1999.

[11]The number in parentheses refers to the identification system used to specify a particular congener.

Table D-2. Potential PCB Target Analytes

2,4'-Dichlorobiphenyl (8)	2,2',3,4,4',5'-Hexachlorobiphenyl (138)
2,2',5-Trichlorobiphenyl (18)	2,2',4,4',5,5'-Hexachlorobiphenyl (153)
2,4,4'-Trichlorobiphenyl (28)	***2,3,3',4,4',5-Hexachlorobiphenyl (156)***
2,2',3,5'-Tetrachlorobiphenyl (44)	***2,3,3',4,4',5'-Hexachlorobiphenyl (157)***
2,2',5,5'-Tetrachlorobiphenyl (52)	***2,3',4,4',5,5'-Hexachlorobiphenyl (167)***
2,3',4,4'-Tetrachlorobiphenyl (66)	***3,3',4,4',5,5'-Hexachlorobiphenyl (169)***
3,3',4,4'-Tetrachlorobiphenyl (77)	2,2',3,3',4,4',5-Heptachlorobiphenyl (170)
3,4,4',5-Tetrachlorobiphenyl (81)	2,2',3,4,4',5,5'-Heptachlorobiphenyl (180)
2,2'4,5,5'-Pentachlorobiphenyl (101)	2,2',3,4',5,5',6-Heptachlorobiphenyl (187)
2,3,3',4,4'-Pentachlorobiphenyl (105)	***2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)***
2,3,4,4',5-Pentachlorobiphenyl (114)	2,2',3,3',4,4',5,6-Octachlorobiphenyl (195)
2,3',4,4',5-Pentachlorobiphenyl (118)	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (206)
2',3,4,4',5'-Pentachlorobiphenyl (123)	2,2',3,3',4,4',5,5',6,6'-Decachlorobiphenyl (209)
3,3',4,4',5-Pentachlorobiphenyl(126) 2,2',3,3',4,4'-Hexachlorobiphenyl (128)	

The 16 PCB congeners in plain text have been indicated as target analytes by the National Oceanic and Atmospheric Administration based on their toxicity, ubiquitousness in the marine environment, presence in commercial Aroclor mixtures, etc. (NOAA, 1993).

5.0 ANALYTICAL METHODS

Aroclors are often used to characterize PCB exposures; however, the use of Aroclors in estimating the human health or ecological risk can be both imprecise and inappropriate because the PCB mixtures to which humans and other biota may be exposed may be considerably different from the original Aroclor mixtures released to the environment. In addition, traditional analytical methods for Aroclor analyses produce estimates that are prone to errors. Both qualitative and quantitative errors may arise from interpreting gas chromatography (**GC**) data.

GCs configured with electron capture detectors (**ECD**) or electrolytic conductivity detectors (**ELCD**) are particularly prone to error. The GC/ECD and GC/ELCD produce a chromatogram that is compared with the characteristic chromatographic patterns of the different Aroclors (US EPA, 1996a). For environmentally weathered and altered mixtures, an absence of these characteristic patterns can suggest the absence of Aroclors even if some congeners are present in high concentrations. Additionally, and commonly, the presence of interferents may also mask the characteristic response pattern of the Aroclors. The "pattern recognition" technique is inherently subjective, and different analysts may reach different conclusions regarding the presence or absence of Aroclors.

GCs configured with mass spectral detectors (**GC/MS**) allow identification of individual chemical compounds. GC/MS also produces a chromatogram, and additionally includes mass spectral information about the chemical identity of each peak in the chromatogram. Therefore, GC/MS adds a qualitative line of evidence above that included in GC/ECD or GC/ELCD techniques. GC/MS may be subject to interference, misinterpretation, or other problems.

High resolution (**HR**) isotope dilution GC/high resolution MS (**HRGC/HRMS**), while not as common technique as GC-ECD or GC-MS, is a specific GC/MS technique that has proven reliable for PCB analysis. In HRGC/HRMS exhaustive sample clean-up techniques are employed, and isotopic tracers are used to support identification.

Therefore, the HWB recommends the use of HRGC/HRMS analyses in evaluating health risks to humans and the environment. If HRGC/HRMS methods are not employed, then site specific data must be used to demonstrate that the methods employed are appropriate to the site, or HRGC/HRMS confirmation must be integrated into the analytical plan, for instance on a one in 20 sample basis, or a for a minimum number of samples, or as otherwise agreed. Both detections and non-detections should be confirmed.

Results of GC techniques may be expressed as Aroclors, congeners, homologues, or as total PCBs in units of weight/weight [mg/kg, µg/kg, nanogram per kilogram (ng/kg)] or weight/volume [µg/L or pictogram per liter (pg/L)]. It is necessary to specify the reporting requirements prior to analysis and negotiate the analytical list and reporting limits. Results must be reported on a dry weight basis for soil, sediment and waste samples (excluding liquids).

In addition to the traditional GC analysis, a number of biological and immunological assays are now available, as well as field GC. These may be suited for use as screening methods to guide day-to-day remediation efforts, but are not suited to evaluating health risks to humans and the environment as stand-alone methodologies.

Table D-3. Analytical Methods for PCBs

Method	Technology	Report As[1]	Approximate Detection Limits	Comments
SW-846 8082A	GC/ECD or GC/ELCD	Aroclors Congeners	50-100 µg/kg	Must supply site-specific performance data or use HRGC/HRMS confirmation
SW-8270D	GC/MS	Aroclors	>1000 µg/kg[2]	Detection limits may not support project data quality objectives
SW-846 8275A	GC/MS	Congeners	200 µg/kg	
Method 1668B	HRGC/HRMS	Congeners	<1µg/kg, often in the ng/kg range[2]	Use this method for confirmation

NOTES:
[1]Reporting types have been limited to those mentioned in the subject methods. Laboratories may offer additional reporting modalities, such as homologues and total PCBs.
[2]Detection Limits not specified in the method. Various sample preparation options and matrix effects may affect results

6.0 STORM WATER RUNOFF MONITORING RECOMMENDATIONS

The potential for transport to human or ecological receptors (including ground and surface water) should be evaluated for all corrective action sites impacted or suspected of being impacted by PCBs. PCB concentrations in storm water runoff resulting from contaminated soil/sediments should be monitored **and** the soils remediated to ensure that there is no release or runoff from the Solid Waste Management Unit (**SWMU**) or Area of Concern (**AOC**) which results in a total PCB concentration in excess of the Clean Water Act (**CWA**)-recommended freshwater aquatic life chronic criterion of 0.014 µg/L[12] (unfiltered water) to a *water of the State.*[13] Likewise, concentrations of PCB-contaminated stream bottom, lake or reservoir deposits should not result in total PCB concentrations in unfiltered water which exceeds the CWA-recommended freshwater aquatic life chronic criterion of 0.014 µg/L.

The evaluation of a site's PCB concentrations and erosion potential will aid in determining and prioritizing the corrective actions and best management practices (**BMPs**) necessary to protect surface water quality. Each facility should develop a method for evaluating the erosion potential[14] and present the methodology to the NMED HWB for approval prior to implementation. This evaluation should be conducted on all known or suspected PCB sites. All PCB sites with elevated erosion potentials should implement BMPs to reduce transport of PCB-contaminated sediments and soils. BMP effectiveness should be evaluated and monitored regularly through a formalized inspection and maintenance program. BMPs should be implemented as interim actions or stabilization measures which are consistent with a final remedy and should not be misconstrued as a final remedy.

NMED's HWB believes that controlling the total suspended solids (**TSS**) load of storm water runoff may effectively control PCB migration in surface water because PCBs are hydrophobic, tend to adsorb to soil and organic particles, and are transported in suspended sediments during storm runoff events. Therefore, the TSS should be monitored to aid in predicting and, therefore, potentially controlling the transport of PCBs into *watercourses*[15].

Storm water samples should be collected from storm water events which are greater than 0.1 inches in magnitude (US EPA, 1992). Grab samples should be collected within the first 30 minutes or as soon as practical, but not more than 1 hour after runoff discharge begins. A sufficient quantity of runoff should be collected (i.e., 5 liters) because additional analyses for PCBs may be required based upon the TSS analytical results. The runoff samples should be analyzed for TSS using Method 2540D of the most recent edition of the *Standard Methods for the Examination of Water and* Wastewater.

---

[12]This concentration is the Clean Water Act §304(a) recommended chronic criterion for aquatic life (http://water.epa.gov/scitech/swguidance/standards/current/index.cfm).

[13]*Water(s) of the State* means all interstate and intrastate water including, natural ponds and lakes, playa lakes, reservoirs, perennial streams and their tributaries, intermittent streams, sloughs, prairie potholes and wetlands (Title 20 New Mexico Annotated Code Chapter 6.1).

[14]NMED HWB recommends the approach to evaluating erosion potential presented in the *Matrix Approach to Contaminant Transport Potential* (Mays and Veenis, 1998).

[15]*Watercourse* means any river, creek, arroyo, canyon, draw, or wash, or any other channel having definite banks and beds with visible evidence of the occasional flow of water (Title 20 New Mexico Annotated Code Chapter 6.1).

Grab samples should be used for monitoring. Composite samples may **not** be used for monitoring; however, flow-weighted composite samples may be used in the development and validation of storm water contaminant transport modeling.

The following bullets describe recommended trigger levels and actions based on the analytical results of TSS analyses:

- If TSS is less than 100 mg/L, no action is required.
- If TSS is greater than 100 mg/L, but less than 1,000 mg/L, then the effectiveness of existing BMPs should be evaluated and repaired as necessary, and additional BMPs may need to be implemented to reduce TSS loading
- If the TSS is greater than 1,000 mg/L, then the remaining portion of the sample should be centrifuged and the solids analyzed for PCBs using EPA SW-846 Method 8082 (US EPA, 1997d), EPA Method 680, or draft EPA Method 1668 (Alford-Stevens, et al., 1985 and US EPA, 1996a).

7.0 RISK EVALUATION

The risk to human health and the environment must be evaluated for all corrective action *solid waste management units/areas of contamination*[16] **(SWMU/AOCs)** impacted or suspected of being impacted by PCBs and having a potential for transport to a human or ecological receptor. The risk posed by PCBs at these SWMU/AOCs may be modeled (based on adequate available data) and should be monitored to ensure an acceptable level of risk[17] (see *Storm Water Runoff Monitoring Recommendations).*

As discussed in *Environmental Processes*, the congener composition of environmentally-aged PCBs can dramatically differ from the original Aroclor mixture released to the environment. Consequently, environmental processes can affect both exposure to, and toxicity of, environmental PCBs. Therefore, the approach to evaluating health risks from environmental PCBs differs depending upon whether the PCB congener- or Aroclor-specific (or homologue-specific) data are available for the environmental media (see also *PCB Cleanup Levels*).

PCB congeners with chlorine atoms in positions 2 and 6 (ortho) are generally more readily metabolized, while those with chlorines in positions 4 and 4' (para) or positions 3, 4 or 3, 4, 5 on one or both rings tend to be more toxic and are retained mainly in fatty tissues (Eisler, 1986). Persistent congeners may retain biological activity long after the exposure. The most toxic PCB

[16] *SWMU* means "any discernable unit at which solid wastes have been placed at any time, irrespective of whether the unit was intended for the management of solid or hazardous waste. Such units include any area at a facility at which solid wastes have been routinely and systematically released." *AOC* "...refers to releases which warrant investigation or remediation under the authorities discussed above, regardless of whether they are associated with a specific SWMU..."

[17] A risk or hazard is considered *acceptable* if an estimated risk/hazard is below pre-established target risk and/or hazard levels.

congeners can assume a conformation, generally similar to that of 2, 3, 7, 8-tetrachloro-dibenzo-dioxin (**TCDD**), and are approximate stereo analogs of this compound (Hoffman, et al., 1996).

These dioxin-like congeners share a common mechanism of toxicity involving binding to the aryl hydrocarbon receptor; the same mechanism of action is believed to induce the toxicity of PCDDs and PCDFs. These congeners were assigned toxicity equivalency factors (**TEFs**) expressed as a fraction of the toxicity of 2,3,7,8-TCDD. Therefore, when PCB congener-specific analytical data are available, risk evaluation of human and ecological health should consider both dioxin-like and other adverse health effects. Two sections within this document (*Human Health, Carcinogenic Effects, Dioxin-like Toxicity Approach* and *Ecological Health, Dioxin-like PCBs*) provide guidance for applying these TEFs where congener-specific analyses are available. If only Aroclor/homologue concentrations are available for a site, total PCB concentrations reported as the sum of Aroclor/homologue concentrations should be used to estimate the risk to human health and the environment.

If a health risk evaluation is based on total PCB concentrations (estimated as the sum of Aroclors or PCB homologues) and the individual congeners comprising the PCB mixtures cannot be identified, the uncertainty and potential bias in the resulting risk estimates should be described in the risk assessment report. For example, if total PCB concentrations have been estimated based on Aroclor analyses, conservative assumptions should be made about the mixture composition and toxicity: the assumption that congeners with greater than four chlorines per PCB molecule comprise greater than 0.5% of total PCBs present in a given abiotic medium at the site triggers the selection of the highest cancer slope factor from Table D-3. Whereas, total PCB concentrations estimated based on the results of PCB homologue analyses may allow for a refinement of these conservative assumptions. More detailed information on an approach to evaluating the health risk from environmental PCBs and PCB data requirements can be found in US EPA (1996b); Van den Berg, et al. (1998); Cogliano (1998); Giesy and Kannan (1998) and Valoppi, et al. (1999).

7.1 Human Health

Since PCBs may cause both carcinogenic and non-carcinogenic adverse human health effects, separate risk assessments must be performed for each of these health effects.

7.1.1 Carcinogenic Effects

The evaluation of carcinogenic risk from exposure to PCB mixtures (i.e., represented by total PCBs or PCB congeners) should follow the slope factor approach described in *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures* (US EPA, 1996b) and as outlined below. This approach distinguishes among toxic potencies of different PCB mixtures by utilizing information regarding environmental processes. In the absence of PCB congener- or homologue-specific analyses (i.e., if total PCB concentrations were estimated based on Aroclor analyses), this approach requires conservative assumptions about the risk and persistence of PCB mixtures at the site.

If congener-specific concentrations are available and congener analyses indicate that congeners with more than 4 (four) chlorines comprise greater that 0.5 percent of total PCBs in a given medium, the slope factor approach should be supplemented by the analysis of dioxin toxicity equivalency quotient (**TEQ**). Risk from *dioxin-like congeners*[18] should be added to the risk estimated for the rest of the PCB mixture which does not exhibit dioxin-like toxicity.

If other dioxin-like compounds (i.e., PCDDs and/or PCDFs) are present at a site in addition to PCBs, TEQs for dioxin-like PCBs should be added to TEQs calculated for those other dioxin-like compounds to yield a total TEQ. A slope factor for 2,3,7,8-TCDD should be applied to this total TEQ. Under these circumstances, the concentrations of dioxin-like PCBs should be subtracted from the total PCB concentration to avoid overestimating risks from dioxin-like PCBs by evaluating them twice.

7.1.1.1 Slope Factor Approach

Site-specific carcinogenic risk evaluations should be performed using PCB cancer potency or slope factors specific to the exposure scenarios and pathways at a particular site. Table D-3 provides the criteria for using these slope factors (categorized into high, medium, and low levels of risk and PCB persistence) that address a variety of exposure scenarios and the toxicity of PCB mixtures in the environment. A review of recent research on PCB toxicity that formed the basis for the derivation of these slope factors and a discussion of uncertainties surrounding toxicity information can be found in US EPA (1996b) and Cogliano (1998).

The slope factors in Table D-4 represent the upper-bound slopes that are recommended for evaluating human health risk from carcinogenic effects of PCBs. Both the upper-bound and central-estimate slopes are available from the US EPA's Integrated Risk Information System (**IRIS**). The central-estimate slopes can be used to support the analysis of uncertainties inherent in available toxicity information on PCBs.

[18] *Dioxin-like congeners* of PCBs are those with dioxin-like health effects and are evaluated using dioxin TEQs (Van den Berg, et al., 1998). A complete listing of PCB congeners can be found at http:\\www.epa.gov/grtlakes/toxteam/pcbid/table.htm (US EPA's Great Lakes website).

Table D-4. PCB Cancer Slope Factor Values by Level of Risk and Persistence[19]

CRITERIA FOR USE	LEVEL OF RISK AND PERSISTENCE	PCB CANCER SLOPE FACTOR VALUES[20] [risk per mg/kg-day]
Food chain exposure	High	2.0
Sediment/soil ingestion		
Dust/aerosol inhalation		
Dermal exposure (if an absorption factor has been applied)		
Presence of dioxin-like, tumor-promoting, or persistent congeners		
Early-life (less than 6 years old) exposure by all pathways and to all mixtures		
Congeners with greater than four chlorines per PCB molecule comprise greater than 0.5% of the total PCBs present		
Congeners with greater than four chlorines per PCB molecule comprise less than 0.5% of the total PCBs present (all pathways except soil ingestion by adults)		
Ingestion of water-soluble (less chlorinated) congeners	Medium	0.4
Inhalation of evaporated (less chlorinated) congeners		
Dermal exposure (if no absorption factor has been applied)		
Congeners with greater than four chlorines per PCB molecule comprise less than 0.5% of the total PCBs present (soil ingestion by adults only)	Low	0.07

The cancer slope factors in Table D-3 characterize the toxic potency of different environmental mixtures of PCBs. Information on potential exposure pathways and PCB mixture composition at a given site guides in the selection of the appropriate cancer slope factors for risk assessment.

The highest slope factor in Table D-3 (2.0 per mg/kg-day) corresponds to the high risk and persistence of environmental PCB mixtures and, as such, should be selected for pathways (including food chain exposures, ingestion of soil and sediment, inhalation of dust or aerosol,

[19]Modified from Cogliano, 1998 and US EPA, 1996b and 1998c.

[20]See IRIS (US EPA, 2011).

exposure to dioxin-like, tumor-promoting or persistent congeners, and early-life exposure) where environmental processes act to increase risk.

A lower slope factor (0.4 per mg/kg-day) corresponds to the low risk and persistence of environmental PCB mixtures and is appropriate for exposure pathways (such as ingestion of water-soluble congeners and inhalation of evaporated congeners) where environmental processes act to decrease risk.

Finally, the lowest slope factor in Table D-3 (0.07 per mg/kg-day) corresponds to the lowest risk and persistence of environmental PCB mixtures and should be selected for soil ingestion by adults when congener or homologue analyses confirm that congeners with greater than four chlorine atoms per PCB molecule comprise less than 0.5% of the total PCBs present at the site.

Once the appropriate slope factor has been selected, it is multiplied by a lifetime average daily dose (**LADD**) to estimate the risk of cancer (see US EPA, 1996b for sample risk calculations). Because the use of Aroclors to characterize PCB exposures can be both imprecise and inappropriate, total PCBs or congener analyses should be used in the following LADD calculation:

$$\mathbf{LADD = (C_T \times IR \times ED \times EF) / (BW \times AT)} \qquad \textit{Equation D-1}$$

Where:

LADD	=	Lifetime average daily dose (mg/kg-day)
C_T	=	Total PCBs or total non-dioxin-like congener concentration in a medium (mg/L [water], mg/kg [soil], or milligram per cubic meter (mg/m^3) [air])
IR	=	Intake rate (L/day [water], mg/day [soil], or mg/m^3 [air])
ED	=	Exposure duration (years)
EF	=	Exposure frequency (days/year)
BW	=	Average body weight of the receptor over the exposure period (kg)
AT	=	Averaging time - the period over which exposure is averaged (days)[21]

The cancer slope factors and recommended Aroclor fate and transport properties (Table D-5), should be used to evaluate the carcinogenic risk posed by PCB mixtures or PCB congeners which do not exhibit a dioxin-like toxicity.

[21]For carcinogens, the averaging time is 25,550 days based on a lifetime exposure of 70 years.

Table D-5. Cancer Slope Factors and Fate & Transport Properties For PCBs

	CRITERIA: Congeners with equal to or greater than four (4) chlorines comprise . . .	CARCINOGENIC EFFECTS	
		Dioxin-like PCBs	Other PCB Congeners[22]
CANCER SLOPE FACTORS[23] $(mg/kg\text{-}day)^{-1}$	. . . **greater than 0.5%** of the total PCBs present	1.3E+05[24]	2.0
	. . . **less than 0.5%** of the total PCBs present	NA[25]	0.07
FATE & TRANSPORT PROPERTIES	. . . **greater than 0.5%** of the total PCBs present	Aroclor 1254	Aroclor 1254
	. . . **less than 0.5%** of the total PCBs present	Aroclor 1016	Aroclor 1016

For example, if a PCB mixture contains 45% congeners with greater than four chlorines, the cancer slope factor for 2,3,7,8-TCDD and the fate and transport properties of Aroclor 1254 would be used.

If the following special exposure conditions exist, a slope factor of 0.4 may be applied to PCBs which do not exhibit dioxin-like toxicity: ingestion of water-soluble congeners, inhalation of evaporated congeners or dermal exposure (with no applied absorption factor).

7.1.1.2 Dioxin-like Toxicity Approach

Dioxin-like PCBs are some of the moderately chlorinated PCB congeners (see Table D-5) which have been demonstrated to produce dioxin-like effects[26] in humans. The dioxin-like toxicity approach should be implemented **only** when congener-specific concentrations are available for environmental media at a site. In this approach, individual dioxin-like PCB congener concentrations are multiplied by TEFs that represent the potency of a given congener relative to 2,3,7 8-TCDD (see Table 2-2 in Volume I).

[22] *Other PCB congeners* mean those congeners which do not exhibit dioxin-like toxicity.

[23] PCB cancer slope factors can be found in IRIS (US EPA, 2010).

[24] US EPA, 2011

[25] *NA* means not applicable. Do not evaluate dioxin-like PCBs if they comprise less than 0.5% of the total PCBs present; evaluate the other PCB congeners.

[26] Dioxin-like congeners can react with the aryl hydrocarbon receptor, the toxicity mechanism that is believed to initiate the adverse effects of PCDDs and PCDFs.

Table 2-2 of Volume I lists the TEF values derived for dioxin-like PCB congeners. Using TEF values in the risk evaluation allows for the estimation of a combined risk resulting from an exposure to a mixture of dioxin-like PCB congeners (assuming that the risks are additive).

The carcinogenic risk resulting from exposure to dioxin-like PCBs should be estimated by calculating the TEQ. The TEQ is the sum of each congener-specific concentration in the medium multiplied by its corresponding congener-specific TEF value. Multiplying the congener-specific medium concentration by the corresponding congener-specific TEF value provides a relative (i.e., "toxicity-weighted") measure of the dioxin concentration within a medium.

The TEQ for dioxin-like PCBs should be calculated as indicated in the following equation:

$$\mathbf{TEQ = \Sigma\ (C_{mi} \times TEF_i)} \qquad \textit{Equation D-2}$$

Where:

TEQ	=	Toxicity equivalency quotient (mg/L [water] or mg/kg [soil or sediment])
C_{mi}	=	Concentration of *i*th congener in medium (mg/L [water] or mg/kg [soil or sediment])
TEF_i	=	Toxicity equivalency factor for *i*th congener (unitless)

Once the dioxin TEQ has been determined, the LADD should be calculated using the following equation:

$$\mathbf{LADD = (TEQ \times IR \times ED \times EF) / (BW \times AT)} \qquad \textit{Equation D-3}$$

Where:

LADD	=	Lifetime average daily dose (mg/kg-day)
TEQ	=	Toxicity equivalency quotient (mg/L [water], mg/kg [soil], or mg/m^3 [air])
IR	=	Intake rate (L/day [water], mg/day [soil], or mg/m^3 [air])
ED	=	Exposure duration (years)
EF	=	Exposure frequency (days/year)
BW	=	Average body weight of the receptor over the exposure period (kg)
AT	=	Averaging time - the period over which exposure is averaged (days)

The following equation can be used to estimate carcinogenic risk from dioxin-like PCBs:

$$\mathbf{Cancer\ Risk = LADD \times CSF_{TCDD}} \qquad \textit{Equation D-4}$$

Where:

LADD	=	Lifetime average daily dose (mg/kg-day)
CSF_{TCDD}	=	Cancer slope factor for 2,3,7,8-TCDD[27]

7.1.2 Non-Carcinogenic Effects

For Aroclors having reference doses (**RfDs**) specified in IRIS (e.g., Aroclor 1254, 1016, etc.), the non-carcinogenic risk should also be evaluated. The evaluation of non-carcinogenic risk should follow the approach typical for other non-PCB chemicals. However, fate and transport properties of the recommended Aroclor (see Table D-6) should be used to evaluate the risk posed.

Table D-6. Toxicological and Fate & Transport Properties For PCBs With Human Health Non-Carcinogenic Effects and Ecological Health Non-Dioxin-Like Effects

CRITERIA: Congeners with equal to or greater than four (4) chlorines comprise . . .	**NON-CARCINOGENIC EFFECTS AND FATE AND TRANSPORT PROPERTIES**
. . . **greater than 0.5%** of the total PCBs present	Aroclor 1254
. . . **less than 0.5%** of the total PCBs present	Aroclor 1016

The RfD derived for Aroclor 1254 should typically be used when conducting a risk assessment. The RfD derived for Aroclor 1016 can be used when at least 99.5% of the mass of the PCB mixture has fewer than four (4) chlorine atoms per molecule as determined by a chromatography/spectroscopy analytical method. Using Table D-6, determine which Aroclor most accurately represents the PCB mixture of concern. Use the RfD and fate and transport properties of this Aroclor as a surrogate to evaluate the non-carcinogenic effects of the PCB mixture.

7.2 Ecological Health

Since PCBs adversely impact both community- and class-specific guild measurement receptors, risks must be estimated for each receptor within both groups. Plants and invertebrates should be evaluated as community measurement receptors (see *Exposure Assessment for Community Measurement Receptors*).

[27]The cancer slope factor for 2,3,7,8-TCDD should be obtained from the most recent IRIS (US EPA, 2010) or HEAST (US EPA, 1997b). The current oral cancer slope factor for 2,3,7,8-TCDD of 1.3E+05 $(mg/kg\text{-}day)^{-1}$ is based on the administered dose from a 105-week dietary rat study and was adopted for inhalation exposure (US EPA, 2011).

When congener-specific concentrations are available, risk from exposure to dioxin-like PCBs should be estimated separately and added to the risk estimated for the remainder of the PCB mixture which does not exhibit dioxin-like toxicity. The resulting risk is likely to be overestimated if toxicity data from total PCBs is applied to those congeners which do not exhibit dioxin-like toxicity. This overestimation of risk should be addressed within the uncertainty analysis of the risk assessment report.

In the absence of PCB congener-specific data, total PCB concentrations, reported as the sum of Aroclor or homologue concentrations, should be used to estimate receptor exposure to PCBs and the toxicity value of the most toxic Aroclor present should be used in the site-specific ecological risk assessment.

7.2.1 Dioxin-like PCBs

Ecological risks to community- and class-specific guild measurement receptors from dioxin-like PCBs should be estimated by calculating a TEQ and then dividing it by the toxicity value for 2,3,7,8-TCDD (which is assumed to be the most toxic dioxin).

If in addition to PCBs, other dioxin-like compounds (i.e., PCDDs and/or PCDFs) are present at a site, TEQs for dioxin-like PCBs should be added to the TEQs calculated for those other dioxin-like compounds to yield a total TEQ. The 2,3,7,8-TCDD toxicity value should be applied to this total TEQ. For this evaluation, the concentrations of dioxin-like PCBs should be subtracted from the total PCB concentrations to avoid overestimating risks from dioxin-like PCBs by evaluating them twice.

The TEF values listed in Table 2-1 of Volume I and in Table D-7 below should be used in the TEQ calculation to convert the exposure media concentration of individual congeners to a relative measure of concentration within a medium.

Table D-7. Fish Toxicity Equivalency Factor Values For Dioxin-Like PCBs[28]

CONGENER	FISH TOXICITY EQUIVALENCY FACTOR VALUES[29]
3,3',4,4'-Tetrachlorobiphenyl (77)[11]	0.0001
3,4,4',5-Tetrachlorobiphenyl (81)	0.0005
2,3,3',4,4'-Pentachlorobiphenyl (105)	<0.000005[30]
2,3,4,4',5-Pentachlorobiphenyl (114)	<0.000005
2,3',4,4',5-Pentachlorobiphenyl (118)	<0.000005
2',3,4,4',5'-Pentachlorobiphenyl (123)	<0.000005
3,3',4,4',5-Pentachlorobiphenyl (126)	0.005
2,3,3',4,4',5-Hexachlorobiphenyl (156)	<0.000005
2,3,3',4,4',5'-Hexachlorobiphenyl (157)	<0.000005
2,3',4,4',5,5'-Hexachlorobiphenyl (167)	<0.000005
3,3',4,4',5,5'-Hexachlorobiphenyl (169)	<0.000005
2,3,3',4,4',5,5'-Heptachlorobiphenyl (189)	<0.000005

Because congener-specific fate and transport data are not available for each of the dioxin-like PCBs listed in Table 2-1 of Volume I and Table D-7, the fate and transport properties of Aroclor 1254 should be used in exposure modeling.

7.2.1.1 Exposure Assessment for Community Measurement Receptors

To evaluate the exposure of water, sediment and soil communities to dioxin-like PCBs, a media-specific TEQ should be calculated. The TEQ is the sum of each congener-specific concentration (in the respective media to which the community is exposed) multiplied by its corresponding congener-specific TEF value derived for fish (Table D-7).

The TEQ for community measurement receptors exposed to dioxin-like PCBs should be calculated as indicated in the following equation:

$$\mathbf{TEQ = \Sigma\ (C_{mi}\ x\ TEF_i)} \qquad \textit{Equation D-5}$$

Where:

[28]Modified from the *Report from the Workshop on the Application of 2,3,7,8-TCDD Toxicity Equivalency Factors to Fish and Wildlife* (US EPA, 1998b).

[29]The surrogate TEF values for fish are presented because invertebrate-specific TEF values have not yet been developed.

[30]For all fish TEFs of "<0.000005," use the value of 0.000005 as a conservative estimate.

TEQ = Toxicity equivalency quotient (µg/L [water] or µg/kg [dry weight soil or sediment])
C_{mi} = Concentration of *i*th congener in abiotic media (µg/L [water] or µg/kg [dry weight soil or sediment])
TEF_i = Toxicity equivalency factor (fish) for *i*th congener (unitless) (Table D-7)

Risk to the water, sediment or soil community is subsequently evaluated by comparing the media-specific TEQ to the media-specific toxicity value for 2,3,7,8-TCDD:

$$\textbf{Risk} = \textbf{TEQ} / \textbf{TRV}_{TCDD} \qquad \textit{Equation D-6}$$

where:
TEQ = Toxicity equivalency quotient (µg/L [water] or µg/kg [dry weight soil or sediment])
TRV_{TCDD} = Toxicity reference value for 2,3,7,8-TCDD (µg/L [water] or µg/kg [dry weight soil or sediment])

7.2.1.2 Exposure Assessment for Class-Specific Guild Measurement Receptors

To evaluate the exposure of class-specific guild measurement receptors to dioxin-like PCBs, congener-specific daily doses of food items (i.e., abiotic media, plants, animals, etc.) ingested by a measurement receptor ($\mathbf{DD_i}$) should be converted to a TEQ-based daily dose ($\mathbf{DD_{TEQ}}$). This DD_{TEQ} can subsequently be compared to the 2,3,7,8-TCDD toxicity values for an evaluation of the risk posed to class-specific guild measurement receptors.

The DD_{TEQ} for each measurement receptor should be calculated as shown in the following equation:

$$\mathbf{DD_{TEQ}} = \Sigma\, \mathbf{DD_i} \times \mathbf{TEF_{MR}} \qquad \textit{Equation D-7}$$

Where:
DD_{TEQ} = Daily dose of PCB TEQ (µg/kg fresh body weight-day)
DD_i = Daily dose of *i*th congener (µg/kg fresh body weight-day)
TEF_{MR} = Toxicity equivalency factor (specific to measurement receptor) (unitless) (Table D-8)

Risk to the class-specific guild being evaluated can be estimated by dividing the DD_{TEQ} by the toxicity reference value for 2,3,7,8-TCDD:

$$\textbf{Risk} = \textbf{TEQ} / \textbf{TRV}_{TCDD} \qquad \textit{Equation D-8}$$

Where:

[31]The congener-specific daily doses of food items ingested by a measurement receptor should be calculated in accordance with the most current EPA and/or State guidance.

DD_{TEQ} = Daily dose of PCB TEQ (µg/kg fresh body weight-day)
TRV_{TCDD} = Toxicity reference value for 2,3,7,8-TCDD (µg/kg fresh body weight-day)

7.2.2 Other PCB Congeners

In addition to the dioxin-like PCB congeners, the remaining PCBs should be evaluated like other bioaccumulating organic contaminants by assessing ecological risks to community- and class-specific guild measurement receptors. The fate and transport properties of Aroclor 1254[32] should be used in the exposure modeling when evaluating the risk from PCB mixtures containing congeners with equal to or greater than 4 chlorines in quantities **greater** than 0.5% of the total PCBs. And, the fate and transport properties of Aroclor 1016[33] should be used in the exposure modeling when evaluating risks from PCB mixtures containing **less** than 0.5 % of PCB congeners with more than 4 chlorines (see Table D-6).

8.0 CONCLUSION

PCBs, which are a class of organic compounds that are persistent in the environment, are toxic to both humans and biota. PCBs may in certain instances become contaminated with more toxic PCDFs and PCDDs. Therefore, the potential presence of these compounds should also be evaluated and possibly investigated.

Based on federal and state regulations and standards, the HWB recommends that PCB-contaminated sediment/soils be remediated to either 1 mg/kg total PCBs or the most stringent of the calculated health risk-based concentrations in order to adequately protect human health and the environment.

Unless soil/sediments are remediated to 1 mg/kg total PCBs, the risk posed by PCBs to human health and the environment should be evaluated using a risk-based approach. All corrective action SWMU/AOCs impacted or suspected of being impacted by PCBs and having a potential for transport to a human or ecological receptor should be evaluated and monitored, as necessary, to protect human health and the environment.

PCB concentrations in soil/sediments should also be protective of both surface water and ground water resources; PCB concentrations in surface water should not exceed 0.014 µg/L and PCB concentrations in ground water cannot exceed 0.5 µg/L (drinking water) or 1 µg/L in ground water with 10,000 mg/L or less total dissolved solids).

9.0 REFERENCES

Advances in Modern Environmental Toxicology, Volume XV, *Risk Assessment and Risk Management of Industrial and Environmental Chemicals*. Edited by Cothren, Mehuman,

[32]Approximately 77% of Aroclor 1254 is composed of PCB congeners with more than 4 chlorines.

[33]Approximately 99% of Aroclor 1016 is comprised of PCB congeners with 4 or less chlorines.

and Marcus and published by Princeton Scientific Publishing Co., Inc., Princeton, New Jersey, 1988.

Agency for Toxic Substances and Disease Registry (ATSDR). 1993. *Toxicological Profile for Chlorodibenzofurans*. US Department of Health and Human Services, Public Health Service. Atlanta, Georgia.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. *Toxicological Profile for Polychlorinated Biphenyls*. Draft for Public Comment. US Department of Health and Human Services, Public Health Service. Atlanta, Georgia.

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. *Toxicological Profile for Chlorinated Dibenzo-p-Dioxin*. Draft for Public Comment. US Department of Health and Human Services, Public Health Service, Atlanta, Georgia.

Alford-Stevens A., T.A. Bellar, J.W. Eichelberger, and W.L. Budde. November 1985. *Method 680: Determination of Pesticides and PCBs in Water and Soil/Sediment by Gas chromatography/Mass Spectrometry*. US EPA Office of Research and Development, Cincinnati, Ohio.

Cogliano J. V. 1998. *Assessing the Cancer Risk from Environmental PCBs*. Environmental Health Perspectives, Volume 106, Number 6, pp. 317-323

Eisler R. 1986. *Polychlorinated Biphenyl Hazard to Fish, Wildlife, and Invertebrates: A synoptic Review*. Contaminant Hazard Reviews Report No. 7, Biological Report 85 (1.7), 72 p. US Department of Interior, Fish and Wildlife Service.

Giesy J. P. and K. Kannan. 1998. *Dioxin-Like and Non-Dioxin-Like Toxic Effects of Polychlorinated Biphenyls (PCBs): Implications for Risk Assessment*. Critical Reviews in Toxicology, Volume 28, Number 6, pp. 511-569.

Hoffman D. J., C. P. Rice, and T. J. Kubiak. 1996. *PCBs and Dioxins in Birds*. Environmental Contaminants in Wildlife. SETAC Special Publication Series. CRC Press, Inc.

Federal Register, Volume 61, Number 85. May 1, 1990. *Correction Action for Releases from Solid Waste Management Units at Hazardous Waste Management Facilities*.

Federal Register, Volume 55, Number 145. July 27, 1990. *Resource Conservation and Recovery Act, Proposed Subpart S.*

Federal Register, Volume 63, Number 124. June 29, 1998. *Disposal of Polychlorinated Biphenyls (PCBs); Final Rule.*

Federal Register, Volume 63, Number 237. December 10, 1998. *National Recommended Water Quality Criteria*, Notice; Republication.

Mays, D.C. and Veenis, Steven. July 1998. *Matrix Approach to Contaminant Transport Potential*. Practice Periodical of Hazardous, Toxic, and Radioactive Waste Management.

New Mexico Environment Department (NMED) Hazardous and Radioactive Materials (HRM) Bureau. 1998. *Document Requirement Guide*, Section III.c.6, *Risk-based Decision Tree*.

NMED. 2011. NMED Technical Background Document for Development of Soil Screening Levels. http://www.nmenv.state.nm.us/hwb/guidance.html

National Oceanic and Atmospheric Administration (NOAA), 1993. *Sampling and Analytical methods of the National Status and Trends Program, National Benthic Surveillance and Mussel Watch Projects 1984-1992*. National Ocean Service, Office of Ocean Resources Conservation and Assessment, Silver Spring, MD, Technical Memorandum NOS ORCA 71, Vol. 1.

Safe Drinking Water Act. Title 40 Code of Federal Regulations, parts 141 through 147 and 149 [40 CFR Parts 141-147 and 149].

State of New Mexico Standards for Interstate and Intrastate Streams, Title 20 New Mexico Annotated Code, Chapter 6, Part 1 [20 NMAC 6.1]. January 23, 1995.

State of New Mexico Ground and Surface Water Quality Protection Standards, Title 20 New Mexico Annotated Code, Chapter 6, Part 2 [20 NMAC 6.2]. December 1, 1995.

US EPA. 1989. Risk Assessment Guidance for Superfund, Volume 1, *Human Health Evaluation Manual (Part A)*, Interim Final. Office of Emergency and Remedial Response, Washington, DC, 20460. EPA/540/1-89/002.

US EPA. July 1992. *NPDES Storm Water Sampling Guidance Document*. Office of Water (EN-336). EPA 833-B-92-001.

US EPA. 1996a. *Method 8082 - Polychlorinated Biphenyls (PCBs) by Gas Chromatography.* Test Methods for Evaluating Solid Waste, Volume IB - Laboratory Manual - Physical/Chemical Methods. Third edition, Update 3, Revision 0. SW-846. Washington, D.C.

US EPA. 1996b. *PCBs: Cancer Dose-Response Assessment and Application to Environmental Mixtures*. Office of Research and Development, Washington, DC. EPA/600/P-96/001A.

US EPA. 1997a. *Guidance for Assessing Chemical Contaminant Data for Use in Fish Advisory.* Volume 2: Risk Assessment and Fish Consumption Limits. Second Edition. Office of Water, Washington, D.C. EPA 823-B-97-009.

US EPA. 1997b. *Health Effects Assessment Summary Tables: FY 1997 Update*. National Center for Environmental Assessment (NCEA), Office of Research and Development and Office of Emergency and Remedial Response, Washington, D.C.

US EPA. 1997c. *Method 1668 - Toxic Polychlorinated Biphenyls by Isotope Dilution High Resolution Gas Chromatography/High Resolution Mass Spectometry*. Office of Water, Offices of Science and Technology, Engineering and Analyses Division, Washington, D.C.

US EPA. 1998a. Memorandum: *Clarification Regarding Use of SW-846 Methods*. Office of Solid Waste, Washington, D.C.

US EPA. 1998b. *Report from the Workshop on the Application of 2,3,7,8-TCDD Toxicity Equivalency Factors to Fish and Wildlife, Chicago, Illinois, January 20-22, 1998*. Eastern Research Group, Inc. Submitted to US EPA Risk Assessment Forum. US EPA. 1998c. *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities*. Peer Review Draft. Office of Solid Waste and Emergency Response, Washington, DC, 20460. EPA 530-D-98-001a.

US EPA. 1999. *Screening Level Ecological Risk Assessment Protocol for Hazardous Waste Combustion Facilities*. Peer Review Draft. Solid Waste and Emergency Response, Dallas, Texas, 75202. EPA 530-D-99-001A

US EPA. 2011. Integrated Risk Information System (IRIS) Data Base, Office of Research and Development/National Center for Environmental Assessment.

US EPA. Region 5 Toxics Reduction Team Website: http://www.epa.gov/grtlakes/toxteam/pcbid/table.htm.

Valoppi, L., M. Petreas, R. M. Donohoe, L. Sullivan, and C.A. Callaham. 1999. *Use of PCB Congener and Homologue Analysis in Ecological Risk Assessment*. Environmental Toxicology and Risk Assessment: Recent Achievements in Environmental Fate and Transport, Ninth Volume, ASTM STP 1381, F. T. Price, K. V. Brix, and N. K. Lane, Eds., American Society for Testing and Materials, West Conshohocken, Pennsylvania.

Van den Berg, M., L. Birnbaum, S. T. C. Bosveld, B. Brunstr_m, P. Cook, M. Feeley, J. P. Giesy, A. Hanberg, R. Hasegawa, S. W. Kennedy, T. Kubiak, J. C. Larsen, F. X. Rolaf van Leeuwen, A. K. Djien Liem, C. Nolt, R. E. Peterson, L. Poellinger, S. Safe, D. Schrenk, D. Tillitt, M. Tysklind, M. Younes, F. Waern, and T. Zacharewski, 1998. *Toxic Equivalency Factors (TEFs) for PCBs, PCDDs, PCDFs for Humans and Wildlife*. Environmental Health Perspectives. Vol. 106, No. 12, pp. 775-792.

VOLUME 2

TIER 1: SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT

PHASE I
Scoping Assessment

TABLE OF CONTENTS

Figures

Attachments

Acronymns and Abbreviations

AUF	Area Use Factor
bgs	below ground surface
COPEC	Constituent of Potential Ecological Concern
ft	foot
GAERPC	Guidance for Assessing Ecological Risks Posed by Chemicals
HI	Hazard Index
HQ	Hazard Quotient
kg	kilogram
LOAEL	Lowest-observed adverse effect level
LULC	land use and land cover
mg	milligram
NMED	New Mexico Environment Department
NOAEL	No-observed adverse effect level
PCSEM	Preliminary Conceptual Site Exposure Model
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assessment
RFI	RCRA Facility Investigation
T&E	Threatened and Endangered
TRV	Toxicity Reference Value
US EPA	United States Environmental Protection Agency

1.0 INTRODUCTION

The purpose of an ecological risk assessment is to evaluate the potential adverse effects that chemical contamination has on the plants and animals that make up ecosystems. The risk assessment process provides a way to develop, organize and present scientific information so that it is relevant to environmental decisions.

The New Mexico Environment Department Hazardous Waste Bureau (NMED) has developed a tiered procedure for the evaluation of ecological risk. This procedure is outlined in the *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Risk Assessment* (GAERPC) (NMED, 2000). Briefly, the tiers of the procedure are organized as follows:

TIER 1: PHASE I - QUALITATIVE ASSESSMENT

- Scoping Assessment
- Screening Assessment

TIER 2: PHASE II - QUANTITATIVE ASSESSMENT

- Site-Specific Ecological Risk Assessment

As discussed above and illustrated in Figure 1, the Scoping Assessment is the first phase of the Tier I Screening-Level Ecological Risk Assessment process as defined by the NMED GAERPC. This document provides specific procedures to assist the facility in conducting the first step (Scoping Assessment) of the Tier I, Screening-Level Ecological Risk Assessment process outlined in the GAERPC. The purpose of the Scoping Assessment is to gather information, which will be used to determine if there is "any reason to believe that ecological receptors and/or complete exposure pathways exist at or in the locality of the site" (NMED, 2000). The scoping assessment step also serves as the initial information-gathering phase for sites clearly in need of a more detailed assessment of potential ecological risk. This document outlines the methodology for conducting a Scoping Assessment, and includes a Site Assessment Checklist (Attachment A), which serves as tool for gathering information about the facility property and surrounding areas. Although the GAERPC provides a copy of the US Environmental Protection Agency (US EPA) Checklist for Ecological Assessment/Sampling (US EPA, 1997), the attached Site Assessment Checklist provides an expanded, user-friendly template, which both guides the user as to what information to collect and furnishes an organized structure in which to enter the information.

After the Site Assessment Checklist has been completed, the assessor must use the collected information to generate a Scoping Assessment Report and Preliminary Conceptual Site Exposure Model (PCSEM). Guidance for performing these tasks is provided in this document, and in the GAERPC. The Scoping Assessment Report and PCSEM are subsequently used to address the first in a series of Technical Decision Points of the tiered GAERPC process. Technical Decision Points are questions which must be answered by the assessor after the completion of certain phases in the process. The resulting answer to the question determines the next step to be

undertaken by the facility. The first Technical Decision Point, as illustrated in Figure 1, is to decide: *Is Ecological Risk Suspected?*

If the answer to the first Technical Decision Point is "no" (that is, ecological risk is not suspected), the assessor may use the Exclusion Criteria Checklist and Decision Tree (Attachment B) to help confirm or deny that possibility. However, it is unlikely that any site containing potential ecological habitat or receptors will meet the Site Exclusion Criteria.

If ecological risk is suspected, the facility will usually be directed to proceed to the next phase of Tier I, which is a Screening Level Ecological Risk Assessment (SLERA). A SLERA is a simplified risk assessment that can be conducted with limited site-specific data by defining assumptions for parameters that lack site-specific data (US EPA, 1997). Values used for screening are consistently biased in the direction of overestimating risk to ensure that sites that might pose an ecological risk are properly identified. The completed Site Assessment Checklist is a valuable source of information needed for the completion of the SLERA. Instructions for performing a SLERA can be found in the GAERPC and in a number of EPA guidance documents (e.g., US EPA, 1997; US EPA, 1998).

2.0 SCOPING ASSESSMENT

The Scoping Assessment serves as the initial information gathering and evaluation phase of the Tier I process. A Scoping Assessment consists of the following steps:

- Compile and Assess Basic Site Information (using Site Assessment Checklist)
- Conduct Site Visit
- Identify Preliminary Contaminants of Potential Ecological Concern
- Develop a Preliminary Conceptual Site Exposure Model
- Prepare a Scoping Assessment Report

The following subsections provide guidance for completing each step of the Scoping Assessment. For additional guidance, readers should refer to the GAERPC (NMED, 2000).

2.1 Compile and Assess Basic Site Information

The first step of the Scoping Assessment process is to compile and assess basic site information. Since the purpose of the Scoping Assessment is to determine if ecological habitats, receptors, and complete exposure pathways are likely to exist at the site, those items are the focus of the information gathering. The Site Assessment Checklist (Attachment A) should be used to complete this step. The questions in the Site Assessment Checklist should be addressed as completely as possible with the information available before conducting a site visit.

In many cases, a large portion of the Site Assessment Checklist can be completed using reference materials and general knowledge of the site. A thorough file search should be conducted to compile all potential reference materials. Resource Conservation and Recovery Act (RCRA)

Facility Assessment (RFA) and Facility Investigation (RFI) reports, inspection reports, RCRA Part B Permit Applications, and facility maps can all be good sources of the information needed for the Site Assessment Checklist.

Habitats and receptors which may be present at the site can be identified by contacting local and regional natural resource agencies. Habitat types may be determined by reviewing land use and land cover maps (LULC), which are available via the Internet at http://www.nationalatlas.gov/scripts. Additional sources of general information for the identification of ecological receptors and habitats are listed in the introduction section of the Site Assessment Checklist (Attachment A).

After all available information has been compiled and entered into the Site Assessment Checklist, the assessor should review the checklist and identify data gaps. Plans should then be made to obtain the missing information by performing additional research and/or by observation and investigation during the site visit.

2.2 Site Visit

When performing a Scoping Assessment, at least one site visit should be conducted to directly assess ecological features and conditions. As discussed in the previous section, completion of the Site Assessment Checklist should have begun during the compilation of basic site information. The site visit allows for verification of the information obtained from the review of references and other information sources. The current land and surface water usage and characteristics at the site can be observed, as well as direct and indirect evidence of receptors. In addition to the site, areas adjacent to the site and all areas where ecological receptors are likely to contact site-related chemicals (i.e., all areas which may have been impacted by the release or migration of chemicals from the site) should be observed or visited and addressed in the Site Assessment Checklist. The focus of the habitat and receptor observations should be on a community level. That is, dominant plant and animal species and habitats (e.g., wetlands, wooded areas) should be identified during the site visit. Photographs should be taken during the site visit and attached to the Scoping Assessment Report. Photographs are particularly useful for documenting the nature, quality, and distribution of vegetation, other ecological features, potential exposure pathways, and any evidence of contamination or impact. While the focus of the survey is on the community level, the U.S. Fish and Wildlife Service and the New Mexico Natural Heritage Program should be contacted prior to the site visit. The intent is to determine if state listed and/or federal listed Threatened & Endangered (T&E) species or sensitive habitats may be present at the site, or if any other fish or wildlife species could occur in the area (as indicated in the Site Assessment Checklist, Section IIID). A trained biologist or ecologist should conduct the biota surveys to appropriately characterize major habitats and to determine whether T&E species are present or may potentially use the site. The site assessment should also include a general survey for T&E species and any sensitive habitats (e.g. wetlands, perennial waters, breeding areas), due to the fact that federal and state databases might not be complete.

Site visits should be conducted at times of the year when ecological features are most apparent (i.e., spring, summer, early fall). Visits during winter might not provide as much evidence of the presence or absence of receptors and potential exposure pathways.

In addition to observations of ecological features, the assessor should note any evidence of chemical releases (including visual and olfactory clues), drainage patterns, areas with apparent erosion, signs of groundwater discharge at the surface (such as seeps or springs), and any natural or anthropogenic site disturbances.

2.3 Identify Contaminants of Potential Ecological Concern

Contaminants of Potential Ecological Concern (COPECs) are chemicals which may pose a threat to individual species or biological communities. For the purposes of the Scoping Assessment, all chemicals known or suspected of being released at the site are considered COPECs. The identification of COPECs is usually accomplished by the review of historical information in which previous site activities and releases are identified, or by sampling data which confirm the presence of contaminants in environmental media at the site. If any non-chemical stressors such as mechanical disturbances or extreme temperature conditions are known to be present at the site, they too are to be considered in the assessment.

After the COPECs have been identified, they should be summarized and organized (such as in table or chart form) for presentation in the Scoping Assessment Report.

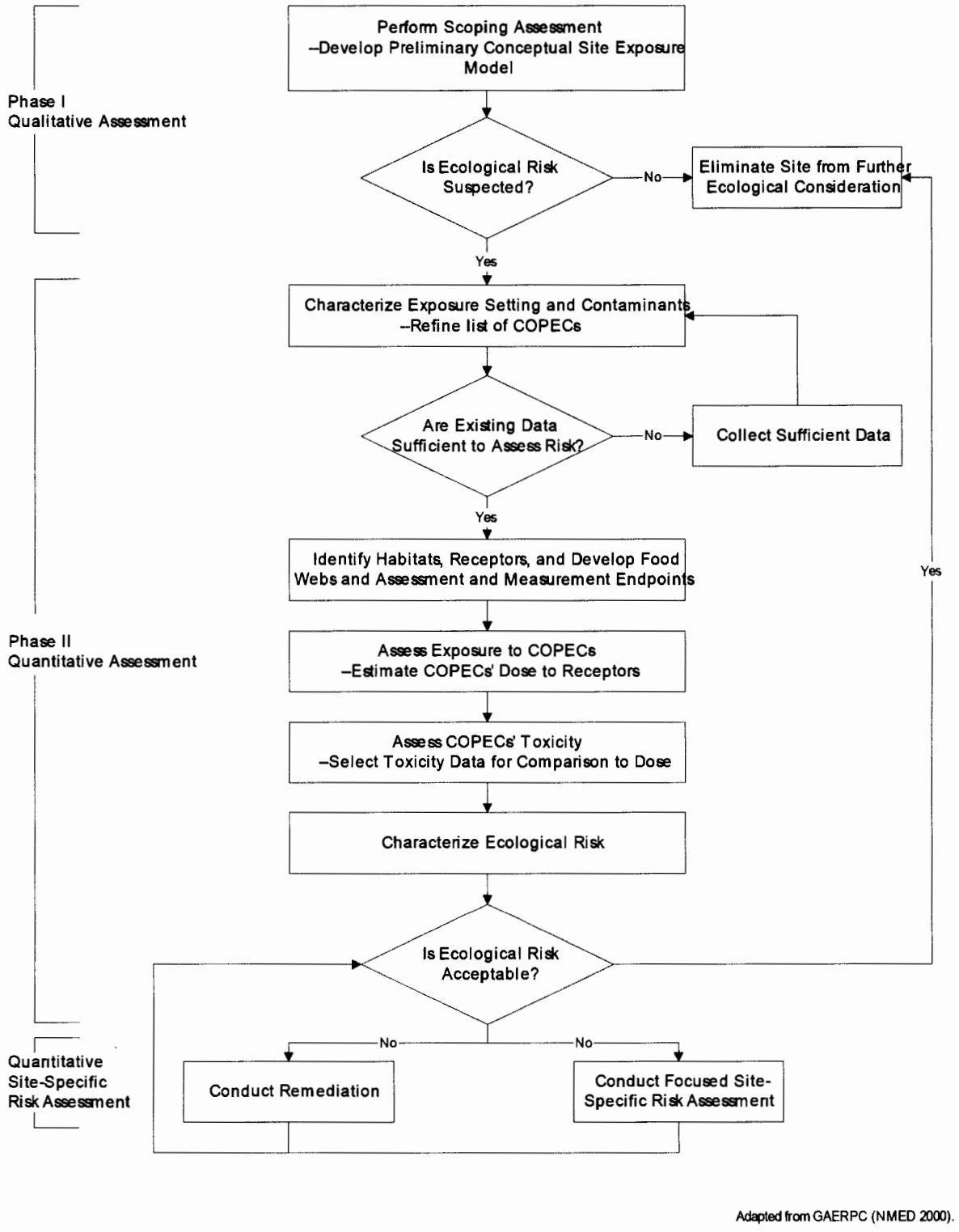
2.4 Developing the Preliminary Conceptual Site Exposure Model

A PCSEM provides a summary of potentially complete exposure pathways, along with potentially exposed receptor types. The PCSEM, in conjunction with the scoping report, is used to determine whether further ecological assessment (i.e., Screening-Level Assessment, Site-Specific Assessment) and/or interim measures are required.

A complete exposure pathway is defined as a pathway having all of the following attributes (US EPA, 1998; NMED, 2000):

- A source and mechanism for hazardous waste/constituent release to the environment
- An environmental transport medium or mechanism by which a receptor can come into contact with the hazardous waste/constituent
- A point of receptor contact with the contaminated media or via the food web, and
- An exposure route to the receptor.

If any of the above components are missing from the exposure pathway, it is not a complete pathway for the site. A discussion regarding all possible exposure pathways and the rationale/justification for eliminating any pathways should be included in the PCSEM narrative and in the Scoping Assessment Report.



Adapted from GAERPC (NMED 2000).

Figure 1. NMED Ecological Risk Assessment Process

The PCSEM is presented as both a narrative discussion and a diagram illustrating potential contaminant migration and exposure pathways to ecological receptors. A sample PCSEM diagram is presented in Figure 2. On the PCSEM diagram, the components of a complete exposure pathway are grouped into three main categories: sources, release mechanisms, and potential receptors. As a contaminant migrates and/or is transformed in the environment, sources and release mechanisms can be defined as primary, secondary, and tertiary.

For example, Figure 2 depicts releases from a landfill that migrate into soils, and reach nearby surface water and sediment via storm water runoff. In this situation, the release from the landfill is considered the primary release, with infiltration as the primary release mechanism. Soil becomes the secondary source, and storm water runoff is the secondary release mechanism to surface water and sediments, the tertiary source.

Subsequent ecological exposures to terrestrial and aquatic receptors will result from this release. The primary exposure routes to ecological receptors are direct contact, ingestion, and possibly inhalation. For example, plant roots will be in direct contact with contaminated sediments, and burrowing mammals will be exposed via dermal contact with soil and incidental ingestion of contaminated soil. In addition, exposures for birds and mammals will occur as they ingest prey items through the food web.

Although completing the Site Assessment Checklist will not provide the user with a readymade PCSEM, a majority of the components of the PCSEM can be found in the information provided by the Site Assessment Checklist. The information gathered for the completion of Section II of the Site Assessment Checklist, can be used to identify sources of releases. The results of Section III, Habitat Evaluation, can be used to both identify secondary and tertiary sources and to identify the types of receptors which may be exposed. The information gathered for completion of Section IV, Exposure Pathway Evaluation, will assist users in tracing the migration pathways of releases in the environment, thus helping to identify release mechanisms and sources.

Once all of the components of the conceptual model have been identified, complete exposure pathways and receptors that have the potential for exposure to site releases can be identified.

For further guidance on constructing a PCSEM, consult the GAERPC (NMED, 2000), and EPA's Office of Solid Waste and Emergency Response's *Soil Screening Guidance: User's Guide* (1996).

2.5 Assembling the Scoping Assessment Report

After completion of the previously described activities of the scoping assessment, the Scoping Assessment Report should be assembled to summarize the site information and present an evaluation of receptors and pathways at the site. The Scoping Assessment Report should be designed to support the decision made regarding the first Technical Decision Point (Is Ecological Risk Suspected?). The Scoping Assessment Report should, at a minimum, contain the following information:

- Existing Data Summary
- Site Visit Summary (including a completed Site Assessment Checklist)

- Evaluation of Receptors and Pathways
- Recommendations
- Attachments (e.g. photographs, field notes, telephone conversation logs with natural resource agencies)
- References/Data Sources

After completion, the Scoping Assessment Report and PCSEM should be submitted to NMED for review and approval. These documents will serve as a basis for decisions regarding future actions at the site.

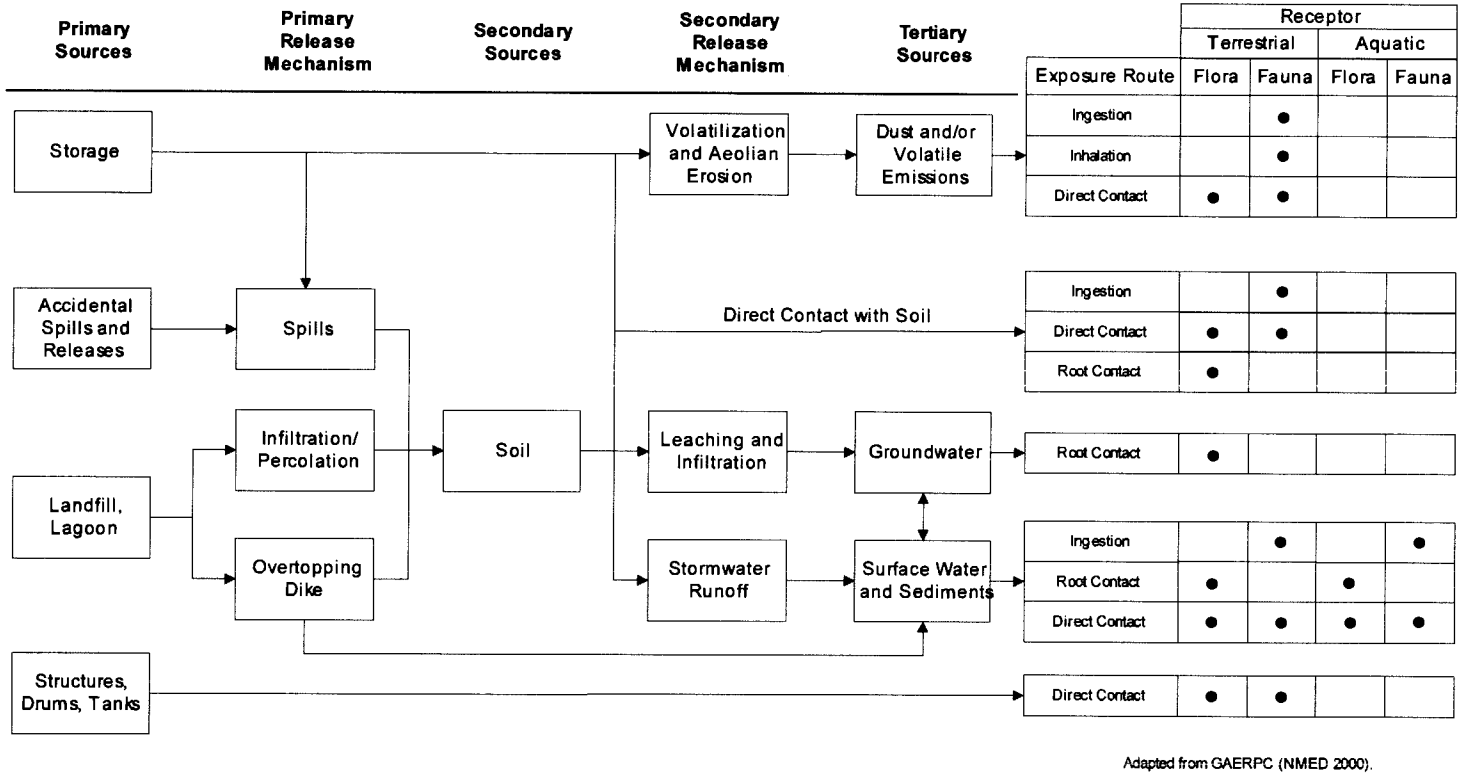


Figure 2. Example Preliminary Conceptual Site Exposure Model Diagram for a Hypothetical Site

3.0 SITE EXCLUSION CRITERIA

If the assessor believes that the answer to the first Technical Decision Point (Is Ecological Risk Suspected?) is "no" based on the results of the PCSEM and Scoping Assessment Report, it should be determined whether the facility meets the NMED Site Exclusion Criteria.

Exclusion criteria are defined as those conditions at an affected property which eliminate the need for a SLERA. The three criteria are as follows:

- Affected property does not include viable ecological habitat.
- Affected property is not utilized by potential receptors.
- Complete or potentially complete exposure pathways do not exist due to affected property setting or conditions of affected property media.

The Exclusion Criteria Checklist and associated Decision Tree (Attachment B) can be used as a tool to help the user determine if an affected site meets the exclusion criteria. The checklist assists in making a conservative, qualitative determination of whether viable habitats, ecological receptors, and/or complete exposure pathways exist at or in the locality of the site where a release of hazardous waste/constituents has occurred. Thus, meeting the exclusion criteria means that the facility can answer "no" to the first Technical Decision Point.

If the affected property meets the Site Exclusion Criteria, based on the results of the checklist and decision tree, the facility must still submit a Scoping Assessment Report to NMED which documents the site conditions and justification for how the criteria have been met. Upon review and approval of the exclusion by the appropriate NMED Bureau, the facility will not be required to conduct any further evaluation of ecological risk. However, the exclusion is not permanent; a future change in circumstances may result in the affected property no longer meeting the exclusion criteria.

4.0 TECHNICAL DECISION POINT: IS ECOLOGICAL RISK SUSPECTED?

As discussed in the beginning of this document, the Scoping Assessment is the first phase of the GAERPC ecological risk assessment process (Figure 1). Following the submission of the Scoping Assessment Report and PCSEM, NMED will decide upon one of the following three recommendations for the site:

- No further ecological investigation at the site, or
- Continue the risk assessment process, and/or
- Undertake a removal or remedial action.

If the information presented in the Scoping Assessment Report supports the answer of "no" to the first Technical Decision Point, and the site meets the exclusion criteria, the site will likely be excused from further consideration of ecological risk. However, this is only true if it can be documented that a complete exposure pathway does not exist and will not exist in the future at

the site based on current conditions. For those sites where valid pathways for potential exposure exist or are likely to exist in the future, further ecological risk assessment (usually in the form of a SLERA) will be required. However, if the Scoping Assessment indicates that a detailed assessment is warranted, the facility would not be required to conduct a SLERA. Instead the facility would move directly to Tier II–Site-Specific Ecological Risk Assessment.

5.0 SCREENING LEVELS ECOLOGICAL RISK ASSESSMENT (SLERA)

If the PSCEM indicates complete exposure pathways, a SLERA is most likely the next step. The data collected during the scoping assessment is used to define facility-wide conditions and define the steps needed for the SLERA and includes the below items. The SLERA should contain a detailed discussion of each of these items.

- Characterization of the environmental setting, including current and future land uses. Ecological assessments must include the evaluation of present day conditions and land uses but also evaluate future land uses.
- Identification of known or likely chemical stressors (chemicals of potential ecological concern, COPECs). The characterization data from the site (e.g., facility investigation) is evaluated to determine what constituents are present in which media. Selection of COPEC should follow the same methodology as outlined in Volume I.
- Identification of the fate and transport pathways that are complete. This includes an understanding of how COPECs may be mobilized from one media to another.
- Identification of the assessment endpoints that should be used to assess impact of the receptors; what is the environmental value to be protected.
- Identification of the complete exposure pathways and exposure routes (as identified in the example in Figure 2). What are the impacted media (soil, surface water, sediment, groundwater, and/or plants) and how might the representative receptors be exposed (direct ingestion, inhalation, and/or direct contact)?
- Species likely to be impacted and selection of representative receptors. From the list of species likely to be present on-site, what species are to be selected to represent specific trophic levels?

5.1 Selection of Representative Species

Sites may include a wide range of terrestrial, semi-aquatic, and aquatic wildlife. A generalized food web is shown in Figure 3. Wildlife receptors for the SLERA should be selected to represent the trophic levels and habitats present or potentially present at the site.

5.2 Exposure Pathways

Typically the exposure pathways for a SLERA are generalized.

For soil, two soil intervals should be evaluated:

- For all non-burrowing receptors, the soil interval to be considered is between zero (0) and five (5) feet below ground surface (ft bgs).
- For all burrowing receptors and plants, the soil interval to be evaluated is 0 – 10 ft bgs.

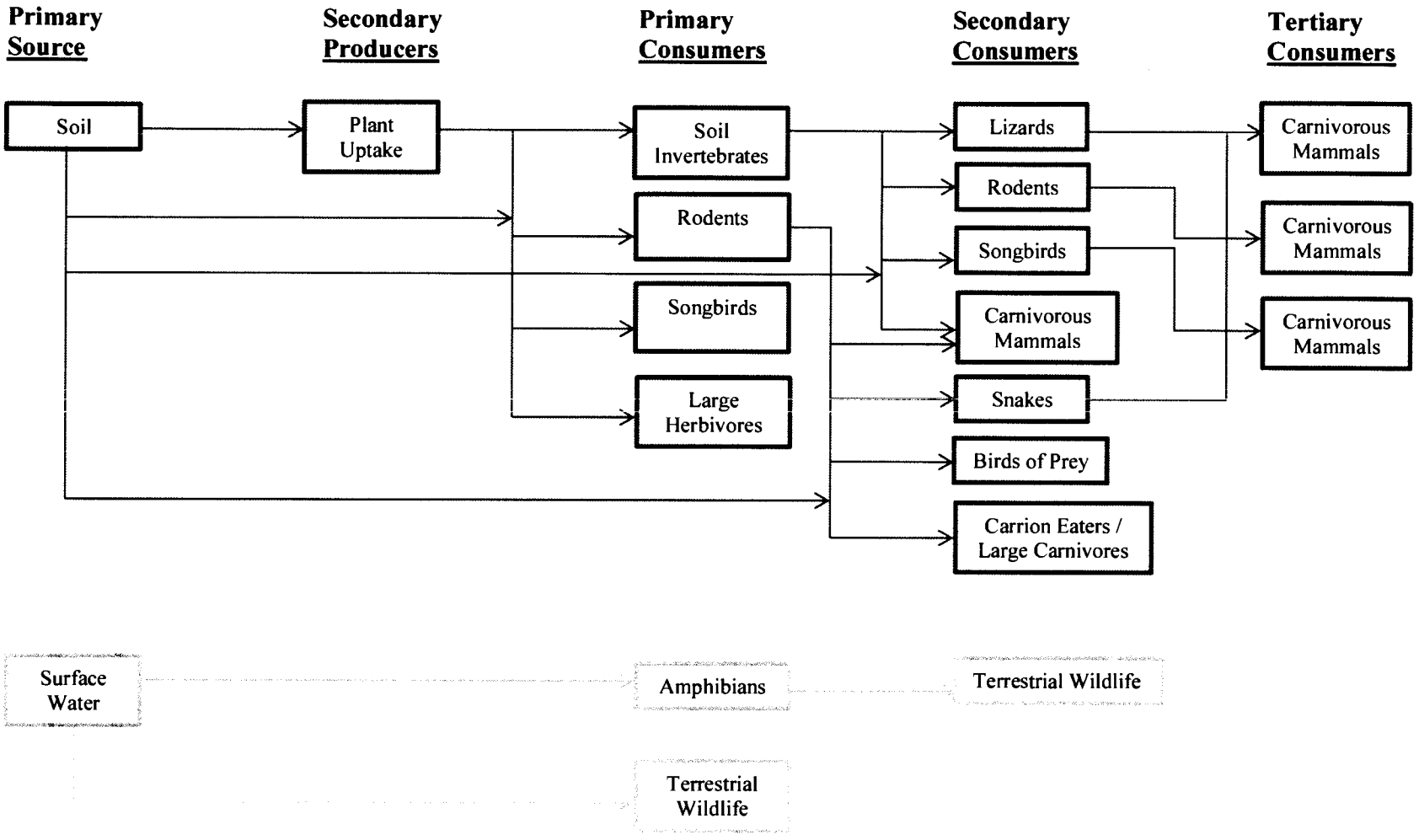


Figure 3. Generic Food Web.

Surface water, sediment, and groundwater should be evaluated based on site-specific conditions.

5.3 SLERA Exposure Estimation

For the initial SLERA, conservative assumptions should be applied as follows:

- 100% of the diet is assumed to contain the maximum concentration of each COPEC detected in the site media.
- Minimum reported body weights should be applied.
- Maximum dietary intake rates should be used.
- Foraging ranges are initial set equal to the size of the site being evaluated. This means that the area use factor (AUF) in the SLERA is set to a value of one.

Exposure doses for the various media should be calculated separately using the following equation:

$$Dose = \frac{C \times IR \times AUF}{BW} \qquad \text{(Equation 1)}$$

Where:

Dose	=	Screening level exposure dose (mg/kg-day)
C	=	Exposure point concentration, which is equal to the maximum detected concentration for the COPC (mg/kg)
IR	=	Ingestion rate set equal to the maximum total dietary intake rate (kg/day)
AUF	=	Area use factor is assumed to be equal to the size of the site and set to a value of one (unitless)
BW	=	Body weight set equal to the minimum reported body weight (kg).

5.4 Effects Assessment

The effects assessment evaluated the potential toxic effects on the receptors being exposed to the COPECs. The effects assessment includes selection of appropriate toxicity reference values (TRVs) for the characterization and evaluation of risk.

For the initial SLERA, the preference for TRVs is based on chronic or long term exposure, when available. The TRVs should be selected from peer-reviewed toxicity studies and from primary literature. Initial risk characterization should be conducted using the lowest appropriate chronic no-observed adverse effect level (NOAEL) for non-lethal or reproductive effects.

5.5 Risk Characterization

Risk is determined by dividing the receptor-specific dose determined using Equation 1 by the appropriate TRV, as follows:

$$HQ = \frac{Dose}{TRV} \qquad \text{Equation 2}$$

Where:

HQ	=	Hazard quotient, calculated for each receptor and COPEC (unitless)

Dose = Screening level exposure dose, calculated for each receptor (mg/kg-day)
TRV = Toxicity reference value, chemical-specific NOAEL (mg/kg-day)

HQs are calculated for each receptor and each COPEC. For each receptor, additive risk must be evaluated. For the initial screening assessment, it is assumed that all COPECs have equal potential risk to the receptor. The overall hazard index (HI) is then calculated for each receptor using Equation 3:

$$HI = HQ_x + HQ_y + ... + HQ_z \qquad \text{Equation 3}$$

Where:

HI = Hazard Index (unitless)
HQ_x = Hazard quotient for each COPEC (unitless)

NMED applies a target risk level for ecological risk assessments of 1.0. If the HI for any receptor is above this target risk level, then there is a potential for adverse effects on ecological receptors and additional evaluation and possibly a site-specific ecological risk assessment may be warranted.

Some additional lines of evidence that may be used to assess risk when the HI is above the target level include:

- Modification of the TRV to reflect the lowest lowest-observed adverse effect level (LOAEL),
- Use of more refined exposure algorithms that incorporate more realistic exposure assumptions (such as specific ingestion rates for plants, soil, and/or water),
- Use of site-specific area use factors and population use factors,
- Evaluation of bioaccumulation, and
- Evaluation of risk by mechanism of effect.

As with all risk assessments, the SLERA should include a discussion of the uncertainties. More detailed information may be found in the *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Risk Assessment(NMED, 2000).*

6.0 TIER 2: PHASE II - QUANTITATIVE ASSESSMENT

In the event that the SLERA does not show that levels of contamination in the impacted media are below the target level of 1.0, additional quantitative analyses may be warranted. This may include incorporation of biota studies to evaluate impact at the site. NMED should be consulted prior to conducting a Tier 2 assessment.

7.0 REFERENCES

Los Alamos National Laboratory (LANL), 1997. *Administrative Procedure 4.5*, Draft

New Mexico Environment Department (NMED), 2000. *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Risk Assessment*, Hazardous and Radioactive Materials Bureau, Final, March.

U.S. Environmental Protection Agency (US EPA), 1996. *Soil Screening Guidance: User's Guide.* Office of Solid Waste and Emergency Response. Washington, DC. EPA-540-R-96/018. July.

U.S. EPA, 1997. *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments*, Environmental Response Team, Interim Final, June 5.

U.S.EPA, 1998. *Guidelines for Ecological Risk Assessment*, Risk Assessment Forum, Final, April. EPA/630/R-95/002F; http://www.epa.gov/ncea/ecorisk.htm.

ATTACHMENT A

SCREENING-LEVEL ECOLOGICAL RISK ASSESSMENT SCOPING ASSESSMENT SITE ASSESSMENT CHECKLIST

INTRODUCTION

This checklist has been developed as a tool for gathering information about the facility property and surrounding areas, as part of the scoping assessment. Specifically, the checklist assists in the compilation of information on the physical and biological aspects of the site including the site environmental setting, usage of the site, releases at the site, contaminant fate and transport mechanisms, and the area's habitats, receptors, and exposure pathways. The completed checklist can then be used to construct the preliminary conceptual site exposure model (PCSEM) for the site. In addition, the checklist and PCSEM will serve as the basis for the scoping assessment report. Section III of this document provides further information on using the completed checklist to develop the PCSEM.

In general, the checklist is designed for applicability to all sites, however, there may be unusual circumstances which require professional judgment in order to determine the need for further ecological evaluation (*e.g.,* cave-dwelling receptors). In addition, some of the questions in the checklist may not be relevant to all sites. Some facilities may have large amounts of data available regarding contaminant concentrations and hydrogeologic conditions at the site, while other may have only limited data. In either case, the questions on the checklist should be addressed as completely as possible with the information available.

Habitats and receptors, which may be present at the site, can be identified by direct or indirect[34] observations and by contacting local and regional natural resource agencies. Habitat types may be determined by reviewing land use and land cover maps (LULC), which are available via the Internet at http://www.nationalatlas.gov/mapit.html. With regard to receptors, it should be noted that receptors are often present at a site even when they are not observed. Therefore, for the purposes of this checklist, it should be assumed that receptors are present if viable habitat is present. The presence of receptors should be confirmed by contacting one or several of the organizations listed below.

Sources of general information available for the identification of ecological receptors and habitats include:

- U.S. Fish and Wildlife Service (http://www.fws.gov)
- Biota Information System of New Mexico (BISON-M) maintained by the New Mexico Department of Game and Fish (NMGF) (http://151.199.74.229/states/nm.htm)
- U.S. Forest Service (USFS) (http://www.fs.fed.us/)
- New Mexico Forestry Division (NMFD) of the Energy, Minerals and Natural Resources Department (http://www.emnrd.state.nm.us/forestry/index.htm)
- U.S. Bureau of Land Management (USBLM) (http://www.blm.gov/nhp/index.htm) or (http://www.nm.blm.gov/www/new_home_2.html)

34 Examples of indirect observations that indicate the presence of receptors include: tracks, feathers, burrows, scat

- United States Geological Service (USGS) (http://www.usgs.gov)
- National Wetland Inventory Maps (http://wetlands.fws.gov)
- National Audubon Society (http://www.audobon.com)
- National Biological Information Infrastructure (http://biology.usgs.gov)
- Sierra Club (http://www.sierraclub.org)
- National Geographic Society (http://www.nationalgeographic.com)
- New Mexico Natural Heritage Program (http://nmnhp.unm.edu/)
- State and National Parks System
- Local universities
- Tribal organizations

INSTRUCTIONS FOR COMPLETING THE CHECKLIST

The checklist consists of four sections: Site Location, Site Characterization, Habitat Evaluation, and Exposure Pathway Evaluation. Answers to the checklist should reflect existing conditions and should not consider future remedial actions at the site. Completion of the checklist should provide sufficient information for the preparation of a PCSEM and scoping report and allow for the identification of any data gaps.

Section I - Site Location, provides general site information, which identifies the facility being evaluated, and gives specific location information. Site maps and diagrams, which should be attached to the completed checklist, are an important part of this section. The following elements should be clearly illustrated: 1) the location and boundaries of the site relative to the surrounding area, 2) any buildings, structures or important features of the facility or site, and 3) all ecological areas or habitats identified during completion of the checklist. It is possible that several maps will be needed to clearly and adequately illustrate the required elements. Although topographical information should be illustrated on at least one map, it is not required for every map. Simplified diagrams (preferably to scale) of the site and surrounding areas will usually suffice.

Section II - Site Characterization, is intended to provide additional temporal and contextual information about the site, which may have an impact on determining whether a certain area should be characterized as ecologically viable habitat or contains receptors. Answers to the questions in Section II will help the reviewer develop a broader and more complete evaluation of the ecological aspects of a site.

Section III - Habitat Evaluation, provides information regarding the physical and biological characteristics of the different habitat types present at or in the locality of the site. Aquatic features such as lakes, ponds, streams, arroyos and ephemeral waters can be identified by reviewing aerial photographs, LULC and topographic maps and during site reconnaissance visits. In New Mexico, there are several well-defined terrestrial communities, which occur naturally. Typical communities include wetlands, forest (e.g., mixed conifer, ponderosa pine and pinyon juniper), scrub/shrub, grassland, and desert. Specific types of vegetation characterize each of these communities and can be used to identify them. Field guides are often useful for identifying vegetation types. A number

of sites may be in areas that have been disturbed by human activities and may no longer match any of the naturally occurring communities typical of the southwest. Particularly at heavily used areas at facilities, the two most common of these areas are usually described as "weed fields" and "lawn grass". Vegetation at "weed fields" should be examined to determine whether the weeds consist primarily of species native to the southwest or introduced species such as Kochia. Fields of native weeds and lawn grass are best evaluated using the short grass prairie habitat guides.

The applicable portions of Section III of the checklist should be completed for each individual habitat identified. For example, the questions in Section III.A of the checklist should be answered for each wetland area identified at or in the locality of the site and the individual areas must be identified on a map or maps.

Section IV- Exposure Pathway Evaluation, is used to determine if contaminants at the site have the potential to impact habitat identified in Section III. An exposure pathway is the course a chemical or physical agent takes from a source to an exposed organism. Each exposure pathway includes a source (or release from a source), an environmental transport mechanism, an exposure point, and an exposure route. A complete exposure pathway is one in which each of these components, as well as a receptor to be exposed, is present. Essentially, this section addresses the fate and transport of contaminants that are known or suspected to have been released at the site. In most cases, without a complete exposure pathway between contaminants and receptors, additional ecological evaluation is not warranted.

Potential transport pathways addressed in this checklist include migration of contaminants via air dispersion, leaching into groundwater, soil erosion/runoff, groundwater discharge to surface water, and irradiation. Due to New Mexico's semi-arid climate, vegetation is generally sparse. The sparse vegetation, combined with the intense nature of summer storms in New Mexico, results in soil erosion that occurs sporadically over a very brief time frame. Soil erosion may be of particular concern for sites located in steeply sloped areas. Several questions within Section IV of this checklist have been developed to aid in the identification of those sites where soil erosion/runoff would be an important transport mechanism.

7.1 Using the Checklist to Develop the Preliminary Conceptual Site Exposure Model

The completed Site Assessment Checklist can be used to construct the PCSEM. An example PCSEM diagram is presented in Figure 1. The CSM illustrates actual and potential contaminant migration and exposure pathways to associated receptors. The components of a complete exposure pathway are simplified and grouped into three main categories: sources, release mechanisms, and potential receptors. As a contaminant migrates and/or is transformed in the environment, sources and release mechanisms may expand into primary, secondary, and tertiary levels. For example, Figure 1 illustrates releases from inactive lagoons (primary sources) through spills (primary release mechanism), which migrate to surface and subsurface soils (secondary sources), which are then leached (secondary release mechanism) to groundwater (tertiary source). Similarly, exposures of various trophic levels to the contaminant(s) and consequent

exposures via the food chain may lead to multiple groups of receptors. For example, Figure 1 illustrates groups of both aquatic and terrestrial receptors which may be exposed and subsequently serve as tertiary release mechanisms to receptors which prey on them.

Although completing the checklist will not provide the user with a readymade PCSEM, a majority of the components of the PCSEM can be found in the answers to the checklist. It is then up to the user to put the pieces together into a comprehensive whole. The answers from Section II of the checklist, Site Characterization, can be used to identify sources of releases. The answers to Section IV, Exposure Pathway Evaluation, will assist users in tracing the migration pathways of releases in the environment, thus helping to identify release mechanisms and sources. The results of Section III, Habitat Evaluation, can be used to both identify secondary and tertiary sources and to identify the types of receptors which may be exposed. Appendix B of the NMED's *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Assessment* also contains sample food webs which may be used to develop the PCSEM.

Once all of the components have been identified, one can begin tracing the steps between the primary releases and the potential receptors. For each potential receptor, the user should consider all possible exposure points (e.g., prey items, direct contact with contaminated soil or water, etc.) then begin eliminating pathways, which are not expected to result in exposure to the contaminant at the site. Gradually, the links between the releases and receptors can be filled in, resulting in potential complete exposure pathways.

For further guidance on constructing a PCSEM, consult the NMED's *Guidance for Assessing Ecological Risks Posed by Chemicals: Screening-Level Ecological Assessment* (2000), and EPA's Office of Solid Waste and Emergency *Response's Soil Screening Guidance: User's Guide* (1996).

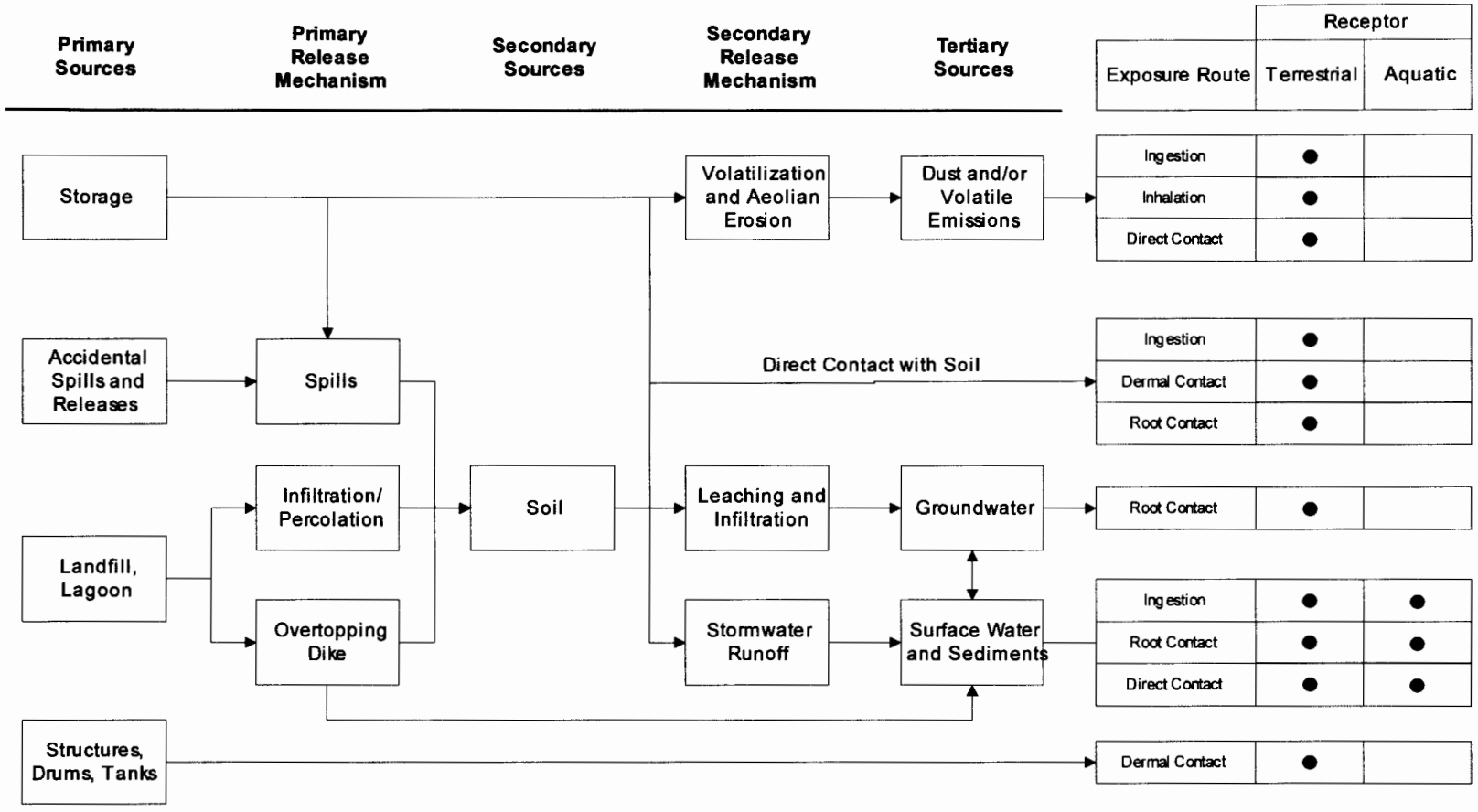


Figure 1. Example Preliminary Conceptual Site Exposure Model Diagram

NEW MEXICO ENVIRONMENT DEPARTMENT
SITE ASSESSMENT CHECKLIST

I. SITE LOCATION

1. Site
   Name:_____
   US EPA I.D.
   Number:_____
   Location:_____
   County:_____
   City:_____State:_____

2. Latitude:_____
   Longitude:_____

3. Attach site maps, including a topographical map, a diagram which illustrates the layout of the facility (e.g., site boundaries, structures, etc.), and maps showing all habitat areas identified in Section III of the checklist. Also, include maps which illustrate known release areas, sampling locations, and any other important features, if available.

II. SITE CHARACTERIZATION

1. Indicate the approximate area of the site (i.e., acres or sq. ft)

   _____

2. Provide an approximate breakdown of the land uses on the site:

_____% Heavy Industrial	_____% Light Industrial	_____% Urban
_____% Residential	_____% Rural	_____% Agricultural[b]
_____% Recreational[a]	_____% Undisturbed	_____% Other[c]

[a]For recreational areas, please describe the usage of the area (e.g., park, playing field, etc.):

_____

[b]For agricultural areas, please list the crops and/or livestock which are present:

_____

[c]For areas designated as "other", please describe the usage of the area:

_____

3. Provide an approximate breakdown of the land uses in the area surrounding the site.

Indicate the radius (in miles) of the area described: _____

_____% Heavy Industrial	_____% Light Industrial	_____% Urban
_____% Residential	_____% Rural	_____% Agricultural[b]
_____% Recreational[a]	_____% Undisturbed	_____% Other [c]

[a]For recreational areas, please describe the usage of the area (e.g., park, playing field, golf course, etc.):

_____

[b]For agricultural areas, please list the crops and/or livestock which are present:

_____

[c]For areas designated as "other", please describe the usage of the area:

_____

_____

4. Describe reasonable and likely future land and/or water use(s) at the site.

_____

_____

_____

_____

_____

_____

5. Describe the historical uses of the site. Include information on chemical releases that may have occurred as a result of previous land uses. For each chemical release, provide information on the form of the chemical released (i.e., solid, liquid, vapor) and the known or suspected causes or mechanism of the release (i.e., spills, leaks, material disposal, dumping, explosion, etc.).

_____

_____

_____

_____

_____

6. If any movement of soil has taken place at the site, describe the degree of the disturbance. Indicate the likely source of any disturbances (e.g., erosion, agricultural, mining, industrial activities, removals, etc.) and estimate when these events occurred.

_____

_____

7. Describe the current uses of the site. Include information on recent (previous 5 years) disturbances or chemical releases that have occurred. For each chemical release, provide information on the form of the chemical released and the causes or mechanism of the release.

8. Identify the location or suspected location of chemical releases at the site. Provide an estimate of the distance between these locations and the areas identified in Section III.

9. Identify the suspected contaminants of concern (COCs) at the site. If known, include the maximum contaminant levels. Please indicate the source of data cited (e.g., RFI, confirmatory sampling, etc.).

10. Identify the media (e.g., soil (surface or subsurface), surface water, air, groundwater) which are known or suspected to contain COCs.

11. Indicate the approximate depth to groundwater (in feet below ground surface [(bgs)].

12. Indicate the direction of groundwater flow (e.g., north, southeast, etc.)

III. HABITAT EVALUATION

III.A Wetland Habitats

Are any wetland[35] areas such as marshes or swamps on or adjacent to the site?

☐ Yes ☐ No

If yes, indicate the wetland area on the attached site map and answer the following questions regarding the wetland area. If more than one wetland area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual wetland area. Distinguish between wetland areas by using names or other designations (such as location), and clearly identify each area on the site map. Also, obtain and attach a National Wetlands Inventory Map (or maps) to illustrate each wetland area.

Identify the sources of the observations and information (e.g., National Wetland Inventory, Federal or State Agency, USGS topographic maps) used to make the determination that wetland areas are or are not present.

_____

_____

_____

_____

If no wetland areas are present, proceed to Section III.B.

Wetland Area Questions

☐ Onsite ☐ Offsite

Name or
Designation:_____

1. Indicate the approximate area of the wetland (acres or ft^2)_____

2. Identify the type(s) of vegetation present in the wetland.

   - ❑ Submergent (i.e., underwater) vegetation
   - ❑ Emergent (i.e., rooted in the water, but rising above it) vegetation
   - ❑ Floating vegetation
   - ❑ Scrub/shrub

35Wetlands are defined in 40 CFR §232.2 as " Areas inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances does support, a prevalence of vegetation typically adapted for life in saturated soil conditions." Examples of typical wetlands plants include: cattails, cordgrass, willows and cypress trees. National wetland inventory maps may be available at http:\\nwi.fws.gov. Additional information on wetland delineation criteria is also available from the Army Corps of Engineers.

- ☐ Wooded
- ☐ Other (Please describe):_____

3. Estimate the vegetation density of the wetland area.

   - ☐ Dense (i.e., greater than 75% vegetation)
   - ☐ Moderate (i.e., 25% to 75% vegetation)
   - ☐ Sparse (i.e., less than 25% vegetation)

4. Is standing water present? ☐ Yes ☐ No

   If yes, is the water primarily: ☐ Fresh or ☐ Brackish
   Indicate the approximate area of the standing water (ft^2):

   _____
   Indicate the approximate depth of the standing water, if known (ft. or in.)_____

5. If known, indicate the source of the water in the wetland.

   - ☐ Stream/River/Creek/Lake/Pond
   - ☐ Flooding
   - ☐ Groundwater
   - ☐ Surface runoff

6. Is there a discharge from the facility to the wetland? ☐ Yes ☐ No
   If yes, please describe:_____
   _____
   _____
   _____
   _____
   _

Wetland Area Questions (Continued)

7. Is there a discharge from the wetland? ☐ Yes ☐ No
   If yes, indicate the type of aquatic feature the wetland discharges into:

   - ☐ Surface stream/River (Name:_____)
   - ☐ Lake/Pond (Name:_____)
   - ☐ Groundwater
   - ☐ Not sure

8. Does the area show evidence of flooding? ☐ Yes ☐ No
   If yes, indicate which of the following are present (mark all that apply):

   - ☐ Standing water
   - ☐ Water-saturated soils
   - ☐ Water marks
   - ☐ Buttressing
   - ☐ Debris lines
   - ☐ Mud cracks
   - ☐ Other (Please describe):_____

9. Animals observed in the wetland area or suspected to be present based on indirect evidence or file material:

   - ☐ Birds
   - ☐ Fish
   - ☐ Mammals
   - ☐ Reptiles (e.g., snakes, turtles)
   - ☐ Amphibians (e.g., frogs, salamanders)
   - ☐ Sediment-dwelling invertebrates (e.g., mussels, crayfish, insect nymphs)

   Specify species, if known:

   _____
   _____
   _____
   _____

III.B Aquatic Habitats

III.B.1 Non-Flowing Aquatic Features

Are any non-flowing aquatic features (such as ponds or lakes) located at or adjacent to the site?

☐ Yes ☐ No

If yes, indicate the aquatic feature on the attached site map and answer the following questions regarding the non-flowing aquatic features. If more than one non-flowing aquatic feature is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual aquatic feature. Distinguish between aquatic features by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.B.2.

Non-Flowing Aquatic Feature Questions

☐ Onsite ☐ Offsite

Name or Designation:_____

1. Indicate the type of aquatic feature present:

   - ❑ Natural (e.g., pond or lake)
   - ❑ Man-made (e.g., impoundment, lagoon, canal, etc.)

2. Estimate the approximate size of the water body (in acres or sq. ft.)_____

3. If known, indicate the depth of the water body (in ft. or in.)._____

Non-Flowing Aquatic Feature Questions (Continued)

4. Indicate the general composition of the bottom substrate. Mark all sources that apply from the following list.

☐ Bedrock	☐ Sand	☐ Concrete
☐ Boulder (>10 in.)	☐ Silt	☐ Debris
☐ Cobble (2.5 - 10 in.)	☐ Clay	☐ Detritus
☐ Gravel (0.1 - 2.5 in.)	☐ Muck (fine/black)	

☐ Other (please specify):_____

5. Indicate the source(s) of the water in the aquatic feature. Mark all sources that apply from the following list.

- ❑ River/Stream/Creek
- ❑ Groundwater
- ❑ Industrial Discharge
- ❑ Surface Runoff
- ❑ Other (please specify):_____

6. Is there a discharge from the facility to the aquatic feature? ☐ Yes ☐ No
   If yes, describe the origin of each discharge and its migration path:
   _____
   _____
   _____
   _____

7. Does the aquatic feature discharge to the surrounding environment? ☐ Yes ☐ No
   If yes, indicate the features from the following list into which the aquatic feature discharges, and indicate whether the discharge occurs onsite or offsite:

- ❑ River/Stream/Creek ☐ onsite ☐ offsite
- ❑ Groundwater ☐ onsite ☐ offsite
- ❑ Wetland ☐ onsite ☐ offsite
- ❑ Impoundment ☐ onsite ☐ offsite
- ❑ Other (please describe)_____

Non-Flowing Aquatic Feature Questions (Continued)

8. Animals observed in the vicinity of the aquatic feature or suspected to be present based on indirect evidence or file material:

- ❑ Birds
- ❑ Fish
- ❑ Mammals
- ❑ Reptiles (e.g., snakes, turtles)
- ❑ Amphibians (e.g., frogs, salamanders)
- ❑ Sediment-dwelling invertebrates (e.g., mussels, crayfish, insect nymphs)

Specify species, if known:

_____
_____
_____
_____

III.B.2 Flowing Aquatic Features

Are any flowing aquatic features (such as streams or rivers) located at or adjacent to the site?

☐ Yes ☐ No

If yes, indicate the aquatic feature on the attached site map and answer the following questions regarding the flowing aquatic features. If more than one flowing aquatic feature is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual aquatic feature. Distinguish between aquatic features by using names or other designations, and clearly identify each area on the site map

If no, proceed to Section III.C.

Flowing Aquatic Feature Questions

☐ Onsite ☐ Offsite

Name or Designation:_____

1. Indicate the type of flowing aquatic feature present.

   - ❑ River
   - ❑ Stream
   - ❑ Creek
   - ❑ Brook
   - ❑ Dry wash
   - ❑ Arroyo
   - ❑ Intermittent stream
   - ❑ Artificially created (ditch, etc.)
   - ❑ Other (specify)
   - ❑

2. Indicate the general composition of the bottom substrate.

☐ Bedrock	☐ Sand	☐ Concrete
☐ Boulder (>10 in.)	☐ Silt	☐ Debris
☐ Cobble (2.5 - 10 in.)	☐ Clay	☐ Detritus
☐ Gravel (0.1 - 2.5 in.)	☐ Muck (fine/black)	

   ☐ Other (please specify):_____

3. Describe the condition of the bank (e.g., height, slope, extent of vegetative cover) of the aquatic feature.

   _____
   _____
   _____
   _____

4. Is there a discharge from the facility to the aquatic feature? ☐ Yes ☐ No
   If yes, describe the origin of each discharge and its migration path:

   _____
   _____
   _____
   _____

5. Indicate the discharge point of the water body. Specify name, if known.

Flowing Aquatic Feature Questions (Continued)

6. If the flowing aquatic feature is a dry wash or arroyo, answer the following questions.
   - ❑ Check here if feature is not a dry wash or arroyo

   If known, specify the average number of days in a year in which flowing water is present in the feature: _____

   Is standing water or mud present? Check all that apply.
   - ❑ Standing water
   - ❑ Mud
   - ❑ Neither standing water or mud

   Does the area show evidence of recent flow (e.g., flood debris clinging to vegetation)?
   - ❑ Yes
   - ❑ No
   - ❑ Not sure
7. Animals observed in the vicinity of the aquatic feature or suspected to be present based on indirect evidence or file material:

   - ❑ Birds
   - ❑ Fish
   - ❑ Mammals
   - ❑ Reptiles (e.g., snakes, turtles)
   - ❑ Amphibians (e.g., frogs, salamanders)
   - ❑ Sediment-dwelling invertebrates (e.g., mussels, crayfish, insect nymphs)

   Specify species, if known:

   _____
   _____
   _____
   _____

III.C Terrestrial Habitats
III.C.1 Wooded

Are any wooded areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the wooded area on the attached site map and answer the following questions. If more than one wooded area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual wooded area. Distinguish between wooded areas by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.2.

Wooded Area Questions

☐ On-site ☐ Off-site

Name or Designation:_____

1. Estimate the approximate size of the wooded area (in acres or sq. ft.)_____

2. Indicate the dominant type of vegetation in the wooded area.

   - ❑ Evergreen
   - ❑ Deciduous
   - ❑ Mixed

   Dominant plant species, if known:_____

3. Estimate the vegetation density of the wooded area.

   - ❑ Dense (i.e., greater than 75% vegetation)
   - ❑ Moderate (i.e., 25% to 75% vegetation)
   - ❑ Sparse (i.e., less than 25% vegetation)

4. Indicate the predominant size of the trees at the site. Use diameter at chest height.

   - ❑ 0-6 inches
   - ❑ 6-12 inches
   - ❑ >12 inches
   - ❑ No single size range is predominant

5. Animals observed in the wooded area or suspected to be present based on indirect evidence or file material:

   - ❑ Birds
   - ❑ Mammals
   - ❑ Reptiles (e.g., snakes, lizards)
   - ❑ Amphibians (e.g., toads, salamanders)

   Specify species, if known:

   _____
   _____
   _____
   _____

III.C.2 Shrub/Scrub

Are any shrub/scrub areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the shrub/scrub area on the attached site map and answer the following questions. If more than one shrub/scrub area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual shrub/scrub area. Distinguish between shrub/scrub areas, using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.3.

Shrub/Scrub Area Questions

☐ Onsite ☐ Offsite

Name or Designation:_____

1. Estimate the approximate size of the shrub/scrub area (in acres or sq. ft.)._____

2. Indicate the dominant type of shrub/scrub vegetation present, if known.

_____
_____
_____
_____

3. Estimate the vegetation density of the shrub/scrub area.

- ❑ Dense (i.e., greater than 75% vegetation)
- ❑ Moderate (i.e., 25% to 75% vegetation)
- ❑ Sparse (i.e., less than 25% vegetation)

4. Indicate the approximate average height of the scrub/shrub vegetation.

- ❑ 0-2 feet
- ❑ 2-5 feet
- ❑ >5 feet

5. Animals observed in the shrub/scrub area or suspected to be present based on indirect evidence or file material:
   - ❑ Birds
   - ❑ Mammals
   - ❑ Reptiles (e.g., snakes, lizards)
   - ❑ Amphibians (e.g., toads, salamanders)

   Specify species, if known:

_____
_____
_____
_____

III.C.3 Grassland

Are any grassland areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the grassland area on the attached site map and answer the following questions. If more than one grassland area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual grassland area. Distinguish between grassland areas by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.4.

Grassland Area Questions

☐ Onsite ☐ Offsite

Name or Designation:_____

1. Estimate the approximate size of the grassland area (in acres or sq. ft.)._____

2. Indicate the dominant plant type, if known.

_____
_____
_____
_____

3. Estimate the vegetation density of the grassland area.

- ❑ Dense (i.e., greater than 75% vegetation)
- ❑ Moderate (i.e., 25% to 75% vegetation)
- ❑ Sparse (i.e., less than 25% vegetation)

4. Indicate the approximate average height of the dominant plant type (in ft. or in.)_

5. Animals observed in the grassland area or suspected to be present based on indirect evidence or file material:

- ❑ Birds
- ❑ Mammals
- ❑ Reptiles (e.g., snakes, lizards)
- ❑ Amphibians (e.g., toads, salamanders)

Specify species, if known:

III.C.4 Desert

Are any desert areas on or adjacent to the site? ☐ Yes ☐ No

If yes, indicate the desert area on the attached site map and answer the following questions. If more than one desert area is present on or adjacent to the site, make additional copies of the following questions and fill out for each individual desert area. Distinguish between desert areas by using names or other designations, and clearly identify each area on the site map.

If no, proceed to Section III.C.5.

Desert Area Questions

☐ Onsite ☐ Offsite

Name or Designation:_____

1. Estimate the approximate size of the desert area (in acres or sq. ft.)._____

2. Describe the desert area (e.g., presence or absence of vegetation, vegetation types, presence/size of rocks, sand, etc.)

_____
_____
_____
_____
_____
_____
_____
_____
_____

3. Animals observed in the desert area or suspected to be present based on indirect evidence or file material:

- ☐ Birds
- ☐ Mammals
- ☐ Reptiles (e.g., snakes, lizards)
- ☐ Amphibians (e.g., toads, salamanders)

Specify species, if known:

_____

III.C.5 Other

1. Are there any other terrestrial communities or habitats on or adjacent to the site which were not previously described?

   ☐ Yes ☐ No

   If yes, indicate the "other" area(s) on the attached site map and describe the area(s) below. Distinguish between onsite and offsite areas. If no, proceed to Section III.D.

III.D Sensitive Environments and Receptors

1. Do any other potentially sensitive environmental areas[36] exist adjacent to or within 0.5 miles of the site? If yes, list these areas and provide the source(s) of information used to identify sensitive areas. *Do not answer "no" without confirmation from the U.S. Fish and Wildlife Service and appropriate State of New Mexico division.*

3 Areas that provide unique and often protected habitat for wildlife species. These areas are typically used during critical life stages such as breeding, hatching, rearing of young and overwintering. Refer to **Table 1** at the end of this document for examples of sensitive environments.

2. Are any areas on or near (i.e., within 0.5 miles) the site which are owned or used by local tribes? If yes, describe. *Contact the Tribal Liaison in the Office of the Secretary (505)827-2855 to obtain this information.*

4. Does the site serve or potentially serve as a habitat, foraging area, or refuge by rare, threatened, endangered, candidate and/or proposed species (plants or animals), or any otherwise protected species? If yes, identify species. *This information should be obtained from the U.S. Fish and Wildlife Service and appropriate State of New Mexico division.*

5. Is the site potentially used as a breeding, roosting or feeding area by migratory bird species? If yes, identify which species.

6. Is the site used by any ecologically[37], recreationally, or commercially important

37 Ecologically important species include populations of species which provide a critical (i.e., not replaceable) food resource for higher organisms and whose function as such would not be replaced by more tolerant species; or perform a critical ecological function (such as organic matter decomposition) and whose functions will not be replaced by other species. Ecologically important species include pest and opportunistic species that populate an area if they serve as a food source for other species, but do not include domesticated animals (e.g., pets and livestock) or plants/animals whose existence is maintained by continuous human interventions (e.g., fish hatcheries, agricultural crops, etc.,)

species? If yes, explain.

_____
_____
_____
_____
_____

IV. EXPOSURE PATHWAY EVALUATION

1. Do existing data provide sufficient information on the nature, rate, and extent of contamination at the site?

   - ❑ Yes
   - ❑ No
   - ❑ Uncertain

   Please provide an explanation for your answer:_____

   _____
   _____
   _____
   _____

2. Do existing data provide sufficient information on the nature, rate, and extent of contamination in offsite affected areas?

   - ❑ Yes
   - ❑ No
   - ❑ Uncertain
   - ❑ No offsite contamination

   Please provide an explanation for your answer:_____

   _____
   _____
   _____
   _____

3. Do existing data address potential migration pathways of contaminants at the site?

   - ❑ Yes
   - ❑ No
   - ❑ Uncertain

Please provide an explanation for your answer:_____

_

_____

_____

_____

_____

4. Do existing data address potential migration pathways of contaminants in offsite affected areas?

   - ❑ Yes
   - ❑ No
   - ❑ Uncertain
   - ❑ No offsite contamination

   Please provide an explanation for your answer:_____

5. Are there visible indications of stressed habitats or receptors on or near (i.e., within 0.5 miles) the site that may be the result of a chemical release? If yes, explain. Attach photographs if available.

6. Is the location of the contamination such that receptors might be reasonably expected to come into contact with it? For soil, this means contamination in the soil 0 to 5 feet below ground surface (bgs). If yes, explain.

7. Are receptors located in or using habitats where chemicals exist in air, soil, sediment or surface water? If yes, explain.

8. Could chemicals reach receptors via groundwater? Can chemicals leach or dissolve to groundwater? Are chemicals mobile in groundwater? Does groundwater discharge into receptor habitats? If yes, explain.

_____
_____
_____
_____
_____
_____
_____

9. Could chemicals reach receptors through runoff or erosion? Answer the following questions:

What is the approximate distance from the contaminated area to the nearest watercourse or arroyo?

- ❑ 0 feet (i.e., contamination has reached a watercourse or arroyo)
- ❑ 1-10 feet
- ❑ 11-20 feet
- ❑ 21-50 feet
- ❑ 51-100 feet
- ❑ 101-200 feet
- ❑ > 200 feet
- ❑ > 500 feet
- ❑ > 1000 feet

What is the slope of the ground in the contaminated area?

- ❑ 0-10%
- ❑ 10-30%
- ❑ > 30%

What is the approximate amount of ground and canopy vegetative cover in the contaminated area?

- ❑ < 25%
- ❑ 25-75%
- ❑ > 75%

Is there visible evidence of erosion (e.g., a rill or gully) in or near the contaminated area?

- ❑ Yes
- ❑ No
- ❑ Do not know

Do any structures, pavement, or natural drainage features direct run-on flow (i.e., surface flows originating upstream or uphill from the area of concern) into the contaminated area?

- ❑ Yes
- ❑ No
- ❑ Do not know

10. Could chemicals reach receptors through the dispersion of contaminants in air (e.g., volatilization, vapors, fugitive dust)? If yes, explain.

11. Could chemicals reach receptors through migration of non-aqueous phase liquids (NAPLs)? Is a NAPL present at the site that might be migrating towards receptors or habitats? Could NAPL discharge contact receptors or their habitat?

12. Could receptors be impacted by external irradiation at the site? Are gamma emitting radionuclides present at the site? Is the radionuclide contamination buried or at the surface?

PHOTOGRAPHIC DOCUMENTATION

During the site visit(s), photographs should be taken to document the current conditions at the site and to support the information entered in the checklist. For example, photographs may be used to document the following:

- The nature, quality, and distribution of vegetation at the site
- Receptors or evidence of receptors
- Potentially important ecological features, such as ponds and drainage ditches
- Potential exposure pathways
- Any evidence of contamination or impact

The following space may be used to record photo subjects.

7.2 SUMMARY OF OBSERVATIONS AND SITE SETTING

Include information on significant source areas and migration pathways that are likely to constitute complete exposure pathways.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

Checklist Completed by_____

Affiliation_____

Author Assisted by_____

Date_____

TABLE 1
EXAMPLES OF SENSITIVE ENVIRONMENTS

National Parks and National Monuments

Designated or Administratively Proposed Federal Wilderness Areas

National Preserves

National or State Wildlife Refuges

National Lakeshore Recreational Areas

Federal land designated for protection of natural ecosystems

State land designated for wildlife or game management

State designated Natural Areas

Federal or state designated Scenic or Wild River

All areas that provide or could potentially provide critical habitat[1] for state and federally listed Threatened or Endangered Species, those species that are currently petitioned for listing, and species designated by other agencies as sensitive or species of concern

All areas that provide or could potentially provide habitat for state protected species as defined in the Wildlife Code, Chapter 17 of the New Mexico Statutes

All areas that provide or could potentially provide habitat for migratory birds as protected by the Migratory Bird Treaty Act (16 U.S.C. §§ 703-712)

All areas that provide or could potentially provide habitat for bald eagles and golden eagles as protected by the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)

---

1 Critical habitats are defined by the Endangered Species Act (50 CFR §424.02(d)) as:

1) Specific areas within the geographical area currently occupied by a species, at the time it is listed in accordance with the Act, on which are found those physical or biological features (I) essential to the conservation of the species and (ii) that may require special management considerations or protection, and 2) Specific areas outside the geographical area occupied by a species at the time it is listed upon a determination by the Secretary [of Interior] that such areas are essential for the conservation of the species.

All areas that provide or could potentially provide habitat for song birds as protected by the State of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-13)

All areas that provide or could potentially provide habitat for hawks, vultures and owls as protected by the State of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-14)

All areas that provide or could potentially provide habitat for horned toads and Bullfrogs as protected by the State of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-15 and 16, resp.)

All perennial waters (e.g., rivers, lakes, playas, sloughs, ponds, etc)

All ephemeral drainage (e.g., arroyos, puddles/pools, intermittent streams, etc) that provide significant wildlife habitat or that could potentially transport contaminants off site to areas that provide wildlife habitat

All riparian habitats

All perennial and ephemeral wetlands (not limited to jurisdictional wetlands)

All areas that are potentially important breeding, staging, and overwintering habitats as well as other habitats important for the survival of animals during critical periods of their life cycle.

ATTACHMENT B
ECOLOGICAL SITE EXCLUSION CRITERIA CHECKLIST AND DECISION TREE

NEW MEXICO ECOLOGICAL EXCLUSION CRITERIA CHECKLIST

The following questions are designed to be used in conjunction with the Ecological Exclusion Criteria Decision Tree (Figure 1). After answering each question, refer to the Decision Tree to determine the appropriate next step. In some cases, questions will be omitted as the user is directed to another section as indicated by the flow diagram in the Decision Tree. For example, if the user answers "yes" to Question 1 of Section I, he or she is directed to proceed to Section II.

I. Habitat

In the following questions, "affected property" refers to all property on which a release has occurred or is believed to have occurred, including off-site areas where contamination may have occurred or migrated.

1. Are any of the below-listed sensitive environments at, adjacent to, or in the locality[1] of the affected property?

   - National Park or National Monument
   - Designated or administratively proposed Federal Wilderness Area
   - National Preserve
   - National or State Wildlife Refuge
   - Federal or State land designated for wildlife or game management
   - State designated Natural Areas
   - All areas that are owned or used by local tribes
   - All areas that are potentially important breeding, staging, and overwintering habitats as well as other habitats important for the survival of animals during critical periods of their life cycle
   - All areas that provide or could potentially provide habitat for state and federally listed Threatened or Endangered Species, those species that are currently petitioned for listing, and species designated by other agencies as sensitive or species of concern
   - All areas that provide or could potentially provide habitat for state protected species as defined in the Wildlife Code, Chapter 17 of the New Mexico Statutes
   - All areas that provide or could potentially provide habitat for migratory birds as protected by the Migratory Bird Treaty Act (16 U.S.C. §§ 703-712)
   - All areas that provide or could potentially provide habitat for bald eagles and golden eagles as protected by the Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)
   - All areas that provide or could potentially provide habitat for song birds as protected by the state of New Mexico statute (New Mexico Statute, 1978, Chapter

---

1 *Locality* of the site refers to any area where an ecological receptor is likely to contact site-related chemicals. The locality of the site considers the likelihood of contamination migrating over time and places the site in the context of its general surrounding. Therefore, the locality is typically larger than the site and the areas adjacent to the site.

17, Game and Fish, 17-2-13)
- All areas that provide or could potentially provide habitat for hawks, vultures and owls as protected by the state of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-14)
- All areas that provide or could potentially provide habitat for horned toads and bullfrogs as protected by the state of New Mexico statute (New Mexico Statute, 1978, Chapter 17, Game and Fish, 17-2-15 and 16, respectively)

2. Does the affected property contain land areas which were not listed in Question 1, but could be considered viable ecological habitat? The following are examples (but not a complete listing) of viable ecological habitats:

- Wooded areas
- Shrub/scrub vegetated areas
- Open fields (prairie)
- Other grassy areas
- Desert areas
- Any other areas which support wildlife and/or vegetation, excluding areas which support only opportunistic species (such as house mice, Norway rats, pigeons, etc.) that do not serve as prey to species in adjacent habitats.

The following features are <u>not</u> considered ecologically viable:

- Pavement
- Buildings
- Paved areas of roadways
- Paved/concrete equipment storage pads
- Paved manufacturing or process areas
- Other non-natural surface cover or structure

3. Does the affected property contain any perennial or ephemeral aquatic features which were not listed in Question 1?

II. Receptors

1. Is any part of the affected property used for habitat, foraging area, or refuge by any rare, threatened, or endangered species (plant *or* animal), or otherwise protected species (e.g., raptors, migratory birds)?

2. Is any part of the affected property used for habitat, foraging area, or refuge by any species used as a recreational (e.g., game animals) and/or commercial resource?

3. Is any part of the affected property used for habitat, foraging area, or refuge by any plant or animal species? This includes plants considered "weeds" and opportunistic insect and animal species (such as cockroaches and rats) if they are used as a food source for other species in the area.

III. Exposure Pathways

1. Could receptors be impacted by contaminants via direct contact?
   Is a receptor located in or using an area where it could contact contaminated air, soil3, or surface water?

   For Questions 2 and 3, note that one must answer "yes" to all three bullets in order to be directed to the "exclusion denied" box of the decision tree. This is because answering "no" to one of the questions in the bullet list indicates that a complete exposure pathway is not present. For example, in Question 2, if the chemical cannot leach or dissolve to groundwater (bullet 1), there is no chance of ecological receptors being exposed to the chemical through contact with contaminated groundwater. Similarly, the responses to the questions in Question 4 determine whether a complete pathway exists for exposure to NAPL.

2. Could receptors contact contaminants via groundwater?
   - Can the chemical leach or dissolve to groundwater4?
   - Can groundwater mobilize the chemical?
   - Could (does) contaminated groundwater discharge into known or potential receptor habitats?

3. Could receptors contact contaminants via runoff (i.e., surface water and/or suspended sediment) or erosion by water or wind?
   - Are chemicals present in surface soils?
   - Can the chemical be leached from or eroded with surface soils?
   - Is there a receptor habitat located downgradient of the leached/eroded surface soil?

4. Could receptors contact contaminants via migration of non-aqueous phase liquids (NAPL)?
   - Is NAPL present at the site?
   - Is NAPL migrating toward potential receptors or habitats?
   - Could NAPL discharge impact receptors or habitats?

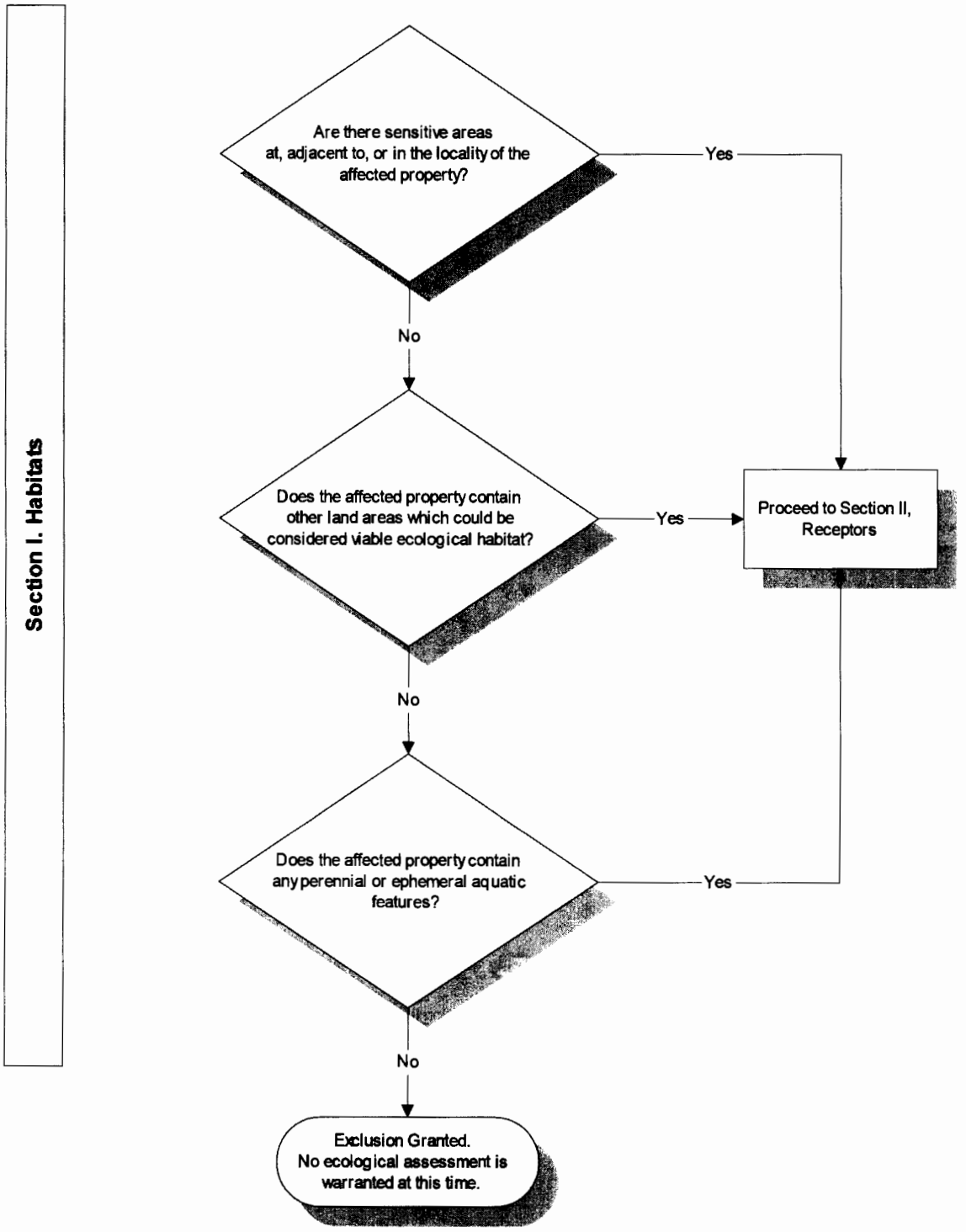
---

3 For soil, this means contamination less than 5 feet below ground surface (bgs).

4 Information on the environmental fate of specific chemicals can be found on the Internet at http://www.epa.gov/opptintr/chemfact/ or at a local library in published copies of the *Hazardous Substances Data Bank*.

Figure 1 -Ecological Exclusion Criteria Decision Tree
(Refer to corresponding checklist for the full text of each question)

Figure 1 - Exclusion Criteria Decision Tree (continued)



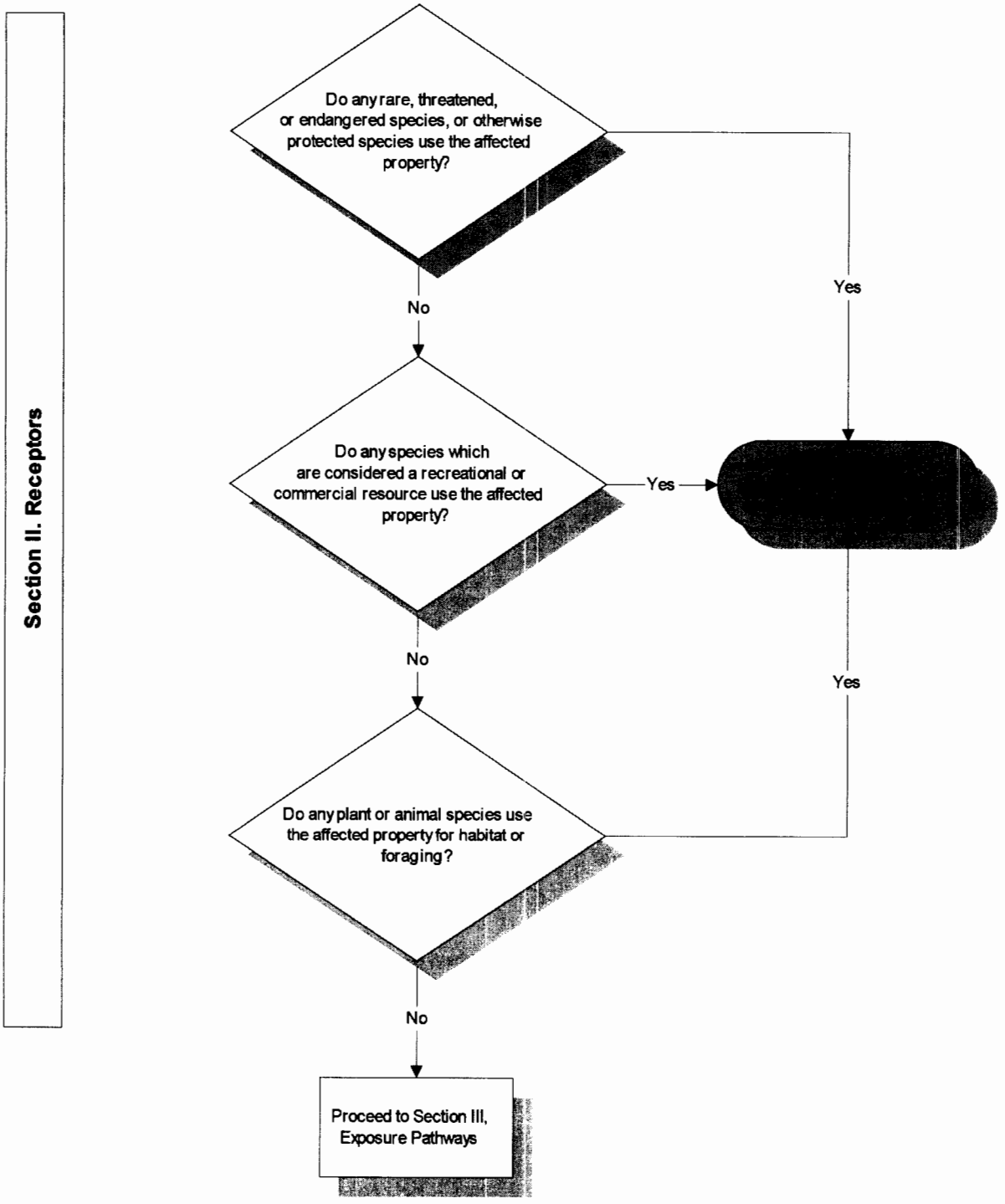
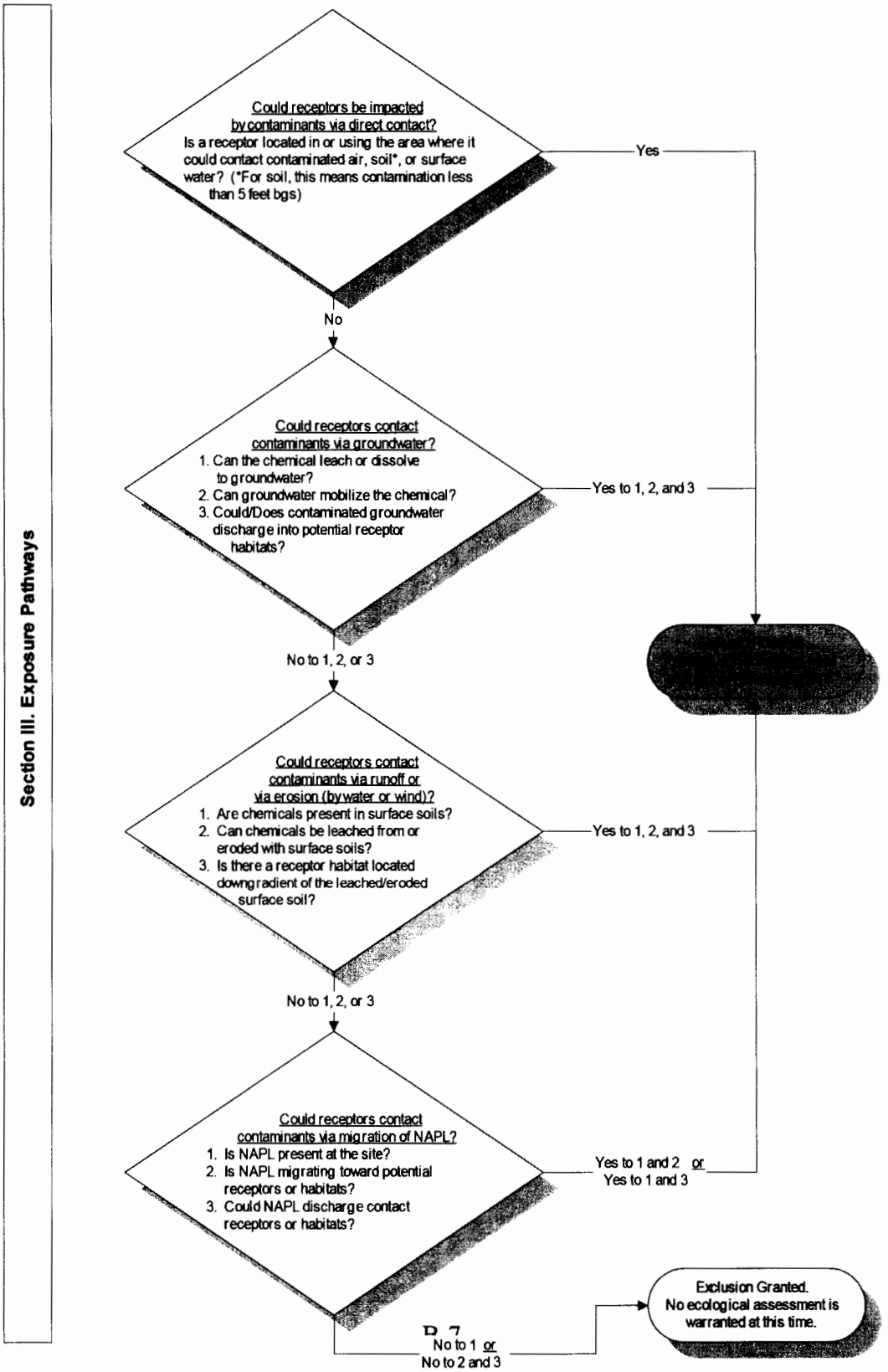

Section II. Receptors
Do any rare, threatened, or endangered species, or otherwise protected species use the affected property?
Yes
No
Do any species which are considered a recreational or commercial resource use the affected property?
Yes
No
Yes
Do any plant or animal species use the affected property for habitat or foraging?
No
Proceed to Section III, Exposure Pathways

Figure 1 - Exclusion Criteria Decision Tree (continued)



Appendix B

Field Methods

Soil Gas Sampling

Sampling Procedure

All water/product levels are determined to an accuracy of 0.01 foot using a Geotech Interface Meter. Injection pressure and injection flow rates are collected from all bioventing wells in which air is being injected. Soil gas samples are taken before groundwater purging and sampling.

Each well is equipped with an air-tight well cap for sample extraction through a sample port at the top of the well casing. Each well has dedicated flexible Teflon Food Grade tubing which extends through both sides of the sample port with one side continuing down into the well casing to approximately 1 foot above the water table. The other end (topside) protrudes from the cap and is available as a connector. Before purging, pressure is measured by attaching a hand-held Magnahelic Pressure Gauge to the topside tubing.

A portable vacuum pump is used for purging and sample collection. The topside tubing is connected to the suction of the vacuum pump and three purge volumes are withdrawn from the well prior to sample collection. After sufficient purging, a Tedlar bag is attached to the tubing at the discharge end of the pump for sample collection. All samples are properly labeled and placed in a cooler for delivery to the analytical laboratory or for field measurements of vapor-phase organics

Well Purging Technique

A vacuum pump is used to remove stagnant air from the soil gas sampling assembly. Approximately three well volumes are purged from the well before sampling. Purged volumes are determined by using the following equation:

$$(\text{Conversion Factor}) \times (\text{depth-to-water}) \times (28 \text{ liters/ft}^3) \times 3$$

The conversion factor is determined by the diameter of the well casing.

Casing	Conversion Factor
6"	0.196L/ft
4"	0.0873L/ft
2"	0.0.0218L/ft
1"	0.0.005545L/ft

Soil Gas Sampling and Sample Handling Procedure

Equipment and supplies needed for collecting representative soil gas samples include:

- Interface Probe
- Vacuum Pump
- 1 Liter Tedlar Bags
- PID Meter
- RKI Eagle Meter
- Cooler to store Tedlar Bags
- Sharpie Permanent Marker
- Field Paperwork/Logsheet
- Trash container (plastic garbage bag)

Tedlar bags and tubing dedicated for each well are used for field measurements. New Tedlar bags are used for BTEX and GRO collection and analysis.

After sufficient purging, samples are collected using the vacuum pump. Field measurements of vapor-phase organics, oxygen, and carbon dioxide concentrations are recorded using portable field instruments. BTEX and GRO samples are labeled immediately with location, date, time, analysis, and sampler and then put in a trash bag and placed in a cooler. The field logsheet is reviewed to verify all entries. Samples are then shipped to the laboratory.

To prevent cross-contamination, procedures include dedicated tubing for each of the wells sampled as well as a five minute purge time of the vacuum pump in ambient air.

Instrument Calibration

The RKI Eagle is a portable gas detection system with sensors for oxygen, carbon dioxide, and methane. Calibration of the instrument is conducted at the beginning of each day of sampling.

The meter is turned on and allowed to warm up. Fill the dedicated Tedlar bags with known calibration gas. One bag is used for the carbon dioxide calibration and the other bag contains the oxygen and methane calibration gasses. Press and hold the AIR/▲ button until a tone sounds. The Eagle automatically sets the toxics circuits to zero and the oxygen circuit to 20.9%.

Press and hold the SHIFT /▼ button, then press the DISP/ADJ button. The calibration menu is displayed. Use the AIR/▲ and SHIFT/▼ buttons to place the prompt next to the SINGLE CALIBRATION menu option. Press the POWER/ENTER button to display the Single Calibration menu. Use the AIR/▲ or SHIFT/▼ button to place the prompt next to the channel to calibrate. Press the POWER/ENTER button. Connect the tubing from the Tedlar bag to the Eagle's probe. If necessary, use the AIR/▲ (increase) and SHIFT/▼ (decrease) buttons to adjust the reading to match the concentration listed on the calibration cylinder. Press the POWER/ENTER button to set the span value. Repeat the steps for any other channels you want to calibrate.

The MiniRae 2000 Portable VOC Monitor (PID) is calibrated at the beginning of each day of sampling. Turn on the monitor and wait for the Ready message display. Press and hold both (N/-) and (MODE) keys for three seconds to enter programming mode. The first menu item "Calibrate/select Gas?" will be displayed. Press (N/-) to scroll to Fresh Air Cal? And press (Y/-) to select that menu item. Clean ambient air can be used for the "fresh air" calibration. Press (Y/-) to begin the zeroing process.

After zeroing is complete, press (N/-) to scroll to the next menu item. When Span Cal? is displayed press (Y/-) to select that menu item. Connect the monitor to a known calibration gas cylinder (isobutylene) after the display shows Apply gas now! The monitor will then perform the calibration. When calibration is completed, turn off the flow of gas, disconnect the cylinder, and exit the programming mode by pressing the (MODE) key once.

Groundwater Sampling

Groundwater Elevation

All water/product levels are determined to an accuracy of 0.01 foot using a Geotech Interface Meter. The technician records separate phase hydrocarbon, depth to water, and total well depth using this probe.

Water Quality/Groundwater Sampling

Prior to purging, an YSI 550A Dissolved Oxygen Probe is used to determine dissolved oxygen (DO) levels. Water quality parameters are measured using an Ultrameter 6P by the Myron L Company. Electrical conductance, oxidation-reduction potential (ORP), pH, and temperature are monitored during purging.

Well Purging Technique

At least three well volumes are purged from the well. Purge volumes are determined using the following equation:

(Well depth) – (Casing height) – (Depth to Liquid) x (Conversion Factor) x 3

The conversion factor is determined by the diameter of the well casing.

Casing	Conversion Factor
6"	1.50 gal/ft
5"	1.02 gal/ft
4"	0.74 gal/ft
3"	0.367 gal/ft
2"	0.163 gal/ft

Well Sampling and Sample Handling Procedure

Equipment and supplies needed for collecting representative groundwater samples include:

- Interface Probe
- Ultrameter 6P
- YSI 550A Dissolved Oxygen Instrument
- Distilled Water
- Disposable Latex Gloves
- Disposable Bailers
- String/Twine
- Cooler with Ice
- Bottle kits with Preservatives (provided by the contract laboratory)
- Sharpie Permanent Marker
- Field Paperwork/Log sheet
- Two 5-gallon buckets
- Trash container (plastic garbage bag)
- Ziploc Bags
- Paper towels

Typically disposable bailers are used for purging and sampling. Each bailer holds one liter of liquid. Three well volumes can be calculated by counting the number of times a well is bailed. All purged water is poured into a 55-gallon drum designated for sampling events.

After sufficient purging, samples are collected with the bailer and poured into the appropriate sample containers. Two people are usually utilized for sampling. Sampling takes place over a bucket to insure that spills are contained

Samples are labeled immediately with location, date, time, analysis, preservative, and sampler. Then they are put in a Ziploc bag and placed in a cooler holding sufficient ice to keep them cool. The field log sheet is reviewed to verify all entries.

Purge and Decontamination Water Disposal

The Ultrameter 6P, YSI 550A DO Probe, and the interface probe are rinsed with distilled water after every well. The rinse procedure takes place over a bucket to insure that spills are contained. All rinse and purge water is contained and then disposed of through the refinery wastewater system.

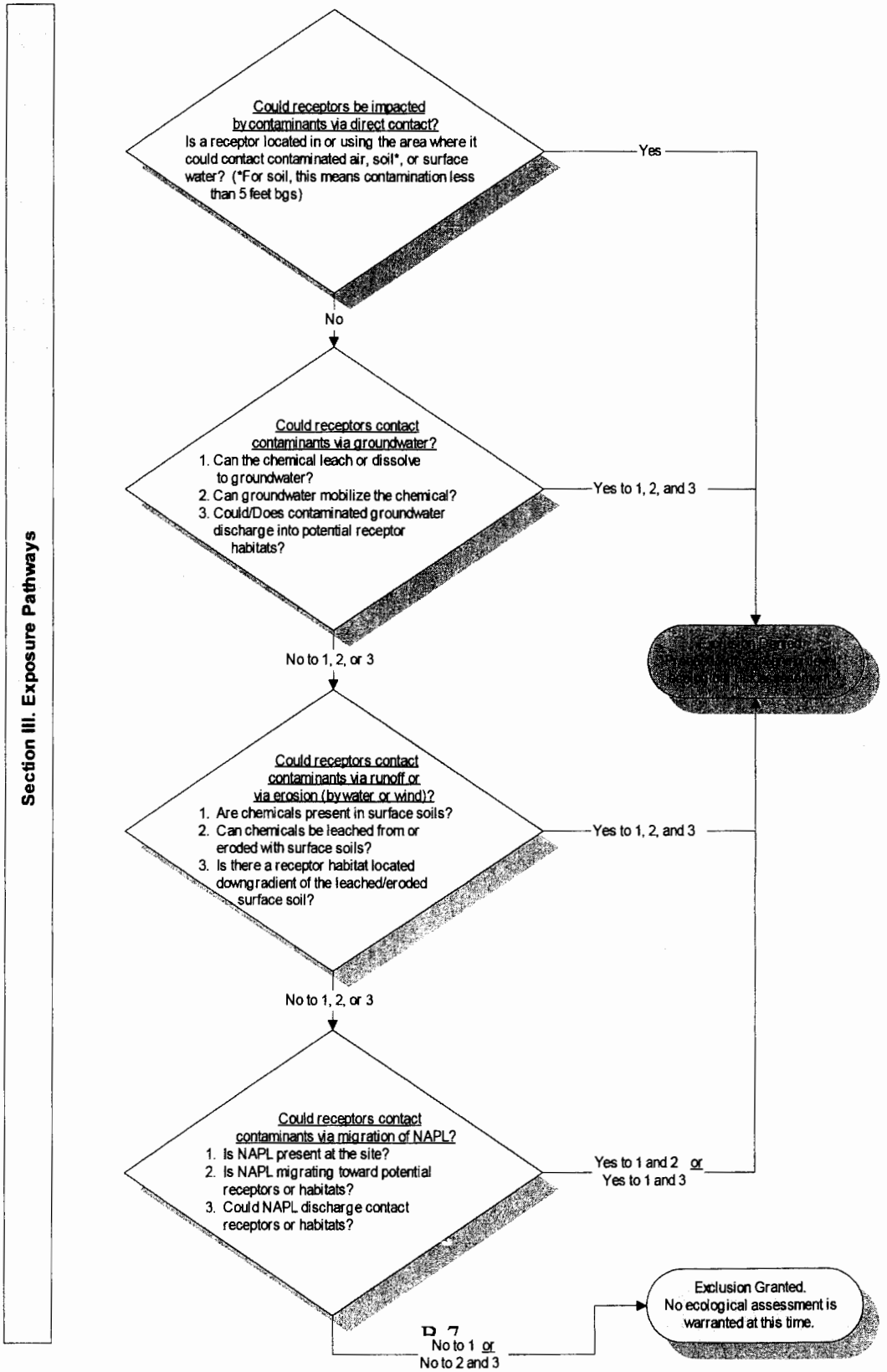
Instrument Calibration

Calibration of the YSI 550A Dissolved Oxygen Instrument occurs at the beginning of each day of sampling. The probe is powered on and allowed to stabilize, which usually takes 15 minutes. Enter the calibration menu. The LCD will prompt you to enter the local altitude in hundreds of feet. When the proper altitude appears on the LCD, press the ENTER key. The LCD will then prompt you to enter the salinity of the water you are about to analyze. After entering the correct salinity, the instrument will return to normal operation.

The Ultrameter 6P instrument calibration occurs at the beginning of each day of sampling. For Conductivity and TDS calibration, the cell is rinsed three times with a 3000 umhos/cm NaCl Standard. The cell cup is refilled with the standard. Either the COND or the TDS button is pressed and then the CAL button is pushed. Press the up or down arrow until the display agrees with the standard. The CAL button is pressed to accept the value.

The Ultrameter 6P has an electronic ORP calibration which is automatically calibrated with the 7 pH. The pH sensor well is rinsed three times with 7.0 buffer solution and then refilled again with that buffer. The pH button is pressed then the CAL button. The up or down arrow is adjusted until the display agrees with the buffer value. The CAL button is pushed to accept that value. Repeat the calibration steps using an acid buffer solution and then again with a base buffer solution.

Figure 1 - Exclusion Criteria Decision Tree (continued)



Appendix B

Field Methods

Soil Gas Sampling

Sampling Procedure

All water/product levels are determined to an accuracy of 0.01 foot using a Geotech Interface Meter. Injection pressure and injection flow rates are collected from all bioventing wells in which air is being injected. Soil gas samples are taken before groundwater purging and sampling.

Each well is equipped with an air-tight well cap for sample extraction through a sample port at the top of the well casing. Each well has dedicated flexible Teflon Food Grade tubing which extends through both sides of the sample port with one side continuing down into the well casing to approximately 1 foot above the water table. The other end (topside) protrudes from the cap and is available as a connector. Before purging, pressure is measured by attaching a hand-held Magnahelic Pressure Gauge to the topside tubing.

A portable vacuum pump is used for purging and sample collection. The topside tubing is connected to the suction of the vacuum pump and three purge volumes are withdrawn from the well prior to sample collection. After sufficient purging, a Tedlar bag is attached to the tubing at the discharge end of the pump for sample collection. All samples are properly labeled and placed in a cooler for delivery to the analytical laboratory or for field measurements of vapor-phase organics

Well Purging Technique

A vacuum pump is used to remove stagnant air from the soil gas sampling assembly. Approximately three well volumes are purged from the well before sampling. Purged volumes are determined by using the following equation:

$$(\text{Conversion Factor}) \times (\text{depth-to-water}) \times (28 \text{ liters/ft}^3) \times 3$$

The conversion factor is determined by the diameter of the well casing.

Casing	Conversion Factor
6"	0.196L/ft
4"	0.0873L/ft
2"	0.0.0218L/ft
1"	0.0.005545L/ft

Soil Gas Sampling and Sample Handling Procedure

Equipment and supplies needed for collecting representative soil gas samples include:

- Interface Probe
- Vacuum Pump
- 1 Liter Tedlar Bags
- PID Meter
- RKI Eagle Meter
- Cooler to store Tedlar Bags
- Sharpie Permanent Marker
- Field Paperwork/Logsheet
- Trash container (plastic garbage bag)

Tedlar bags and tubing dedicated for each well are used for field measurements. New Tedlar bags are used for BTEX and GRO collection and analysis.

After sufficient purging, samples are collected using the vacuum pump. Field measurements of vapor-phase organics, oxygen, and carbon dioxide concentrations are recorded using portable field instruments. BTEX and GRO samples are labeled immediately with location, date, time, analysis, and sampler and then put in a trash bag and placed in a cooler. The field logsheet is reviewed to verify all entries. Samples are then shipped to the laboratory.

To prevent cross-contamination, procedures include dedicated tubing for each of the wells sampled as well as a five minute purge time of the vacuum pump in ambient air.

Instrument Calibration

The RKI Eagle is a portable gas detection system with sensors for oxygen, carbon dioxide, and methane. Calibration of the instrument is conducted at the beginning of each day of sampling.

The meter is turned on and allowed to warm up. Fill the dedicated Tedlar bags with known calibration gas. One bag is used for the carbon dioxide calibration and the other bag contains the oxygen and methane calibration gasses. Press and hold the AIR/▲ button until a tone sounds. The Eagle automatically sets the toxics circuits to zero and the oxygen circuit to 20.9%.

Press and hold the SHIFT /▼ button, then press the DISP/ADJ button. The calibration menu is displayed. Use the AIR/▲ and SHIFT/▼ buttons to place the prompt next to the SINGLE CALIBRATION menu option. Press the POWER/ENTER button to display the Single Calibration menu. Use the AIR/▲ or SHIFT/▼ button to place the prompt next to the channel to calibrate. Press the POWER/ENTER button. Connect the tubing from the Tedlar bag to the Eagle's probe. If necessary, use the AIR/▲ (increase) and SHIFT/▼ (decrease) buttons to adjust the reading to match the concentration listed on the calibration cylinder. Press the POWER/ENTER button to set the span value. Repeat the steps for any other channels you want to calibrate.

The MiniRae 2000 Portable VOC Monitor (PID) is calibrated at the beginning of each day of sampling. Turn on the monitor and wait for the Ready message display. Press and hold both (N/-) and (MODE) keys for three seconds to enter programming mode. The first menu item "Calibrate/select Gas?" will be displayed. Press (N/-) to scroll to Fresh Air Cal? And press (Y/-) to select that menu item. Clean ambient air can be used for the "fresh air" calibration. Press (Y/-) to begin the zeroing process.

After zeroing is complete, press (N/-) to scroll to the next menu item. When Span Cal? is displayed press (Y/-) to select that menu item. Connect the monitor to a known calibration gas cylinder (isobutylene) after the display shows Apply gas now! The monitor will then perform the calibration. When calibration is completed, turn off the flow of gas, disconnect the cylinder, and exit the programming mode by pressing the (MODE) key once.

Groundwater Sampling

Groundwater Elevation

All water/product levels are determined to an accuracy of 0.01 foot using a Geotech Interface Meter. The technician records separate phase hydrocarbon, depth to water, and total well depth using this probe.

Water Quality/Groundwater Sampling

Prior to purging, an YSI 550A Dissolved Oxygen Probe is used to determine dissolved oxygen (DO) levels. Water quality parameters are measured using an Ultrameter 6P by the Myron L Company. Electrical conductance, oxidation-reduction potential (ORP), pH, and temperature are monitored during purging.

Well Purging Technique

At least three well volumes are purged from the well. Purge volumes are determined using the following equation:

(Well depth) – (Casing height) – (Depth to Liquid) x (Conversion Factor) x 3

The conversion factor is determined by the diameter of the well casing.

Casing	Conversion Factor
6"	1.50 gal/ft
5"	1.02 gal/ft
4"	0.74 gal/ft
3"	0.367 gal/ft
2"	0.163 gal/ft

Well Sampling and Sample Handling Procedure

Equipment and supplies needed for collecting representative groundwater samples include:

- Interface Probe
- Ultrameter 6P
- YSI 550A Dissolved Oxygen Instrument
- Distilled Water
- Disposable Latex Gloves
- Disposable Bailers
- String/Twine
- Cooler with Ice
- Bottle kits with Preservatives (provided by the contract laboratory)
- Sharpie Permanent Marker
- Field Paperwork/Log sheet
- Two 5-gallon buckets
- Trash container (plastic garbage bag)
- Ziploc Bags
- Paper towels

Typically disposable bailers are used for purging and sampling. Each bailer holds one liter of liquid. Three well volumes can be calculated by counting the number of times a well is bailed. All purged water is poured into a 55-gallon drum designated for sampling events.

After sufficient purging, samples are collected with the bailer and poured into the appropriate sample containers. Two people are usually utilized for sampling. Sampling takes place over a bucket to insure that spills are contained

Samples are labeled immediately with location, date, time, analysis, preservative, and sampler. Then they are put in a Ziploc bag and placed in a cooler holding sufficient ice to keep them cool. The field log sheet is reviewed to verify all entries.

Purge and Decontamination Water Disposal

The Ultrameter 6P, YSI 550A DO Probe, and the interface probe are rinsed with distilled water after every well. The rinse procedure takes place over a bucket to insure that spills are contained. All rinse and purge water is contained and then disposed of through the refinery wastewater system.

Instrument Calibration

Calibration of the YSI 550A Dissolved Oxygen Instrument occurs at the beginning of each day of sampling. The probe is powered on and allowed to stabilize, which usually takes 15 minutes. Enter the calibration menu. The LCD will prompt you to enter the local altitude in hundreds of feet. When the proper altitude appears on the LCD, press the ENTER key. The LCD will then prompt you to enter the salinity of the water you are about to analyze. After entering the correct salinity, the instrument will return to normal operation.

The Ultrameter 6P instrument calibration occurs at the beginning of each day of sampling. For Conductivity and TDS calibration, the cell is rinsed three times with a 3000 umhos/cm NaCl Standard. The cell cup is refilled with the standard. Either the COND or the TDS button is pressed and then the CAL button is pushed. Press the up or down arrow until the display agrees with the standard. The CAL button is pressed to accept the value.

The Ultrameter 6P has an electronic ORP calibration which is automatically calibrated with the 7 pH. The pH sensor well is rinsed three times with 7.0 buffer solution and then refilled again with that buffer. The pH button is pressed then the CAL button. The up or down arrow is adjusted until the display agrees with the buffer value. The CAL button is pushed to accept that value. Repeat the calibration steps using an acid buffer solution and then again with a base buffer solution.

Appendix C

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory

QUALITY ASSURANCE PLAN

Effective Date: July 2nd, 2012

Revision 9.5

www.hallenvironmental.com

Control Number: 00000120

Approved By:

Andy Freeman
Laboratory Manager

6/29/12
Date

Approved By:

Carolyn Swanson
Quality Assurance/Quality Control Officer

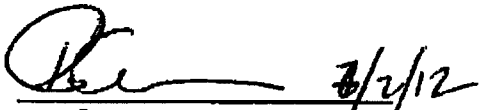
6/29/2012
Date

4901 Hawkins NE ■ Suite D ■ Albuquerque, NM 87109
505.345.3975 ■ Fax 505.345.4107
www.hallenvironmental.com

Approved By:

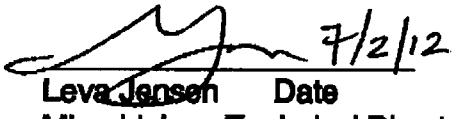
Andy Freeman Date
Organics Technical Director

Approved By:



Ian Cameron Date
Inorganics Technical Director

Approved By:



Leva Jansen Date
Microbiology Technical Director

Table of Contents

This Page was intentionally left blank.

3.0 Introduction

Purpose of Document

The purpose of this Quality Assurance Plan is to formally document the quality assurance policies and procedures of Hall Environmental Analysis Laboratory, Inc. (HEAL), for the benefit of its employees, clients, and accrediting organizations. HEAL continually implements all aspects of this plan as an essential and integral part of laboratory operations in order to ensure that high quality data is produced in an efficient and effective manner.

Objectives

The objective of HEAL is to achieve and maintain excellence in environmental testing. This is accomplished by developing, incorporating and documenting the procedures and policies specified by each of our accrediting authorities and outlined in this plan. These activities are carried out by a laboratory staff that is analytically competent, well-qualified, and highly trained. An experienced management team, knowledgeable in their area of expertise, monitors them. Finally, a comprehensive quality assurance program governs laboratory practices and ensures that the analytical results are valid, defensible, reproducible, reconstructable and of the highest quality.

HEAL establishes and thoroughly documents its activities to ensure that all data generated and processed will be scientifically valid and of known and documented quality. Routine laboratory activities are detailed in method specific standard operating procedures (SOP). All data reported meets the applicable requirements for the specific method that is referenced, ORELAP, TCEQ, EPA, client specific requirements and/or State Bureaus. In the event that these requirements are ever in contention with each other, it is HEAL's policy to always follow the most prudent requirement available. For specific method requirements refer to HEAL's Standard Operating Procedures (SOP's), EPA methods, Standard Methods 20th edition, ASTM methods or state specific methods.

HEAL management ensures that this document is correct in terms of required accuracy and data reproducibility, and that the procedures contain proper quality control measures. HEAL management additionally ensures that all equipment is reliable, well-maintained and appropriately calibrated. The procedures and practices of the laboratory are geared towards not only strictly following our regulatory requirements but also allowing the flexibility to conform to client specific specifications. Meticulous records are maintained for all samples and their respective analyses so that results are well-documented and defensible in a court of law.

The HEAL Quality Assurance/Quality Control Officer (QA/QCO) and upper management are responsible for supervising and administering this quality assurance program, and ensuring each individual is responsible for its proper implementation. All HEAL

management remains committed to the encouragement of excellence in analytical testing and will continue to provide the necessary resources and environment conducive to its achievement.

Policies

Understanding that quality cannot be mandated, it is the policy of this laboratory to provide an environment that encourages all staff members to take pride in the quality of their work. In addition to furnishing proper equipment and supplies, HEAL stresses the importance of continued training and professional development. Further, HEAL recognizes the time required for data interpretation. Therefore, no analyst should feel pressure to sacrifice data quality for data quantity. Each staff member must perform with the highest level of integrity and professional competence, always being alert to problems that could compromise the quality of their technical work.

Management and senior personnel supervise analysts closely in all operations. Under no circumstance is the willful act or fraudulent manipulation of analytical data condoned. Such acts must be reported immediately to HEAL management. Reported acts will be assessed on an individual basis and resulting actions could result in dismissal. The laboratory staff is encouraged to speak with lab managers or senior management if they feel that there are any undo commercial, financial, or other pressures, which might adversely affect the quality of their work; or in the event that they suspect that data quality has been compromised in any way. HEAL's Quality Assurance/Quality Control Officer is available if any analyst and/or manager wishes to anonymously report any suspected or known breaches in data integrity.

Understanding the importance of meeting customer requirements in addition to the requirements set forth in statutory and regulatory requirements, HEAL shall periodically seek feedback from customers and evaluate the feedback in order to initiate improvements.

All proprietary rights and client information at HEAL (including national security concerns) are considered confidential. No information will be given out without the express verbal or written permission of the client. All reports generated will be held in the strictest of confidence.

HEAL shall continually improve the effectiveness of its management system through the use of the policies and procedures outlined in this Quality Assurance Plan. Quality control results, internal and external audit findings, management reviews, new and continual training and corrective and preventive actions are continually evaluated to identify possible improvements and to ensure that appropriate communication processes are taking place regarding the effectiveness of the management system. HEAL shall ensure that the integrity of the quality system is maintained when changes to the system are planned and implemented.

This is a controlled document. Each copy is assigned a unique tracking number and when released to a client or accrediting agency the QA/QCO keeps the tracking number on file. This document is reviewed on an annual basis to ensure that it is valid and representative of current practices at HEAL.

4.0 Organization and Responsibility

Company

HEAL is accredited in accordance with the 2009 TNI standard (see NELAC accredited analysis list in the Document Control Logbook), through ORELAP and TCEQ and by the Arizona Department of Health Services. Additionally, HEAL is qualified as defined under the State of New Mexico Water Quality Control Commission regulations and the New Mexico State Drinking Water Bureau. HEAL is a locally owned small business that was established in 1991. HEAL is a full service environmental analysis laboratory with analytical capabilities that include both organic and inorganic methodologies and has performed analyses of soil, water, and air as well as various other matrices for many sites in the region. HEAL's client base includes local, state and federal agencies, private consultants, commercial industries as well as individual homeowners. HEAL has performed as a subcontractor to the state of New Mexico and to the New Mexico Department of Transportation. HEAL has been acclaimed by its customers as producing quality results and as being adaptive to client-specific needs.

The laboratory is divided into an organic section and an inorganic section. Each section has a designated manager/technical director. The technical directors report directly to the laboratory manager, who oversees all operations.

Certifications

ORELAP – NELAC Oregon Primary accrediting authority.

TCEQ – NELAC Texas Secondary accrediting authority.

The Arizona Department of Health Services

The New Mexico Drinking Water Bureau

The New Mexico Department of Health

See the current Document Control Logbook for copies of current licenses and licensed parameters, or refer to our current list of certifications online at www.hallenvironmental.com.

In the event of a certification being revoked or suspended, HEAL will notify, in writing, those clients that require the affected certification.

Personnel

HEAL management ensures the competence of all who operate equipment, perform environmental tests, evaluate results, and sign test reports. Personnel performing specific tasks shall be qualified on the basis of appropriate education, training, experience and /or demonstrated skills.

HEAL ensures that all personnel are aware of the relevance and importance of their activities and how each employee contributes to the achievement of the objectives defined throughout this document.

All personnel shall be responsible for complying with HEAL's quality assurance/quality control requirements that pertain to their technical function. Each technical staff member must have a combination of experience and education to adequately demonstrate specific knowledge of their particular function and a general knowledge of laboratory operations, test methods, quality assurance/quality control procedures, and records management.

All employees' training certificates and diplomas are kept on file with demonstrations of capability for each method they perform. An Organizational Chart can be found at the end of this section and a personnel list is available in the current Document Control Logbook.

Laboratory Director

The Laboratory Director is responsible for overall technical direction and business leadership of HEAL. The Laboratory Manager, the Project Manager and Quality Assurance/Quality Control Officer report directly to the Laboratory Director. Someone with a minimum of 7 years of directly related experience and a bachelor's degree in a scientific or engineering discipline should fill this position.

Laboratory Manager/Lead Technical Director

The Laboratory Manager shall exercise day–to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results. The Laboratory Manager shall be experienced in the fields of accreditation for which the laboratory is approved or seeking accreditation. The Laboratory Manager shall certify that personnel with appropriate educational and/or technical background perform all tests for which HEAL is accredited. Such certification shall be documented.

The Laboratory Manager shall monitor standards of performance in quality control and quality assurance and monitor the validity of the analyses performed and data generated at HEAL to assure reliable data.

The Laboratory Manager is responsible for the daily operations of the laboratory. The Laboratory Manager is the lead technical director of the laboratory and, in conjunction

with the section technical directors, is responsible for coordinating activities within the laboratory with the overall goal of efficiently producing high quality data within a reasonable time frame.

In events where employee scheduling or current workload is such that new work cannot be incorporated, without missing hold times, the Laboratory Manager has authority to modify employee scheduling, re-schedule projects or, when appropriate, allocate the work to approved subcontracting laboratories.

Additionally, the laboratory manager reviews and approves new analytical procedures and methods, and performs a final review of most analytical results. The Laboratory Manager provides technical support to both customers and HEAL staff.

The Laboratory Manager also observes the performance of supervisors to ensure that good laboratory practices and proper techniques are being taught and utilized, and to assist in overall quality control implementation and strategic planning for the future of the company. Other duties include assisting in establishing laboratory policies that lead to the fulfillment of requirements for various certification programs, assuring that all Quality Assurance and Quality Control documents are reviewed and approved, and assisting in conducting Quality Assurance Audits.

The laboratory manager addresses questions or complaints that cannot be answered by the section managers.

The Laboratory Manager shall have a bachelor's degree in a chemical, environmental, biological sciences, physical sciences or engineering field, and at least five years of experience in the environmental analysis of representative inorganic and organic analytes for which the laboratory seeks or maintains accreditation.

Quality Assurance Quality Control Officer

The Quality Assurance/Quality Control Officer (QA/QCO) serves as the focal point for QA/QC and shall be responsible for the oversight and/or review of quality control data. The QA/QCO functions independently from laboratory operations and shall be empowered to halt unsatisfactory work and/or prevent the reporting of results generated from an out-of-control measurement system. The QA/QCO shall objectively evaluate data and perform assessments without any outside/managerial influence. The QA/QCO shall have direct access to the highest level of management at which decisions are made on laboratory policy and/or resources. The QA/QCO shall notify laboratory management of deficiencies in the quality system in periodic, independent reports.

The QA/QCO shall have general knowledge of the analytical test methods for which data review is performed and have documented training and/or experience in QA/QC procedures and in the laboratory's quality system. The QA/QCO will have a

minimum of a BS in a scientific or related field and a minimum of three years of related experience.

The QA/QCO shall schedule and conduct internal audits as per the Internal Audit SOP at least annually, monitor and trend Corrective Action Reports as per the Data Validation SOP, periodically review control charts for out of control conditions, and initiate any appropriate corrective actions.

The QA/QCO shall oversee the analysis of proficiency testing in accordance with our standards and monitor any corrective actions issued as a result of this testing.

The QA/QCO reviews all standard operating procedures and statements of work in order to assure their accuracy and compliance to method and regulatory requirements.

The QA/QCO shall be responsible for maintaining and updating this quality manual.

Project Manager

The role of the project manager is to act as a liaison between HEAL and our clients. The Project Manager updates clients on the status of projects in-house, prepares quotations for new work, and is responsible for HEAL's marketing effort.

All new work is assessed by the Project Manager and reviewed with the other managers so as to not exceed the laboratory's capacity. In events where employee scheduling or current workload is such that new work cannot be incorporated without missing hold times, the Project Manager has authority to re-schedule projects.

It is also the duty of the project manager to work with the Laboratory Manager and QA/QCO to insure that before new work is undertaken, the resources required and accreditations requested are available to meet the client's specific needs.

Additionally, the Project Manager can initiate the review of the need for new analytical procedures and methods, and perform a final review of some analytical results. The Project Manager provides technical support to customers. Someone with a minimum of 2 years of directly related experience and a bachelor's degree in a scientific or engineering discipline should fill this position.

Technical Directors

Technical Directors are full-time members of the staff at HEAL who exercise day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results for their department within HEAL. A Technical Director's duties shall include, but not be limited to, monitoring standards of performance in quality

control and quality assurance, monitoring the validity of the analyses performed and the data generated in their sections to ensure reliable data, overseeing training and supervising departmental staff, scheduling incoming work for their sections, and monitoring laboratory personnel to ensure that proper procedures and techniques are being utilized. They supervise and implement new Quality Control procedures as directed by the QA/QCO, update and maintain quality control records including, but not limited to, training forms, IDOCs, ADOCPs, and MDLs, and evaluate laboratory personnel in their Quality Control activities. In addition, technical directors are responsible for upholding the spirit and intent of HEAL's data integrity procedures.

As Technical Directors of their associated section, they review analytical data to acknowledge that data meets all criteria set forth for good Quality Assurance practices. Someone with a minimum of 2 years of experience in the environmental analysis of representative analytes for which HEAL seeks or maintains accreditation and a bachelor's degree in a scientific or related discipline should fill this position.

Section Supervisors

Section Supervisors are full time members of staff at HEAL who exercise day-to-day supervision of laboratory operations for the appropriate fields of accreditation and reporting of results for their department within HEAL. Section Supervisors report directly to their technical director. A Section Supervisor's duties shall include, but not be limited to, monitoring standards of performance in quality control and quality assurance, monitoring the validity of the analyses performed and the data generated in their sections to ensure reliable data, overseeing training and supervising departmental staff, scheduling incoming work for their sections, and monitoring laboratory personnel to ensure that proper procedures and techniques are being utilized. They supervise and implement new Quality Control procedures as directed by the QA/QCO, update and maintain quality control records including, but not limited to, training forms, IDOCs, ADOCPs, and MDLs, and evaluate laboratory personnel in their Quality Control activities. In addition, Section Supervisors are responsible for upholding the spirit and intent of HEAL's data integrity procedures. Section Supervisors update their Technical Director on the status and needs of their departments and submit all Quality Control documents to their technical director for their review, approval and signature.

As section supervisors, they review analytical data to acknowledge that data meets all criteria set forth for good Quality Assurance practices. Someone with a minimum of 2 years of experience in the environmental analysis of representative analytes for which HEAL seeks or maintains accreditation and a bachelor's degree, or equivalent experience in a scientific or related discipline should fill this position.

Health and Safety / Chemical Hygiene Officer

Refer to the most recent version of the Health and Safety and Chemical Hygiene Plans for the roles, responsibilities, and basic requirements of the Health and Safety Officer (H&SO) and the Chemical Hygiene Officer (CHO). These jobs can be executed by the same employee.

Analyst I, II and III

Analysts are responsible for the analysis of various sample matrices including, but not limited to, solid, aqueous, and air, as well as the generation of high quality data in accordance with the HEAL SOPs and QA/QC guidelines in a reasonable time as prescribed by standard turnaround schedules or as directed by the Section Manager or Laboratory Manager.

Analysts are responsible for making sure all data generated is entered in the database in the correct manner and the raw data is reviewed, signed and delivered to the appropriate peer for review. An analyst reports daily to the section manager and will inform them as to material needs of the section specifically pertaining to the analyses performed by the analyst. Additional duties may include preparation of samples for analysis, maintenance of lab instruments or equipment, and cleaning and providing technical assistance to lower level laboratory staff.

The senior analyst in the section may be asked to perform supervisory duties as related to operational aspects of the section. The analyst may perform all duties of a lab technician.

The position of Analyst is a full or part time hourly position and is divided into three levels, Analyst I, II, and III. All employees hired into an Analyst position at HEAL must begin as an Analyst I and remain there at a minimum of three months regardless of their education and experience. Analyst I must have a minimum of an AA in a related field or equivalent experience (equivalent experience means years of related experience can be substituted for the education requirement). An Analyst I is responsible for analysis, instrument operation, including calibration and data reduction. Analyst II must have a minimum of an AA in a related field or equivalent experience and must have documented and demonstrated aptitude to perform all functions of an Analyst II. An Analyst II is responsible for the full analysis of their test methods, routine instrument maintenance, purchase of consumables as dictated by their Technical Director, advanced data reduction, and basic data review. Analyst II may also assist Analyst III in method development and, as dictated by their Technical Director, may be responsible for the review and/or revision of their method specific SOPs. Analyst III must have Bachelors degree or equivalent experience and must have documented and demonstrated aptitude to perform all functions of an Analyst III. An Analyst III is responsible for all tasks completed by an Analyst I and II as well as advanced data review, non-routine instrument maintenance, assisting their technical director in basic supervisory duties and method development.

Laboratory Technician

A laboratory technician is responsible for providing support to analysts in the organics, inorganics and disposal departments. Laboratory Technicians can assist analysts in basic sample preparation, general laboratory maintenance, glassware washing, chemical inventories, sample disposal and sample kit preparation. This position can be filled by someone without the education and experience necessary to obtain a position as an analyst.

Sample Control Manager

The sample control manager is responsible for receiving samples and reviewing the sample login information after it has been entered into the computer. The sample control manager also checks the samples against the chain-of-custody for any sample and/or labeling discrepancies prior to distribution.

The sample control manager is responsible for sending out samples to the sub-contractors along with the review and shipping of field sampling bottle kits. The sample control manager acts as a liaison between the laboratory and field sampling crew to ensure that the appropriate analytical test is assigned. If a discrepancy is noted, the sample control manager or sample custodian will contact the customer to resolve any questions or problems. The sample control manager is an integral part of the customer service team.

This position should be filled by someone with a high school diploma and a minimum of 2 years of related experience and can also be filled by a senior manager.

Sample Custodians

Sample Custodians work directly under the Sample Control Manager. They are responsible for sample intake into the laboratory and into the LIMS. Sample Custodians take orders from our clients and prepare appropriate bottle kits to meet the clients' needs. Sample Custodians work directly with the clients in properly labeling and identifying samples as well as properly filling out legal COCs. When necessary, Sample Custodians contact clients to resolve any questions or problems associated with their samples. Sample Custodians are responsible for distributing samples throughout the laboratory and are responsible for notifying analysts of special circumstances such as short holding times or improper sample preservation upon receipt.

Sample Disposal Custodian

The sample disposal custodian is responsible for characterizing and disposing of samples in accordance to the most recent version of the sample disposal SOP. The sample disposal custodian collects waste from the laboratory and transports it to the disposal warehouse for storage and eventual disposal. The sample disposal custodian is responsible for maintaining the disposal warehouse and following the requirements for documentation, integrity, chemical hygiene and health and safety as set forth in the various HEAL administrative SOPs. The sample disposal custodian is responsible for overseeing any laboratory technicians employed at the disposal warehouse.

This position should be filled by someone with a high school diploma and a minimum of 1 year of related experience.

Bookkeeper

The Bookkeeper is responsible for the preparation of quarterly financials and quarterly payroll reports. The bookkeeper monitors payables, receivables, deposits, pays all bills and maintains an inventory of administrative supplies. The Bookkeeper completes final data package assembly and oversees the consignment of final reports. The Bookkeeper assists in the project management of drinking water compliance samples for NMED and NMEFC and any other tasks as assigned by the Laboratory Manager. This position should be filled by someone with a degree in accounting or a minimum of a high school diploma and at least 4 years of directly related experience.

Administrative Assistant

The Administrative Assistant is responsible for aiding administrative staff in tasks that include but are not limited to: the processing and consignment of final reports, and the generation of client specific spreadsheets. This position should be filled by someone with a minimum of a high school diploma.

IT Specialist

The IT Specialist is responsible for the induction and maintenance of all hard and software technology not maintained through a service agreement. The IT Specialist follows the requirements of this document, all regulatory documents and the EPAs Good Automated Laboratory Practices. This position should be filled by someone with a degree in a computer related field, or at least two years of directly related experience.

Delegations in the Absence of Key Personnel

Planned absences shall be preceded by notification to the Laboratory Manager. The appropriate staff members shall be informed of the absence. In the case of unplanned absences, the superior shall either assume the responsibilities and duties or delegate the responsibilities and duties to another appropriately qualified employee.

In the event that the Laboratory Manager is absent for a period of time exceeding fifteen consecutive calendar days, another full-time staff member meeting the basic qualifications and competent to temporarily perform this function will be designated. If this absence exceeds thirty-five consecutive calendar days, HEAL will notify ORELAP in writing of the absence and the pertinent qualifications of the temporary laboratory manager.

Laboratory Personnel Qualification and Training

All personnel joining HEAL shall undergo orientation and training. During this period the new personnel shall be introduced to the organization and their responsibilities, as well as the policies and procedures of the company. They shall also undergo on-the-job training and shall work with trained staff. They will be shown required tasks and be observed while performing them.

When utilizing staff undergoing training, appropriate supervision shall be dictated and overseen by the appropriate section technical director. Prior to analyzing client samples, a new employee, or an employee new to a procedure, must meet the following basic requirements. The SOP and Method for the analysis must be read and signed by the employee indicating that they read, understand, and intend to comply with the requirements of the documents. The employee must undergo documented training. Training is conducted by a senior analyst familiar with the procedure and overseen by the section Technical Director. This training is documented by any means deemed appropriate by the trainer and section Technical Director, and kept on file in the employees file located in the QA/QCO's office. The employee must perform a successful Initial Demonstration of Proficiency (IDOC). See the current Document Control Logbook for the training documents and checklists utilized at HEAL to ensure that all of these requirements are met. Once all of the above requirements are met it is incumbent upon the section Technical Director to determine at which point the employee can begin to perform the test unsupervised. A Certification to Complete Work Unsupervised (see the current Document Control Logbook) is then filled out by the employee and technical director.

IDOCs are required for all new analysts and methods prior to sample analysis. IDOCs are also required any time there is a change in the instrument, analyte list or method. If more than twelve months have passed since an analyst performed an IDOC and they have not performed the method and/or have not met the continuing DOC requirements, the analyst must perform an IDOC prior to resuming the test.

All IDOCs shall be documented through the use of the certification form which can be found in the current Document Control Logbook. IDOCs are performed by analyzing four Laboratory Control Spikes (LCSs). Using the results of the LCSs the mean recovery is calculated in the appropriate reporting units and the standard deviations of the population sample (n-1) (in the same units) as well as the relative percent difference for each parameter of interest. When it is not possible or pertinent to determine mean and standard deviations HEAL assesses performance against establish and documented criteria dictated in the method SOP. The mean and standard deviation are compared to the corresponding acceptance criteria for precision and accuracy in the test method (if applicable) or in laboratory-generated acceptance criteria. In the event that the HEAL SOP or test method fail to establish the pass/fail criteria the default limits of +/- 20% for calculated recovery and <20% relative percent difference based on the standard deviation will be utilized. If all parameters meet the acceptance criteria, the IDOC is successfully completed. If any one of the parameters do not meet the acceptance criteria, the performance is unacceptable for that parameter and the analyst must either locate and correct the source of the problem and repeat the test for all parameters of interest or repeat the test for all parameters that failed to meet criteria. Repeat failure, however, confirms a general problem with the measurement system. If this occurs the source of the problem must be identified and the test repeated for all parameters of interest.

New employees that do not have prior analysis experience will not be allowed to perform analysis until they have demonstrated attention to detail with minimal errors in the assigned tasks. To ensure a sustained level of quality performance among staff members, continuing demonstration of capability shall be performed at least once a year. These are as an Annual Documentation of Continued Proficiency (ADOCP).

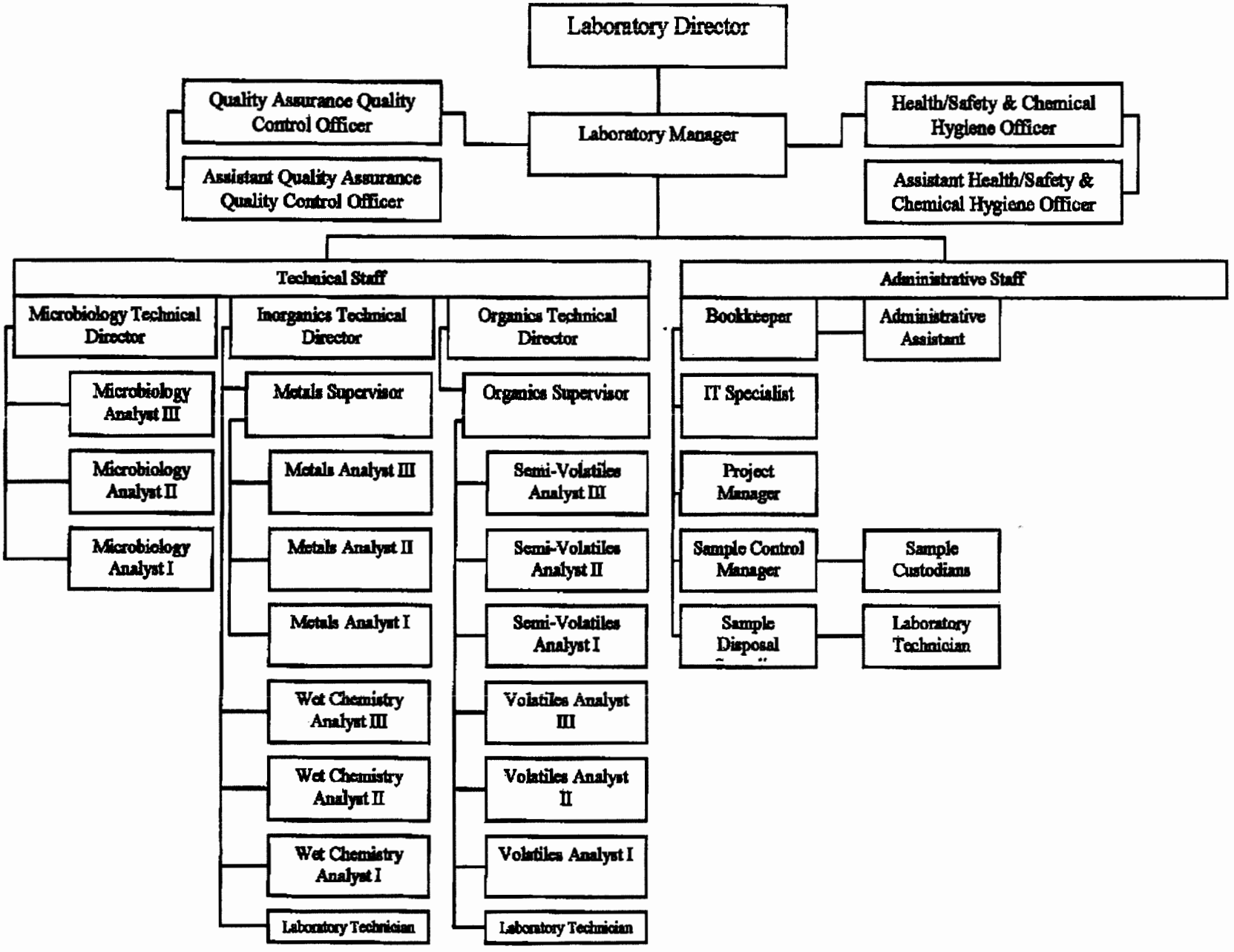
At least once per year an ADOCP must be completed. This is achieved by the acceptable performance of a blind sample (typically by using a PT sample, but can be a single blind (to the analyst) sample), by performing another IDOC, or by summarizing the data of four consecutive laboratory control samples with acceptable levels of precision and accuracy (these limits are those currently listed in the LIMS for an LCS using the indicated test method.) ADOCPs are documented using a standard form and are kept on file in each analyst's employee folder.

Each new employee shall be provided with data integrity training as a formal part of their new employee orientation. Each new employee will sign an ethics and data integrity agreement to ensure that they understand that data quality is our main objective. Every HEAL employee recognizes that although turn around time is important, quality is put above any pressure to complete the task expediently. Analysts are not compensated for passing QC parameters nor are incentives given for the quantity of work produced. Data Integrity and Ethics training are performed on an annual basis in order to remind all employees of HEAL's policy on data quality. Employees are required to understand that any infractions of the laboratory data integrity procedures will result in a detailed investigation that could lead to very serious

consequences including immediate termination, debarment, or civil/criminal prosecution.

Training for each member of HEAL's technical staff is further established and maintained through documentation that each employee has read, understood, and is using the latest version of this Quality Assurance Manual. Training courses or workshops on specific equipment, analytical techniques, or laboratory procedures are documented through attendance sheets, certificates of attendance, training forms, or quizzes. This training documentation is located in analyst specific employee folders in the QA/QCO Office. On the front of all methods, SOPs, and procedures for HEAL, there is a signoff sheet that is signed by all pertinent employees, indicating that they have read, understand, and agree to perform the most recent version of the document.

The effectiveness of training will be evaluated during routine data review, annual employee reviews, and internal and external audits. Repetitive errors, complaints and audit findings serve as indicators that training has been ineffective. When training is deemed to have been ineffective a brief review of the training process will be completed and a re-training conducted as soon as possible.


Laboratory Director
Quality Assurance Quality Control Officer
Assistant Quality Assurance Quality Control Officer
Laboratory Manager
Health/Safety & Chemical Hygiene Officer
Assistant Health/Safety & Chemical Hygiene Officer
Technical Staff
Administrative Staff
Microbiology Technical Director
Inorganics Technical Director
Organics Technical Director
Bookkeeper
Administrative Assistant
Microbiology Analyst III
Microbiology Analyst II
Microbiology Analyst I
Metals Supervisor
Metals Analyst III
Metals Analyst II
Metals Analyst I
Wet Chemistry Analyst III
Wet Chemistry Analyst II
Wet Chemistry Analyst I
Laboratory Technician
Organics Supervisor
Semi-Volatiles Analyst III
Semi-Volatiles Analyst II
Semi-Volatiles Analyst I
Volatiles Analyst III
Volatiles Analyst II
Volatiles Analyst I
Laboratory Technician
IT Specialist
Project Manager
Sample Control Manager
Sample Custodians
Sample Disposal
Laboratory Technician

5.0 Receipt and Handling of Samples

Sampling

Procedures

HEAL does not provide field sampling for any projects. Sample kits are prepared and provided for clients upon request. The sample kits contain the appropriate sampling containers (with a preservative when necessary), labels, blue ice (The use of "blue ice" by anyone except HEAL personnel is discouraged because it generally does not maintain the appropriate temperature of the sample. If blue ice is used, it should be completely frozen at the time of use, the sample should be chilled before packing, and special notice taken at sample receipt to be certain the required temperature has been maintained.), a cooler, chain-of-custody forms, plastic bags, bubble wrap, and any special sampling instructions. Sample kits are reviewed prior to shipment for accuracy and completeness.

Containers

Containers which are sent out for sampling are purchased by HEAL from a commercial source. Glass containers are certified "EPA Cleaned" QA level 1. Plastic containers are certified clean when required. These containers are received with a Certificate of Analysis verifying that the containers have been cleaned according to the EPA wash procedure. Containers are used once and discarded. If the samples are collected and stored in inappropriate containers the laboratory may not be able to accurately quantify the amount of the desired components. In this case, re-sampling may be required.

Preservation

If sampling for analyte(s) requires preservation, the sample custodians fortify the containers prior to shipment to the field, or provide the preservative for the sampler to add in the field. The required preservative is introduced into the vials in uniform amounts and done so rapidly to minimize the risk of contamination. Vials that contain a preservative are labeled appropriately. If the samples are stored with inappropriate preservatives, the laboratory may not be able to accurately quantify the amount of the desired components. In this case re-sampling may be required.

Refer to the current Login SOP and/or the current price book for detailed sample receipt and handling procedures, appropriate preservation and holding time requirements.

Sample Custody

Chain-of-Custody Form

A Chain-of-Custody (COC) form is used to provide a record of sample chronology from the field to receipt at the laboratory. HEAL's COC contains the client's name, address, phone and fax numbers, the project name and number, the project manager's name, and the field sampler's name. It also identifies the date and time of sample collection, sample matrix, field sample ID number, number/volume of sample containers, sample temperature upon receipt, and any sample preservative information.

There is also a space to record the HEAL ID number assigned to samples after they are received. Next to the sample information is a space for the client to indicate the desired analyses to be performed. There is a section for the client to indicate the data package level as well as any accreditation requirements. Finally, there is a section to track the actual custody of the samples. The custody section contains lines for signatures, dates and times when samples are relinquished and received. The COC form also includes a space to record special sample related instructions, sampling anomalies, time constraints, and any sample disposal considerations.

It is paramount that all COCs arrive at HEAL complete and accurate so that the samples can be processed and allocated for testing in a timely and efficient manner. A sample chain-of-custody form can be found in the current Document Control Logbook or on line at www.hallenvironmental.com.

Receiving Samples

Samples are received by authorized HEAL personnel. Upon arrival, the COC is compared to the respective samples. After the samples and COC have been determined to be complete and accurate, the sampler signs over the COC. The HEAL staff member in turn signs the chain-of-custody, also noting the current date, time, and sample temperature. This relinquishes custody of the samples from the sampler and delegates sample custody to HEAL. The first (white) copy of the COC form is filed in the appropriate sample folder. The second (yellow) copy of the COC form is filed in the COC file in the sample control manger's office. The third (pink) copy of the COC form is given to the person who has relinquished custody of the samples.

Logging in Samples and Storage

Standard Operating Procedures have been established for the receiving and tracking of all samples (refer to the current HEAL Login SOP). These procedures ensure that samples are received and properly logged into the laboratory and that all associated documentation, including chain of custody forms, is complete and consistent with the samples received. Each sample set is given a unique HEAL tracking ID number.

Individual sample locations within a defined sample set are given a unique sample ID suffix-number. Labels with the HEAL numbers, and tests requested, are generated and placed on their respective containers. The pH of preserved, non-volatile samples is checked and noted if out of compliance. Due to the nature of the samples, the pHs of volatiles samples are checked after analysis. Samples are reviewed prior to being distributed for analysis.

Samples are distributed for analysis based upon the requested tests. In the event that sample volume is limited and different departments at HEAL are required to share the sample, volatile work takes precedence and will always be analyzed first before the sample is sent to any other department for analysis.

All samples that require thermal preservation shall be acceptably stored at a temperature range just above freezing to 6°C.

Each project (sample set) is entered into the Laboratory Information Management System (LIMS) with a unique ID that will be identified on every container. The ID tag includes the Lab ID, Client ID, date and time of collection, and the analysis/analyses to be performed. The LIMS continually updates throughout the lab. Therefore, at any time, an analyst or manager may inquire about a project and/or samples status. For more information about the login procedures, refer to the Sample Login SOP.

Disposal of Samples

Samples are held at HEAL for a minimum of thirty days and then transferred to the HEAL warehouse for disposal. Analytical results are used to characterize their respective sample contamination level(s) so that the proper disposal can be performed. These wastes will be disposed of according to their hazard as well as their type and level of contamination. Refer to the Hall Environmental Analysis Laboratory Chemical Hygiene Plan and current Sample Disposal SOP for details regarding waste disposal.

Waste drums are provided by an outside agency. These drums are removed by the outside agency and disposed of in a proper manner.

The wastes that are determined to be non-hazardous are disposed of as non-hazardous waste in accordance with the Chemical Hygiene Plan and Sample Disposal SOP.

6.0 Analytical Procedures

All analytical methods used at HEAL incorporate necessary and sufficient Quality Assurance and Quality Control practices. A Standard Operating Procedure (SOP) is used for each method to provide the necessary criteria to yield acceptable results. These procedures are reviewed at least annually and revised as necessary and are attached as a pdf file in the Laboratory Information Management System (LIMS) for easy access by each analyst. The sample is often consumed or altered during the analytical process. Therefore, it is important that each step in the analytical process be correctly followed in order to yield valid data.

When unforeseen problems arise, the analyst, technical director, and, when necessary, laboratory manager meet to discuss the factors involved. The analytical requirements are evaluated and a suitable corrective action or resolution is established. The client is notified in the case narrative with the final report or before, if the validity of their result is in question.

List of Procedures Used

Typically, the procedures used by HEAL are EPA approved methodologies or 20th edition Standard Methods. However, proprietary methods for client specific samples are sometimes used. The following tables list EPA and Standard Methods Method numbers with their corresponding analytes and/or instrument classification.

Methods Utilized at HEAL

Drinking Water(DW) Non-Potable Water (NPW) Solids (S)

Methodology	Matrix	Title of Method
120.1	DW NPW	"Conductance(Specific Conductance, *u*ohms at 25 ° C)"
180.1	DW NPW	"Turbidity (Nephelometric)"
200.2	DW NPW	"Sample Preparation Procedure For Spectrochemical Determination of Total Recoverable Elements"
200.7	DW NPW	"Determination of Metals and Trace Elements In Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry"
200.8	DW NPW	"Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry."
245.1	DW NPW	"Mercury (Manual Cold Vapor Technique)"
300	DW NPW S	"Determination of Inorganic Anions by Ion Chromatography"

413.2	NPW S	"Oil and Grease"
418.1	NPW S	"Petroleum Hydrocarbons (Spectrophotometric, Infrared)"
504.1	DW	"EDB, DBCP and 123TCP in Water by Microextraction and Gas Chromatography"
505	DW	"Analysis of Organohalide Pesticides and Commercial Polychlorinated Biphenyl (PCB) Products in Water by Microextraction and Gas Chromatography"
515.1	DW	"Determination of Chlorinated Acids in Water by Gas Chromatography with an Electron Capture Detector"
524.2	DW	"Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry"
531.1	DW	"Measurement of N-Methylcarbomoyloximes and N-Methylcarbamates in Water by Direct Aqueous Injection HPLC with Post Column Derivatization"
547	DW	"Determination of Glyphosate in Drinking Water by Direct-Aqueous Injection HPLC, Post-Column Derivatization, and Fluorescence Detection"
552.1	DW	"Determination of Haloacetic Acids and Dalapon in Drinking Water by Ion-Exchange Liquid-Solid Extraction and Gas Chromatography with an Electron Capture Detector"
624	DW	Appendix A to Part 136 Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater Method 624-Purgeables"
625	DW	Appendix A to Part 136 Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater Method 625-Base/Neutrals and Acids"
1311	S	"Toxicity Characteristic Leaching Procedure"
1311ZHE	S	"Toxicity Characteristic Leaching Procedure"
1164A	NPW	"N-Hexane Extractable Material (HEM; Oil and Grease) and Silica Gel Treated N-Hexane Extractable Material) by Extraction and Gravimetry"
3005A	NPW	"Acid Digestion of Waters for Total Recoverable or Dissolved Metals for Analysis by FLAA or ICP Spectroscopy"
3010A	S	"Acid Digestion of Aqueous Samples and Extracts for Total Metals for Analysis by FLAA or ICP Spectroscopy"
3050B	S	"Acid Digestion of Sediment, Sludge, and Soils"
3510C	DW NPW	"Separatory Funnel Liquid-Liquid Extraction"

3540	S	"Soxhlet Extraction"
3545	S	"Pressurized Fluid Extraction(PFE)"
3665	NPW S	"Sulfuric Acid/Permanganate Cleanup"
5030B	NPW	"Purge-and-Trap for Aqueous Samples"
5035	S	"Closed-System Purge-and-Trap and Extraction for Volatile Organics in Soil and Waste Samples"
6010B	NPW S	"Inductively Coupled Plasma-Atomic Emission Spectrometry"
6020	NPW S	"Inductively Coupled Plasma-Mass Spectrometry"
7470A	NPW	"Mercury in Liquid Waste (Manual Cold-Vapor Technique)"
7471A	S	"Mercury in Solid or Semisolid Waste (Manual Cold Vapor Technique)"
8021B	NPW S	"Aromatic and Halogenated Volatiles By Gas Chromatography Using Photoionization and/or Electrolytic Conductivity Detectors"
8015B	NPW S	"Nonhalogenated Volatile Organics by Gas Chromatography" (Gasoline Range and Diesel Range Organics)
8015AZ	S	"C10-C32 Hydrocarbons in Soil-8015AZ"
8081A	NPW S	"Organochlorine Pesticides by Gas Chromatography"
8082	NPW S	"Polychlorinated Biphenyls (PCBs) by Gas Chromatography"
8260B	NPW S	"Volatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS)"
8270C	NPW S	"Semivolatile Organic Compounds by Gas Chromatography/ Mass Spectrometry (GC/MS)"
8310	NPW S	"Polynuclear Aromatic Hydrocarbons"
9045C	S	"Soil and Waste pH"
9060	NPW	"Total Organic Carbon"
9067	NPW S	"Phenolics (Spectrophotometric, MBTH With Distillation)"
9095	S	Paint Filter
Walkley/Black	S	FOC/TOC WB
SM2320 B	DW NPW	"Alkalinity"
SM2540 B	NPW	"Total Solids Dried at 103-105° C"

SM2540 C	DW NPW	"Total Dissolved Solids Dried at 180° C"
SM2540 D	NPW	"Total Suspended Solids Dried at 103-105° C"
SM4500-CL G	DW	"Chlorine (Residual) 4500-CL G. DPD Colorimetric Method"
SM4500-H+B	DW NPW	"pH Value"
SM4500-NH3 C	NPW S	"4500-NH3" Ammonia
SM4500-Norg C	NPW S	"4500-Norg" Total Kjeldahl Nitrogen (TKN)
SM5210 B	NPW	"5210 B. 5-day BOD Test"
SM5310 B	DW	"5310" Total Organic Carbon (TOC)
8000B	NPW S	"Determinative Chromatographic Separations"
8000C	NPW S	"Determinative Chromatographic Separations"

Criteria for Standard Operating Procedures

HEAL has Standard Operating Procedures (SOPs) for each of the test methods listed above. These SOPs are based upon the listed methods and detail the specific procedure and equipment utilized as well as the quality requirements necessary to prove the integrity of the data. SOPs are reviewed or revised every twelve months or sooner if necessary. The review/revision is documented in the Master SOP Logbook filed in the QA/QC Office. All SOPs are available in the LIMS linked under the specific test method. Administrative SOPs, which are not linked in the LIMS, are available on desktops throughout the laboratory in the link to administrative SOPs folder.

Hand written corrections or alterations to SOPs are not permitted. In the event that a correction is needed and a revision is not immediately possible, a corrective action report will be generated documenting the correction or alteration, signed by the section Technical Director and the QA/QC Officer and will be scanned into the current SOP and will document the change until a new revision is possible.

Each HEAL test method SOP shall include or reference the following topics where applicable:

Identification of the test method;
Applicable matrix or matrices;
Limits of detection and quantitation;
Scope and application, including parameters to be analyzed;
Summary of the test method;
Definitions;
Interferences;
Safety;
Equipment and supplies;
Reagents and standards;
Sample collection, preservation, shipment and storage;
Quality control parameters;
Calibration and standardization;
Procedure;
Data analysis and calculations;
Method performance;
Pollution prevention;
Data assessment and acceptance criteria for quality control measures;
Corrective actions for out-of-control data;
Contingencies for handling out-of-control or unacceptable data;
Waste management;
References; and
Any tables, diagrams, flowcharts and validation data.

7.0 Calibration

All equipment and instrumentation used at HEAL are operated, maintained and calibrated according to manufacturers' guidelines, as well as criteria set forth in applicable analytical methodology. Personnel who have been properly trained in their procedures perform the operation and calibration. Brief descriptions of the calibration processes for our major laboratory equipment and instruments are found below.

Thermometers

The thermometers in the laboratory are used to measure the temperatures of the refrigerators, freezers, ovens, water baths, incubators, hot blocks, ambient laboratory conditions, TCLP Extractions, digestion blocks, and samples at the time of log-in. All NIST traceable thermometers are either removed from use upon their documented expiration date or they are checked annually with a NIST-certified thermometer and a correction factor is noted on each thermometer log. See the most current Login SOP for detailed procedures on this calibration procedure.

Data Loggers are used to record refrigerator temperatures. These data loggers are calibrated quarterly with NIST-certified thermometers.

Refrigerators/Freezers

Each laboratory refrigerator or freezer contains a thermometer capable of measuring to a minimum precision of 0.1°C. The thermometers are kept with the bulb immersed in liquid. Each day of use, the temperatures of the refrigerators are recorded to insure that the refrigerators are within the required designated range. Samples are stored separately from the standards to reduce the risk of contamination.

See the current Catastrophic Failure SOP for the procedure regarding how to handle failed refrigerators or freezers.

Ovens

The ovens contain thermometers graduated by 1° C. The ovens are calibrated quarterly against NIST thermometers and checked each day of use as required and in whatever way is dictated by or appropriate for the method in use.

Analytical and Table Top Balances

The table top balances are capable of weighing to a minimum precision of 0.01 grams. The analytical balances are capable of weighing to a minimum precision of 0.0001 grams. Records are kept of daily calibration checks for the balances in use. Working weights are used in these checks. The balances are annually certified by an outside source and the certifications are on file with the QA/QCO.

Balances, unless otherwise indicated by method specific SOPs, will be checked each day of use with at least two weights that will bracket the working range of the balance for the day. Daily balance checks will be done using working weights that are calibrated annually against Class S weights. Class S weights are calibrated by an external provider as required. The Class S weights are used once a year, or more frequently if required, to assign values to the Working Weights. During the daily balance checks, the working weights are compared to their assigned values and must pass in order to validate the calibration of the balance. The assigned values, as well as the daily checks, for the working weights are recorded in the balance logbook for each balance.

Instrument Calibration

An instrument calibration is the relationship between the known concentrations of a set of calibration standards introduced into an analytical instrument and the measured response they produce. Calibration curve standards are a prepared series of aliquots at various known concentration levels from a primary source reference standard. Specific mathematical types of calibration techniques are outlined in SW-846 8000B and/or 8000C. The entire initial calibration must be performed prior to sample analyses.

The lowest standard in the calibration curve must be at or below the required reporting limit.

Refer to the current SOP to determine the minimum requirement for calibration points.

Most compounds tend to be linear and a linear approach should be favored when linearity is suggested by the calibration data. Non-linear calibration should be considered only when a linear approach cannot be applied. It is not acceptable to use an alternate calibration procedure when a compound fails to perform in the usual manner. When this occurs, it is indicative of instrument issues or operator error.

If a non-linear calibration curve fit is employed, a minimum of six calibration levels must be used for second-order (quadratic) curves.

When more than 5 levels of standards are analyzed in anticipation of using second-order calibration curves, all calibration points MUST be used regardless of the calibration option employed. The highest or lowest calibration point may be excluded for the purpose of narrowing the calibration range and meeting the requirements for a specific calibration option. Otherwise, unjustified exclusion of calibration data is expressly forbidden.

Analytical methods vary in QC acceptance criteria. HEAL follows the method specific guidelines for QC acceptance. The specific acceptance criteria are outlined in the analytical methods and their corresponding SOPs.

pH Meter

The pH meter measures to a precision of 0.01 pH units. The pH calibration logbook contains the calibration before each use, or each day of use, if used more than once per day. It is calibrated using a minimum of 3 certified buffers. Also available with the pH meter is a magnetic stirrer with a temperature sensor. See the current pH SOP (SM4500 H^+ B) for specific details regarding calibration of the pH probe.

Other Analytical Instrumentation and Equipment

The conductivity probe is calibrated as needed and checked daily when in use.

Eppendorf (or equivalent brands) pipettes are checked gravimetrically prior to use.

Standards

All of the source reference standards used are ordered from a reliable commercial vendor. A Certificate of Analysis (CoA), which verifies the quality of the standard, accompanies the standards from the vendor. The Certificates of Analysis are dated and stored on file by the Technical Directors or their designee. These standards are traceable to the National Institute of Standards (NIST). When salts are purchased and used as standards the certificate of purity must be obtained from the vendor and filed with the CoAs.

All standard solutions, calibration curve preparations, and all other quality control solutions are labeled in a manner that can be traced back to the original source reference standard. All source reference standards are entered into the LIMS with an appropriate description of the standard. Dilutions of the source reference standard (or any mixes of the source standards) are fully tracked in the LIMS. Standards are labeled with the date opened for use and with an expiration date.

As part of the quality assurance procedures at HEAL, analysts strictly adhere to manufacturer recommendations for storage times/expiration dates and policies of analytical standards and quality control solutions.

Reagents

HEAL ensures that the reagents used are of acceptable quality for their intended purpose. This is accomplished by ordering high quality reagents and adhering to good laboratory practices so as to minimize contamination or chemical degradation. All reagents must meet any specifications noted in the analytical method. Refer to the current Purchase of Consumables SOP for details on how this is accomplished and documented.

Upon receipt, all reagents are assigned a separate ID number, and logged into the LIMS. All reagents shall be labeled with the date received into the laboratory and again with the date opened for use. Recommended shelf life, as defined by the manufacturer, shall be documented and controlled. Dilutions or solutions prepared shall be clearly labeled, dated, and initialed. These solutions are traceable back to their primary reagents and do not extend beyond the expiration date listed for the primary reagent.

All gases used with an instrument shall meet specifications of the manufacturer. All safety requirements that relate to maximum and/or minimum allowed pressure, fitting types, and leak test frequency, shall be followed. When a new tank of gas is placed in use, it shall be checked for leaks and the date put in use will be written in the instrument maintenance logbook.

HEAL continuously monitors the quality of the reagent water and provides the necessary indicators for maintenance of the purification systems in order to assure that the quality of laboratory reagent water meets established criteria for all analytical methods.

Reagent blank samples are also analyzed to ensure that no contamination is present at detectable levels. The frequency of reagent blank analysis is typically the same as calibration verification samples. Refrigerator storage blanks are stored in the volatiles refrigerator for a period of one week and analyzed and replaced once a week.

8.0 Maintenance

Maintenance logbooks are kept for each major instrument and all support equipment in order to document all repair and maintenance. In the front of the logbook, the following information is included:

Unique Name of the Item or Equipment
Manufacturer
Type of Instrument
Model Number
Serial Number
Date Received and Date Placed into Service
Location of Instrument
Condition of Instrument Upon Receipt

For routine maintenance, the following information shall be included in the log:

Maintenance Date
Maintenance Description
Maintenance Performed by Initials

A manufacturer service agreement (or equivalent) covers most major instrumentation to assure prompt and reliable response to maintenance needs beyond HEAL instrument operator capabilities.

Refer to the current Maintenance and Troubleshooting SOP for each section in the laboratory for further information.

9.0 Data Integrity

For HEAL's policy on ethics and data integrity, see section 3.0 of this document. Upon being hired, and annually there after, all employees at HEAL undergo documented data integrity training. All new employees sign an Ethics and Data Integrity Agreement, documenting their understanding of the high standards of integrity required at HEAL and outlining their responsibilities in regards to ethics and data integrity. See the current Document Control Logbook for a copy of this agreement.

In instances of ethical concern, analysts are required to report the known or suspected concern to their Technical Director, the Laboratory Manager, or the QA/QCO. This will be done in a confidential and receptive environment, allowing all employees to privately discuss ethical issues or report items of ethical concern.

Once reported and documented, the ethical concern will be immediately elevated to the Laboratory Manager and the need for an investigation, analyst remediation, or termination will be determined on a case-by-case basis.

All reported instances of ethical concern will be thoroughly documented and handled in a manner sufficient to rectify any breaches in data integrity with an emphasis on preventing similar incidences from happening in the future.

10.0 Quality Control

Internal Quality Control Checks

HEAL utilizes various internal quality control checks, including duplicates, matrix spikes, matrix spike duplicates, method blanks, laboratory control spikes, laboratory control spike duplicates, surrogates, internal standards, calibration standards, quality control charts, proficiency tests and calculated measurement uncertainty.

Refer to the current method SOP to determine the frequency and requirements of all quality controls. In the event that the frequency of analysis is not indicated in the method specific SOP, duplicate samples, laboratory control spikes (LCS), Method Blanks (MB), and matrix spikes and matrix spike duplicates (MS/MSD) are analyzed for every batch of twenty samples.

When sample volume is limited on a test that requires an MS/MSD an LCSD shall be analyzed to demonstrate precision and accuracy and when possible a sample duplicate will be analyzed.

Duplicates are identical tests repeated for the same sample or matrix spike in order to determine the precision of the test method. A Relative Percent Difference (RPD) is calculated as a measure of this precision. Unless indicated in the SOP, the default acceptance limit is </= 20%.

Matrix Spikes and Matrix Spike Duplicates are spiked samples (MS/MSD) that are evaluated with a known added quantity of a target compound. This is to help determine the accuracy of the analyses and to determine the matrix affects on analyte recovery. A percent recovery is calculated to assess the quality of the accuracy. In the event that the acceptance criteria is not outlined in the SOP, a default limits of 70-130% will be utilized. When an MSD is employed an RPD is calculated and when not indicated in the SOP shall be acceptable at </= 20%.

When appropriate for the method, a Method Blank should be analyzed with each batch of samples processed to assess contamination levels in the laboratory. MBs consist of all the reagents measured and treated as they are with samples, except without the samples. This enables the laboratory to ensure clean reagents and procedures. Guidelines should be in place for accepting or rejecting data based on the level of contamination in the blank. In the event that these guidelines are not dictated by the SOP or in client specific work plans, the MB should be less than the MDL reported for the analyte being reported.
A Laboratory Control Spike and Laboratory Control Spike Duplicate (LCS/LCSD) are reagent blanks, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to assess the performance of all or a portion of the measurement system. Guidelines are outlined in each

SOP for the frequency and pass fail requirements for LCS and LCSDs. These limits can be set utilizing control charts as discussed below.

Surrogates are utilized when dictated by method and are substances with properties that mimic the analytes of interest. The surrogate is an analyte that is unlikely to be found in environmental samples. Refer to the appropriate Method and SOP for guidelines on pass/fail requirements for surrogates.

Internal Standards are utilized when dictated by the method and are known amounts of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method. Refer to the appropriate Method and SOP for guidelines on pass/fail requirements for Internal Standards.

Proficiency Test (PT) Samples are samples provided by an unbiased third party. They are typically analyzed twice a year, between five and seven months apart, or at any other interval as defined in the method SOP. They contain a pre-determined concentration of the target compound, which is unknown to HEAL. HEAL's management and all analysts shall ensure that all PT samples are handled in the same manner as real environmental samples utilizing the same staff, methods, procedures, equipment, facilities and frequency of analysis as used for routine analysis of that analyte. When analyzing a PT, HEAL shall employ the same calibration, laboratory quality control and acceptance criteria, sequence of analytical steps, number of replicates and other procedures as used when analyzing routine samples. PT results are reported as normal samples, within the working range of the associated calibration curve. In the event an analyte concentration is less than the PQL, the result shall be reported as less than the PQL.

With regards to analyzing PT Samples HEAL shall not send any PT sample, or portion of a PT sample, to another laboratory for any analysis for which we seek accreditation, or are accredited. HEAL shall not knowingly receive any PT sample or portion of a PT sample from another laboratory for any analysis for which the sending laboratory seeks accreditation; or is accredited. Laboratory management or staff will not communicate with any individual at another laboratory concerning the PT sample. Laboratory management or staff shall not attempt to obtain the assigned value of any PT sample from the PT Provider.

Upon receiving a Not Acceptable PT result for any analyte, a root cause analysis is conducted and the cause of the failure determined and corrected. As defined by TNI, two out of the past three PTs must be acceptable to maintain accreditation for any given analyte. If this requirement is not met a successful history will be reestablished by the analysis of an additional PT sample. For accredited tests, the PT provider will be notified, when the PT is for corrective action purposes. The analysis dates of successive PT samples for the same accredited analyte shall be at least fifteen days apart.

Calibration standards are standards run to calibrate. Once the calibration is established the same standards can be analyzed as Continuing Calibration Verifications (CCV), used to confirm the consistency of the instrumentation. Calibration standards can be utilized at the beginning and end of each batch, or more frequently as required. Typically Continuing

Calibration Blanks (CCB) are run in conjunction with CCVs. Refer to the current method SOP for frequency and pass/fail requirements of CCVs and CCBs.

Control Limits are limits of acceptable ranges of the values of quality control checks. The control limits approximate a 99% confidence interval around the mean recovery. Any matrix spike, surrogate, or LCS results outside of the control limits require further evaluation and assessment. This should begin with the comparison of the results from the samples or matrix spike with the LCS results. If the recoveries of the analytes in the LCS are outside of the control limits, then the problem may lie with the application of the extraction, with cleanup procedures, or with the chromatographic procedure. Once the problem has been identified and addressed, corrective action may include reanalysis of samples or re-extraction followed by reanalysis. When the LCS results are within the control limits, the issue may be related to the sample matrix or to the use of an inappropriate extraction, cleanup, and/or determinative method for the matrix. If the results are to be used for regulatory compliance monitoring, then steps must be taken to demonstrate that the analytes of concern can be determined in the sample matrix at the levels of interest. Data generated with laboratory control samples that fall outside of the established control limits are judged to be generated during an "out-of-control" situation. These data are considered suspect and shall be repeated or reported with qualifiers.

Control limits are to be updated only by Technical Directors, Section Supervisors or the Quality Assurance Officer. Control limits should be established and updated according to the requirements of the method being utilized. When the method does not specify, and control limits are to be generated or updated for a test, the following guidelines shall be utilized.

Limits should typically be generated utilizing the most recent 20-40 data values. In order to obtain an even distribution across multiple instruments and to include more than a single day's worth of data, surrogate limits should be generated using around 100 data values. The data values used shall not reuse values that were included in the previous Control Limit update. The data values shall also be reviewed by the LIMS for any Grubbs Outliers, and if identified, the outliers must be removed prior to generating new limits. The results used to update control limits should meet all other QC criteria associated with the determinative method. For example, MS/MSD recoveries from a GC/MS procedure should be generated from samples analyzed after a valid tune and a valid initial calibration that includes all analytes of interest. Additionally, no analyte should be reported when it is beyond the working range of the calibration currently in use. MS/MSD and surrogate limits should be generated using the same set of extraction, cleanup, and analysis procedures.

All generated limits should be evaluated for appropriateness. Where limits have been established for MS/MSD samples, the LCS/LCSD limits should fall within those limits, as the LCS/LCSD are prepared in a clean matrix. Surrogate limits should be updated using all sample types and should be evaluated to ensure that all instruments as well as a reasonable dispersion across days are represented by the data. LCS/LCSD recovery limits should be evaluated to verify that they are neither inappropriately wide nor unreasonably tight. The default LCS/LCSD acceptance limits of 70-130% and RPD of 20% (or those limits

specified by the method for LCS/LCSD and/or CCV acceptability), should be used to help make this evaluation. Technical directors may choose to use warning limits when they feel their generated limits are too wide, or default LCS limits when they feel their limits have become arbitrarily tight.

Once new Control Limits have been established and updated in the LIMS, the Control Charts shall be printed and reviewed by the appropriate section supervisor and primary analyst performing the analysis for possible trends and compared to the previous Control Charts. The technical director initials the control charts, indicating that they have been reviewed and that the updated Limits have been determined to be accurate and appropriate. Any manual alterations to the limits will be documented and justified on the printed control chart. These initialed charts are then filed in the QA/QCO office.

Once established, control limits should be reviewed after every 20-30 data values and updated at least every six months, provided that there are sufficient points to do so. The limits used to evaluate results shall be those in place at the time that the sample was analyzed. Once limits are updated, those limits apply to all subsequent analyses.

When updating surrogate control limits, all data, regardless of sample/QC type, shall be updated together and assigned one set of limits for the same method/matrix.

In the event that there are insufficient data points to update limits that are over a year old, the default limits, as established in the method or SOP, shall be re-instated. Refer to the requirements in SW-846 method 8000B and 8000C for further guidance on generating control limits.

Calculated Measurement Uncertainty is calculated annually using LCSs in order to determine the laboratory specific uncertainty associated with each test method. These uncertainty values are available to our clients upon request and are utilized as a trending tool internally to determine the effectiveness of new variables introduced into the procedure over time.

Precision, Accuracy, Detection Levels

Precision

The laboratory uses sample duplicates, laboratory control spike duplicates, and matrix spike duplicates to assess precision in terms of relative percent difference (RPD). HEAL requires the RPD to fall within the 99% confidence interval of established control charts or an RPD of less than 20% if control charts are not available. RPD's greater than these limits are considered out-of-control and require an appropriate response.

$$RPD = \frac{2 \times (\text{Sample Result} - \text{Duplicate Result})}{(\text{Sample Result} + \text{Duplicate Result})} \times 100$$

Accuracy

The accuracy of an analysis refers to the difference between the calculated value and the actual value of a measurement. The accuracy of a laboratory result is evaluated by comparing the measured amount of QC reference material recovered from a sample and the known amount added. Control limits can be established for each analytical method and sample matrix. Recoveries are assessed to determine the method efficiency and/or the matrix effect.

Analytical accuracy is expressed as the Percent Recovery (%R) of an analyte or parameter. A known amount of analyte is added to an environmental sample before the sample is prepared and subsequently analyzed. The equation used to calculate percent recovery is:

%Recovery = {(concentration* recovered)/(concentration* added)} X 100

*or amount

HEAL requires that the Percent Recovery to fall within the 99 % confidence interval of established control limits. A value that falls outside of the confidence interval requires a warning and process evaluation. The confidence intervals are calculated by determining the mean and sample standard deviation. If control limits are not available, the range of 80 to 120% is used unless the specific method dictates otherwise. Percent Recoveries outside of this range mandate additional action such as analyses by Method of Standard Additions, additional sample preparation(s) where applicable, method changes, and out-of-control action or data qualification.

Detection Limit

Current practices at HEAL define the Detection Limit (DL) as the smallest amount that can be detected above the baseline noise in a procedure within a stated confidence level.

HEAL presently utilizes an Instrument Detection Limit (IDL), a Method Detection Limit (MDL), and a Practical Quantitation Limit (PQL). The relationship between these levels is approximately
IDL: MDL: PQL = 1:5:5.

The IDL is a measure of the sensitivity of an analytical instrument. The IDL is the amount which, when injected, produces a detectable signal in 99% of the analyses at that concentration. An IDL can be considered the minimum level of analyte concentration that is detectable above random baseline noise.

The MDL is a measure of the sensitivity of an analytical method. MDL studies are required annually for each quality system matrix, technology and analyte, unless indicated otherwise in the referenced method. An MDL determination (as required in 40CFR part 136 Appendix B) consists of replicate spiked samples carried through all necessary preparation steps. The spike concentration is three times the standard deviation of three replicates of spikes. At least seven replicates are spiked and analyzed and their standard deviation(s) calculated. Routine variability is critical in passing the 10 times rule and is best achieved by running the MDLs over different days and when possible over several calibration events. Standard Methods and those methods used for drinking water analysis must have MDL studies that are performed over a period of at least three days in order to include day to day variations. The method detection limit (MDL) can be calculated using the standard deviation according to the formula:

$$MDL = s * t\,(99\%),$$

where t (99%) is the Student's t-value for the 99% confidence interval. The t-value depends on the number of trials used in calculating the sample standard deviation, so choose the appropriate value according to the number of trials.

Number of Trials	t(99%)
6	3.36
7	3.14
8	3.00
9	2.90

The calculated MDL must not be less than 10 times the spiked amount or the study must be performed again with a lower concentration.

Where there are multiple MDL values for the same test method in the LIMS the highest MDL value is utilized.

The PQL is significant because different laboratories can produce different MDLs although they may employ the same analytical procedures, instruments and sample matrices. The PQL is about two to five times the MDL and represents a practical, and routinely achievable, reporting level with a good certainty that the reported value is reliable. It is often determined by regulatory limits. The reported PQL for a sample is dependent on the dilution factor utilized during sample analysis.

In the event that an analyte will not be reported less than the PQL, an MDL study is not required and a PQL check shall be done, at least annually, in place of the MDL study. The PQL check shall consist of a QC sample spiked at or below the PQL. All sample-processing and analysis steps of the analytical method shall be included in the PQL check and shall be done for each quality system matrix, technology, and analyte. A successful check is one where the recovery of each analyte is within the

established method acceptance criteria. When this criterion is not defined by the method or SOP, a default limit of +/-50% shall be utilized.

Quality Control Parameter Calculations

Mean

The sample mean is also known as the arithmetic average. It can be calculated by adding all of the appropriate values together, and dividing this sum by the number of values.

$$\text{Average} = (\Sigma x_i) / n$$

x_i = the value x in the i^{th} trial
n = the number of trials

Standard Deviation

The sample standard deviation, represented by s, is a measure of dispersion. The dispersion is considered to be the difference between the average and each of the values x_i. The variance, s^2, can be calculated by summing the squares of the differences and dividing by the number of differences. The sample standard deviation, s, can be found by taking the square root of the variance.

$$\text{Standard deviation} = s = [\Sigma (x_i - \text{average})^2 / (n-1)]^{1/2}$$

Percent Recovery (LCS and LCSD)

$$\text{Percent Recovery} = \frac{\text{(Spike Sample Result)}}{\text{(Spike Added)}} \text{X100}$$

Percent Recovery (MS, MSD)

$$\text{Percent Recovery} = \frac{\text{(Spike Sample Result} - \text{Sample Result)}}{\text{(Spike Added)}} \text{X100}$$

Control Limits

Control Limits are calculated by the LIMS using the average percent recovery (x), and the standard deviation (s).

$$\text{Upper Control Limit} = x + 3s$$
$$\text{Lower Control Limit} = x - 3s$$

These control limits approximate a 99% confidence interval around the mean recovery.

RPD (Relative Percent Difference)

Analytical precision is expressed as a percentage of the difference between the results of duplicate samples for a given analyst. Relative percent difference (RPD) is calculated as follows:

$$RPD = \frac{2 \times (\text{Sample Result} - \text{Duplicate Result})}{(\text{Sample Result} + \text{Duplicate Result})} \times 100$$

Uncertainty Measurements

Uncertainty, as defined by ISO, is the parameter associated with the result of a measurement that characterizes the dispersion of the values that could reasonably be attributed to the measurement. Ultimately, uncertainty measurements are used to state how good a test result is and to allow the end user of the data to properly interpret their reported data. All procedures allow for some uncertainty. For most analyses, the components and estimates of uncertainty are reduced by following well-established test methods. To further reduce uncertainty, results generally are not reported below the lowest calibration point (PQL) or above the highest calibration point (UQL). Understanding that there are many influential quantities affecting a measurement result, so many in fact that it is impossible to identify all of them, HEAL calculates measurement uncertainty at least annually using LCSs. These estimations of measurement uncertainty are kept on file in the method folders in the QA/QC office.

Measurement Uncertainty contributors are those that may be determined statistically. These shall be generated by estimating the overall uncertainty in the entire analytical process by measuring the dispersion of values obtained from laboratory control samples over time. At least 20 of the most recent LCS data points are gathered. The standard deviation(s) is calculated using these LCS data points. Since it can be assumed that the possible estimated values of the spikes are approximately normally distributed with approximate standard deviation(s), the unknown value of the spike is

believed to lie in 95% confidence interval, corresponding to an uncertainty range of +/- 2(s).

Calculate standard deviation (s) and 95% confidence interval according to the following formulae:

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{(n-1)}}$$

Where: s = standard deviation
x = number in series
$\bar{x}$ = calculated mean of series
n = number of samples taken

$95\%\ confidence = 2 \times s$

Example: Assuming that after gathering 20 of the most recent LCS results for Bromide, we have calculated the standard deviations of the values and achieved a result of 0.0326, our measurement of uncertainty for Bromide (at 95% confidence = 2 x s) is 0.0652.

Total Nitrogen

Total nitrogen is calculated as follows:

Total Nitrogen = TKN + NO_2 + NO_3

Calibration Calculations

1. Response Factor or Calibration Factor:

$RF = ((A_x)(C_{is}))/((A_{is})(C_x))$ $\qquad$ $CF = (A_x)/(C_x)$

a. Average RF or CF

$RF_{AVE} = \Sigma\ RF_i / n$

b. Standard Deviation

$s = SQRT\ \{ [\ \Sigma\ (RF_i - RF_{AVE})^2\ ] / (n-1)\ \}$

c. Relative Standard Deviation

$RSD = s / RF_{AVE}$

Where:
A_x = Area of the compound
C_x = Concentration of the compound
A_{is} = Area of the internal standard
C_{is} = Concentration of the internal standard
n = number of pairs of data
RF_i = Response Factor (or other determined value)
RF_{AVE} = Average of all the response factors
Σ = the sum of all the individual values

2. Linear Regression

$y=mx+b$

a. Slope (m)

$$m = (n\Sigma x_i y_i - (n\Sigma x_i)*(n\Sigma y_i)) / (n\Sigma x_i^2 - (\Sigma x_i)^2)$$

b. Intercept (b)

$$b = y_{AVE} - m*(x_{AVE})$$

c. Correlation Coefficient (cc)

$$CC\ (r) = \{ \Sigma((x_i-x_{ave})*(y_i-y_{ave})) \} / \{ SQRT((\Sigma(x_i-x_{ave})^2)*(\Sigma(y_i-y_{ave})^2)) \}$$

Or

$$CC\ (r) = [(\Sigma w * \Sigma wxy) - (\Sigma wx * \Sigma wy)] / (sqrt(([(\Sigma w * \Sigma wx^2) - (\Sigma wx * \Sigma wx)] * [(\Sigma w * \Sigma wy^2) - (\Sigma wy * \Sigma wy)])))]$$

d. Coefficient of Determination

$$COD\ (r^2) = CC*CC$$

Where:
y = Response (Area) Ratio A_x/A_{is}
x = Concentration Ratio C_x/C_{is}
m = slope
b = intercept
n = number of replicate x,y pairs
x_i = individual values for independent variable
y_i = individual values for dependent variable

Σ = the sum of all the individual values
x_{ave} = average of the x values
y_{ave} = average of the y values
w = weighting factor, for equal weighting w=1

3. Quadratic Regression

$$y = ax^2 + bx + c$$

a. Coefficient of Determination

$$COD\ (r^2) = (\Sigma(y_i-y_{ave})^2 - \{[(n-1)/(n-p)] * [\Sigma(y_i-Y_i)^2]\}) / \Sigma(y_i-y_{ave})^2$$

Where:
y = Response (Area) Ratio A_x/A_{is}
x = Concentration Ratio C_x/C_{is}
a = x^2 coefficient
b = x coefficient
c = intercept
y_i = individual values for each dependent variable
x_i = individual values for each independent variable
y_{ave} = average of the y values
n = number of pairs of data
p = number of parameters in the polynomial equation (I.e., 3 for third order, 2 for second order)
Yi = ((2*a*(C_x/C_{is})^2)-b^2+b+(4*a*c))/(4a)

b. Coefficients (a,b,c) of a Quadratic Regression

$$a = S_{(x2y)}S_{(xx)}-S_{(xy)}S_{(xx2)} / S_{(xx)}S_{(x2x2)}-[S_{(xx2)}]^2$$

$$b = S_{(xy)}S_{(x2x2)}-S_{(x2y)}S_{(xx2)} / S_{(xx)}S_{(x2x2)}-[S_{(xx2)}]^2$$

$$c = [(\Sigma yw)/n] - b*[(\Sigma xw)/n] - a*[\Sigma(x^2w)/n]$$

Where:
n = number of replicate x,y pairs
x = x values
y = y values
$w = S^{-2} / (\Sigma S^{-2}/n)$
$S_{(xx)} = (\Sigma x^2w) - [(\Sigma xw)^2 / n]$
$S_{(xy)} = (\Sigma xyw) - [(\Sigma xw)*(\Sigma yw) / n]$
$S_{(xx2)} = (\Sigma x^3w) - [(\Sigma xw)*(\Sigma x^2w) / n]$
$S_{(x2y)} = (\Sigma x^2yw) - [(\Sigma x^2w)*(\Sigma yw) / n]$

$S_{(x2x2)} = (\Sigma x^4 w) - [(\Sigma x^2 w)^2 / n]$
Or If unweighted calibration, w=1
S(xx) = (Sx2) - [(Sx)2 / n]
S(xy) = (Sxy) - [(Sx)*(Sy) / n]
S(xx2) = (Sx3) - [(Sx)*(Sx2) / n]
S(x2y) = (Sx2y) - [(Sx2)*(Sy) / n]
S(x2x2) = (Sx4) - [(Sx2)2 / n]

Concentration Calculations

On-Column Concentration for Average RRF Calibration using Internal Standard

On-Column Concentration $C_x = ((A_x)(C_{is}))/((A_{is})(RF_{AVE}))$

On-Column Concentration for Average CF Calibration using External Standard

On-Column Concentration $C_x = (A_x)/(CF_{AVE})$

On-Column Concentration for Linear Calibration

If determining an external standard, then exclude the A_{is} and C_{is} for internal standards
On-Column Concentration C_x = ((Absolute{[$(A_x)/(A_{is})$] - b})/m) * C_{is}

Where: m = slope
b = intercept
A_x = Area of the Sample
C_{is} = Concentration of the Internal Standard
A_{is} = Area of the Internal Standard

On-Column Concentration for Quadratic Calibration

If determining an external standard, then exclude the A_{is} and C_{is} for internal standards
On-Column Concentration =[(+SQRT(b^2-(4*a*(c-y)))-b)/(2*a)] * C_{is}
Where: a = x^2 coefficient
b = x coefficient
c = intercept
y = Area Ratio = A_x/A_{is}
C_{is} = Concentration of the Internal Standard

Final Concentration (Wet Weight)

$$\text{Concentration for Extracted Samples} = \frac{\text{(On-Column Conc)(Dilution)(Final Volume)}}{\text{(Initial Amount)(Injection Volume)}}$$

$$\text{Concentration for Purged Samples} = \frac{\text{(On-Column Conc)(Purged Amount)(Dilution)}}{\text{(Purged Amount)}}$$

Dry Weight Concentration

$$\text{Dry Weight Concentration} = \frac{\text{Final Concentration Wet Weight}}{\text{Total Solids}}$$

Percent Difference

$$\%\ \text{Difference} = \frac{\text{Absolute(Continuing Calibration RRF - Average RRF)}}{} * 100$$

Average RRF

Percent Drift

$$\% \text{ Drift} = \frac{\text{Absolute(Calculated Concentration - Theoretical Concentration)}}{\text{Theoretical Concentration}} * 100$$

Dilution Factor

Dilution Factor =(Volume of Solvent + Solute) / Volume of Solute

Relative Retention Time

RRT =RT of Compound / RT of ISTD

Breakdown Percent

$$\text{Breakdown} = \frac{\text{Area of DDD + Area of DDE}}{\text{Average (DDT, DDE and DDD)}}$$

-or-

$$\frac{\text{Area of Endrin Ketone + Area of Endrin Aldehyde}}{\text{Average (Endrin, Endrin Ketone, Endrin Aldehyde)}}$$

11.0 Data Reduction, Validation, Reporting, and Record Keeping

All data reported must be of the highest possible accuracy and quality. During the processes of data reduction, validation, and report generation, all work is thoroughly checked to insure that error is minimized.

Data Reduction

The analyst who generated the data usually performs the data reduction. The calculations include evaluation of surrogate recoveries (where applicable), and other miscellaneous calculations related to the sample quantitation.

If the results are computer generated, then the formulas must be confirmed by hand calculations, at minimum, one per batch.

See the current Data Validation SOP for details regarding data reduction.

Validation

A senior analyst, most often the section supervisor, validates the data. All data undergoes peer review. If an error is detected, it is brought to the analyst's attention so that he or she can rectify the error, and perform further checks to ensure that all data for that batch is sound. Previous and/or common mistakes are stringently monitored throughout the validation process. Data is reported using appropriate significant figure criteria. In most cases, two significant digits are utilized, but three significant digits can be used in QC calculations. Significant digits are not rounded until after the last step of a sample calculation. All final reports undergo a review by the laboratory manager, the project manager, or their designee, to provide a logical review of all results before they are released to the client.

If data is to be manually transferred between media, the transcribed data is checked by a peer. This includes data typing, computer data entry, chromatographic data transfer, data table inclusion to a cover letter, or when data results are combined with other data fields.

All hand-written data from run logs, analytical standard logbooks, hand-entered data logbooks, or on instrument-generated chromatograms, are systematically archived should the need for future retrieval arise.

See the current Data Validation SOP for details regarding data validation.

Reports and Records

All records at HEAL are retained and maintained through the procedures outlined in the most recent version of the Records Control SOP.

Sample reports are compiled by the Laboratory Information Management System (LIMS). Most data is transferred directly from the instruments to the LIMS. After being processed by the analyst and reviewed by a data reviewer, final reports are approved and signed by the senior laboratory management. A comparative analysis of the data is performed at this point. For example, if TKN and NH3 are analyzed on the same sample, the NH3 result should never be greater than the TKN result. Lab results and reports are released only to appropriately designated individuals. Release of the data can be by fax, email, electronic deliverables, or mailed hard copy.

When a project is completed, the final report, chain of custody, any relevant supporting data, and the quality assurance/control worksheets are scanned as a .pdf file onto the main server. Original client folders are kept on file and are arranged by project number. Additionally, all electronic data is backed up routinely on the HEAL main server. The backup includes raw data, chromatograms, and report documents. Hard copies of chromatograms are stored separately according to the instrument and the analysis date. All records and analytical data reports are retained in a secure location as permanent records for a minimum period of five years (unless specified otherwise in a client contract). Access to archived information shall be documented with an access log. Access to archived electronic reports and data will be password protected. In the event that HEAL transfers ownership or terminates business practices, complete records will be maintained or transferred according to the client's instructions.

After issuance, the original report shall remain unchanged. If a correction to the report is necessary, then an additional document shall be issued. This document shall have a title of "Addendum to Test Report or Correction to Original Report", or equivalent. Demonstration of original report integrity comes in two forms. First, the report date is included on each page of the final report. Second, each page is numbered in sequential order, making the addition or omission of any data page(s) readily detectable.

12.0 Corrective Action

Refer to the most recent version of the Data Validation SOP for the procedure utilized in filling out a Corrective Action Report. A blank copy of the corrective action report is available in the current Document Control Logbook.

The limits that have been defined for data acceptability also form the basis for corrective action initiation. Initiation of corrective action occurs when the data generated from continuing calibration standard, sample surrogate recovery, laboratory control spike, matrix spike, or sample duplicates exceed acceptance criteria. If corrective action is necessary, the analyst or the section supervisor will coordinate to take the following guidelines into consideration in order to determine and correct the measurement system deficiency:

Check all calculations and data measurements systems (Calibrations, reagents, instrument performance checks, etc.).

Assure that proper procedures were followed.

Unforeseen problems that arise during sample preparation and/or sample analysis that lead to treating a sample differently from documented procedures shall be documented with a corrective action report. The section supervisor and laboratory manager shall be made aware of the problem at the time of the occurrence. See the appropriate SOP regarding departures from documented procedures.

Continuing calibration standards below acceptance criteria can not be used for reporting analytical data unless method specific criteria states otherwise.

Continuing calibration standards above acceptance criteria can be used to report data as long as the failure is isolated to a single standard and the corresponding samples are non-detect for the failing analyte.

Samples with non-compliant surrogate recoveries should be reanalyzed, unless deemed un-necessary by the supervisor for matrix, historical data, or other analysis-related anomalies.

Laboratory and Matrix Spike acceptance criteria vary significantly depending on method and matrix. Analysts and supervisors meet and discuss appropriate corrective action measures as spike failures occur.

Sample duplicates with RPD values outside control limits require supervisor evaluation and possible reanalysis.

A second mechanism for initiation of corrective action is that resulting from Quality Assurance performance audits, system audits, inter- and intra-laboratory comparison studies. Corrective Actions initiated through this mechanism will be monitored and coordinated by the laboratory QA/QCO.

All corrective action forms are entered in the LIMS and included with the raw data for peer review, signed by the technical director of the section and included in the case narrative to the client whose samples were affected. All Corrective action forms in the LIMS are reviewed by the QA/QCO.

13.0 Quality Assurance Audits, Reports and Complaints

Internal/External Systems' Audits, Performance Evaluations, and Complaints

Several procedures are used to assess the effectiveness of the quality control system. One of these methods includes internal performance evaluations, which are conducted by the use of control samples, replicate measurements, and control charts. External performance audits, which are conducted by the use of inter-laboratory checks, such as participation in laboratory evaluation programs and performance evaluation samples available from a NELAC-accredited Proficiency Standard Vendor, are another method.

Proficiency samples will be obtained twice per year from an appropriate vendor for all tests and matrices for which we are accredited and for which PTs are available. HEAL participates in soil, waste water, drinking water, and underground storage tank PT studies. Copies of results are available upon request. HEAL's management and all analysts shall ensure that all PT samples are handled in the same manner as real environmental samples utilizing the same staff, methods, procedures, equipment, facilities, and frequency of analysis as used for routine analysis of that analyte. When analyzing a PT, HEAL shall employ the same calibration, laboratory quality control and acceptance criteria, sequence of analytical steps, number of replicates, and other procedures as used when analyzing routine samples.

With regards to analyzing PT Samples, HEAL shall not send any PT sample, or portion of a PT sample, to another laboratory for any analysis for which we seek accreditation, or are accredited. HEAL shall not knowingly receive any PT sample or portion of a PT sample from another laboratory for any analysis for which the sending laboratory seeks accreditation, or is accredited. Laboratory management or staff will not communicate with any individual at another laboratory concerning the PT sample. Laboratory management or staff shall not attempt to obtain the assigned value of any PT sample from the PT Provider.

Internal Audits are performed annually by the QA/QCO in accordance with the current Internal Audit SOP. The system audit consists of a qualitative inspection of the QA system in the laboratory and an assessment of the adequacy of the physical facilities for sampling, calibration, and measurement. This audit includes a careful evaluation and review of laboratory quality control procedures. Internal audits are performed using the guidelines outlined below, which include, but are not limited to:

1. Review of staff qualifications, demonstration of capability, and personnel training programs
2. Storage and handling of reagents, standards, and samples
3. Standard preparation logbook and LIMS procedures
4. Extraction logbooks
5. Raw data logbooks
6. Analytical logbooks or batch printouts and instrument maintenance logbooks
7. Data review procedures

8. Corrective action procedures
9. Review of data packages, which is performed regularly by the lab manager/QA Officer.

The QA/QCO will conduct these audits on an annual basis.

Management Reviews

HEAL management shall periodically, and at least annually, conduct a review of the laboratory's quality system and environmental testing activities to ensure their continuing suitability and effectiveness, and to introduce necessary changes or improvements. The review shall take account of:

1. the suitability and implementation of policies and procedures
2. reports from managerial and supervisory personnel
3. the outcome of recent internal audits
4. corrective and preventive actions
5. assessments by external bodies
6. the results of inter-laboratory comparisons or proficiency tests
7. changes in volume and type of work
8. client feed back
9. complaints
10. other relevant factors, such as laboratory health and safety, QC activities, resources, and staff training.

Findings from management reviews and the actions that arise from them shall be recorded and any corrective actions that arise shall be completed in an appropriate and agreed upon timescale.

Complaints

Complaints from clients are documented and given to the laboratory manager. The lab manager shall review the information and contact the client. If doubt is raised concerning the laboratory's policies or procedures, then an audit of the section or sections may be performed. All records of complaints and subsequent actions shall be maintained in the client compliant logbook for five years unless otherwise stated.

Internal and External Reports

The QA/QCO is responsible for preparation and submission of quality assurance reports to the appropriate management personnel as problems and issues arise. These reports include the assessment of measurement systems, data precision and accuracy, and the results of performance and system audits. Additionally, they include significant QA

problems, corrective actions, and recommended resolution measures. Reports of these Quality Assurance Audits describe the particular activities audited, procedures utilized in the examination and evaluation of laboratory records, and data validation procedures. Finally, there are procedures for evaluating the performance of Quality Control and Quality Assurance activities, and laboratory deficiencies and the implementation of corrective actions with the review requirements.

Appendix D

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

February 10, 2012

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 1st QTR 2012 OrderNo.: 1202044

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 2/1/2012 for the analyses presented in the following report.

There were no problems with the analytical events associated with this report unless noted in the Case Narrative. Analytical results designated with a "J" qualifier are estimated and represent a detection above the Method Detection Limit (MDL) and less than the Reporting Limit (PQL). These analytes are not reviewed nor narrated as to whether they are laboratory artifacts.

Quality control data is within laboratory defined or method specified acceptance limits except if noted.

If you have any questions regarding these tests results, please feel free to call.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1202044**
10-Feb-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC 1st QTR 2012

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1202044-001	GAC Lead		1/31/2012 1:25:00 PM	2/1/2012 9:40:00 AM	Aqueous
1202044-001	GAC Lead		1/31/2012 1:25:00 PM	2/1/2012 9:40:00 AM	Aqueous
1202044-002	GAC-Lag		1/31/2012 1:20:00 PM	2/1/2012 9:40:00 AM	Aqueous
1202044-002	GAC-Lag		1/31/2012 1:20:00 PM	2/1/2012 9:40:00 AM	Aqueous
1202044-003	GAC-Inlet		1/31/2012 1:30:00 PM	2/1/2012 9:40:00 AM	Aqueous
1202044-003	GAC-Inlet		1/31/2012 1:30:00 PM	2/1/2012 9:40:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** GAC Lead
Project: GAC 1st QTR 2012 **Collection Date:** 1/31/2012 1:25:00 PM
Lab ID: 1202044-001 **Matrix:** AQUEOUS **Received Date:** 2/1/2012 9:40:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	2/6/2012 2:24:28 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	2/6/2012 2:24:28 PM
Surr: DNOP	97.4	69-152		%REC	1	2/6/2012 2:24:28 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **RAA**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	2/2/2012 1:32:14 AM
Surr: BFB	93.6	69.3-120		%REC	1	2/2/2012 1:32:14 AM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 1st QTR 2012
Lab ID: 1202044-002 **Matrix:** AQUEOUS

Client Sample ID: GAC-Lag
Collection Date: 1/31/2012 1:20:00 PM
Received Date: 2/1/2012 9:40:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	2/6/2012 3:29:33 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	2/6/2012 3:29:33 PM
Surr: DNOP	93.5	69-152		%REC	1	2/6/2012 3:29:33 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **RAA**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	2/2/2012 2:01:01 AM
Surr: BFB	94.0	69.3-120		%REC	1	2/2/2012 2:01:01 AM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** GAC-Inlet
Project: GAC 1st QTR 2012 **Collection Date:** 1/31/2012 1:30:00 PM
Lab ID: 1202044-003 **Matrix:** AQUEOUS **Received Date:** 2/1/2012 9:40:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	0.57	0.20		mg/L	1	2/6/2012 3:50:57 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	2/6/2012 3:50:57 PM
Surr: DNOP	102	69-152		%REC	1	2/6/2012 3:50:57 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **RAA**
Gasoline Range Organics (GRO)	2.1	0.50		mg/L	10	2/2/2012 2:29:43 AM
Surr: BFB	139	69.3-120	S	%REC	10	2/2/2012 2:29:43 AM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1202044**

10-Feb-12

Client: Western Refining Southwest, Inc.

Project: GAC 1st QTR 2012

Sample ID **MB-595**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **595**	RunNo: **779**
Prep Date: **2/6/2012**	Analysis Date: **2/6/2012**	SeqNo: **22407** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.50		0.5000		99.3	69	152			

Sample ID **LCS-595**	SampType: **LCS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **LCSW**	Batch ID: **595**	RunNo: **779**
Prep Date: **2/6/2012**	Analysis Date: **2/6/2012**	SeqNo: **22408** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.1	0.20	2.500	0	83.2	74	157			
Surr: DNOP	0.25		0.2500		100	69	152			

Sample ID **1202044-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC Lead**	Batch ID: **595**	RunNo: **779**
Prep Date: **2/6/2012**	Analysis Date: **2/6/2012**	SeqNo: **22411** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.2	0.20	2.500	0	88.7	71	161			
Surr: DNOP	0.24		0.2500		97.9	69	152			

Sample ID **1202044-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC Lead**	Batch ID: **595**	RunNo: **779**
Prep Date: **2/6/2012**	Analysis Date: **2/6/2012**	SeqNo: **22412** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.5	0.20	2.500	0	102	71	161	13.5	23	
Surr: DNOP	0.25		0.2500		102	69	152	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1202044**

"all Environmental Analysis Laboratory, Inc.

10-Feb-12

Client: Western Refining Southwest, Inc.
Project: GAC 1st QTR 2012

Sample ID **5ML-RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R713**	RunNo: **713**
Prep Date:	Analysis Date: **2/1/2012**	SeqNo: **20355** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	19		20.00		94.1	69.3	120			

Sample ID **2.5GRO LCS**	SampType: **LCS**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **LCSW**	Batch ID: **R713**	RunNo: **713**
Prep Date:	Analysis Date: **2/1/2012**	SeqNo: **20359** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.57	0.050	0.5000	0	114	81.8	120			
Surr: BFB	20		20.00		101	69.3	120			

Qualifiers:

- X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1202044

Received by/date: AG 2/1/12

Logged By: Michelle Garcia 2/1/2012 9:40:00 AM Michelle Garcia

Completed By: Michelle Garcia 2/1/2012 1:53:10 PM Michelle Garcia

Reviewed By: 2/1/12

Chain of Custody

1. Were seals intact? Yes ☑ No ☐ Not Present ☐
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? UPS

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
11. VOA vials have zero headspace? Yes ☐ No ☐ No VOA Vials ☑
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)
Adjusted? _____
Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date: _____
By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: _____
Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	2.5	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: 50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-~~4172~~4135

email or Fax#: 505-632-3911

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other _____

☐ EDD (Type) _____

Turn-Around Time:
☒ Standard ☐ Rush _____

Project Name:
GAC 1ST QTR 2012

Project #:

Project Manager:
Kelly Robinson 1/31/12

Sampler: Terry

On Ice: ☒ Yes ☐ No

Sample Temperature: 2

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1202044	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/~~Diesel~~)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8270 (Semi-VOA)	8015 DRO				Air Bubbles (Y or N)
1-31-12	1:25	Aqueous	GAC Lead	3-VOA	HCl	1			X									X				
"	"	"	" "	500ML Amber	Amber	1												X				
	1:20		GAC-LAG	3-VOA	HCl	2			X													
	"			500ml	Amber	2												X				
	1:30		GAC-INLET	3-VOA	HCl	3			X													
	"			500ml	Amber	3												X				

Analysis Request

Date:	Time:	Relinquished by:	Received by:	Date	Time
1-31-12	3:00	Peter Knoblow		2/1/12	940
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

March 01, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 2-14-12 OrderNo.: 1202506

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 1 sample(s) on 2/15/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman

Laboratory Manager

4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1202506**
01-Mar-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC 2-14-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1202506-001	GAC Lead		2/14/2012 8:20:00 AM	2/15/2012 9:40:00 AM	Aqueous
1202506-001	GAC Lead		2/14/2012 8:20:00 AM	2/15/2012 9:40:00 AM	Aqueous

Analytical Report
Lab Order **1202506**
Date Reported: **3/1/2012**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 2-14-12
Lab ID: 1202506-001 **Matrix:** AQUEOUS

Client Sample ID: GAC Lead
Collection Date: 2/14/2012 8:20:00 AM
Received Date: 2/15/2012 9:40:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	2/17/2012 12:26:25 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	2/17/2012 12:26:25 PM
Surr: DNOP	106	69-152		%REC	1	2/17/2012 12:26:25 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **RAA**
Gasoline Range Organics (GRO)	0.052	0.050		mg/L	1	2/17/2012 8:07:07 PM
Surr: BFB	95.1	69.3-120		%REC	1	2/17/2012 8:07:07 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	5.9	1.0		µg/L	1	2/23/2012 5:53:43 PM
Toluene	ND	1.0		µg/L	1	2/23/2012 5:53:43 PM
Ethylbenzene	ND	1.0		µg/L	1	2/23/2012 5:53:43 PM
Xylenes, Total	ND	2.0		µg/L	1	2/23/2012 5:53:43 PM
Surr: 1,2-Dichloroethane-d4	97.3	70-130		%REC	1	2/23/2012 5:53:43 PM
Surr: 4-Bromofluorobenzene	107	70-130		%REC	1	2/23/2012 5:53:43 PM
Surr: Dibromofluoromethane	82.5	69.8-130		%REC	1	2/23/2012 5:53:43 PM
Surr: Toluene-d8	101	70-130		%REC	1	2/23/2012 5:53:43 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

WO#: **1202506**

"all Environmental Analysis Laboratory, Inc.

01-Mar-12

Client: Western Refining Southwest, Inc.
Project: GAC 2-14-12

Sample ID **MB-755**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **755**	RunNo: **992**
Prep Date: **2/17/2012**	Analysis Date: **2/17/2012**	SeqNo: **28979** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.54		0.5000		108	69	152			

Sample ID **LCS-755**	SampType: **LCS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **LCSW**	Batch ID: **755**	RunNo: **992**
Prep Date: **2/17/2012**	Analysis Date: **2/17/2012**	SeqNo: **28981** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0	106	74	157			
Surr: DNOP	0.27		0.2500		109	69	152			

Sample ID **1202506-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC Lead**	Batch ID: **755**	RunNo: **992**
Prep Date: **2/17/2012**	Analysis Date: **2/17/2012**	SeqNo: **29043** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
˙el Range Organics (DRO)	2.5	0.20	2.500	0	101	71	161			
˛urr: DNOP	0.27		0.2500		110	69	152			

Sample ID **1202506-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC Lead**	Batch ID: **755**	RunNo: **992**
Prep Date: **2/17/2012**	Analysis Date: **2/17/2012**	SeqNo: **29045** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0	104	71	161	3.53	23	
Surr: DNOP	0.27		0.2500		107	69	152	0	0	

Qualifiers:

- X Value exceeds Maximum Contaminant Level.
- ˛ Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1202506**

01-Mar-12

Client: Western Refining Southwest, Inc.

Project: GAC 2-14-12

Sample ID **5ML-RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R1022**	RunNo: **1022**
Prep Date:	Analysis Date: **2/17/2012**	SeqNo: **29549** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	19		20.00		95.9	69.3	120			

Sample ID **2.5UG GRO LCS**	SampType: **LCS**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **LCSW**	Batch ID: **R1022**	RunNo: **1022**
Prep Date:	Analysis Date: **2/17/2012**	SeqNo: **29553** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.57	0.050	0.5000	0	114	101	123			
Surr: BFB	23		20.00		114	69.3	120			

Sample ID **2.5UG GRO LCSD**	SampType: **LCSD**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **LCSS02**	Batch ID: **R1022**	RunNo: **1022**
Prep Date:	Analysis Date: **2/17/2012**	SeqNo: **29554** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.58	0.050	0.5000	0	117	101	123	2.50	17.1	
Surr: BFB	20		20.00		102	69.3	120	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1202506**

"all Environmental Analysis Laboratory, Inc.

01-Mar-12

Client: Western Refining Southwest, Inc.
Project: GAC 2-14-12

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R1112**	RunNo: **1112**
Prep Date:	Analysis Date: **2/23/2012**	SeqNo: **31734** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	9.7		10.00		97.3	70	130			
Surr: 4-Bromofluorobenzene	9.9		10.00		98.6	70	130			
Surr: Dibromofluoromethane	7.7		10.00		77.3	69.8	130			
Surr: Toluene-d8	10		10.00		101	70	130			

Sample ID **100ng lcs**	SampType: **LCS**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **LCSW**	Batch ID: **R1112**	RunNo: **1112**
Prep Date:	Analysis Date: **2/23/2012**	SeqNo: **31735** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	19	1.0	20.00	0	95.2	84.1	126			
Toluene	19	1.0	20.00	0	95.8	80	120			
Surr: 1,2-Dichloroethane-d4	9.6		10.00		95.5	70	130			
Surr: 4-Bromofluorobenzene	9.9		10.00		98.9	70	130			
Surr: Dibromofluoromethane	7.8		10.00		78.3	69.8	130			
Surr: Toluene-d8	10		10.00		101	70	130			

Qualifiers:

- X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1202506

Received by/date: LM 02/15/12

Logged By: Anne Thorne 2/15/2012 9:40:00 AM Anne Thorne

Completed By: Anne Thorne 2/15/2012 Anne Thorne

Reviewed By: MG 2/15/12

Chain of Custody

1. Were seals intact?	Yes ☐	No ☐	Not Present ☑
2. Is Chain of Custody complete?	Yes ☑	No ☐	Not Present ☐
3. How was the sample delivered?	UPS		

Log In

4. Coolers are present? (see 19. for cooler specific information)	Yes ☑	No ☐	NA ☐
5. Was an attempt made to cool the samples?	Yes ☑	No ☐	NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C	Yes ☑	No ☐	NA ☐
7. Sample(s) in proper container(s)?	Yes ☑	No ☐	
8. Sufficient sample volume for indicated test(s)?	Yes ☑	No ☐	
9. Are samples (except VOA and ONG) properly preserved?	Yes ☑	No ☐	
10. Was preservative added to bottles?	Yes ☐	No ☑	NA ☐
11. VOA vials have zero headspace?	Yes ☑	No ☐	No VOA Vials ☐
12. Were any sample containers received broken?	Yes ☐	No ☑	
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes ☑	No ☐	
14. Are matrices correctly identified on Chain of Custody?	Yes ☑	No ☐	
15. Is it clear what analyses were requested?	Yes ☑	No ☐	
16. Were all holding times able to be met? (If no, notify customer for authorization.)	Yes ☑	No ☐	

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)

Adjusted? _____

Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date _____

By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person

Regarding: _____

Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	3.8	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: 50 Road 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#: 505-632-3911

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other _____

☐ EDD (Type) _____

Turn-Around Time:
☒ Standard ☐ Rush _____

Project Name: GAC 2-14-12

Project #:

Project Manager:

Sampler: Bob + Terry

On Ice: ☒ Yes ☐ No

Sample Temperature: 4

TEAL No. 102506

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No.
2-14-12	8:20	H_2O	GAC lead	3-VOA	HCL	-1
2-14-12	8:20	H_2O	GAC Lead	500 ml	Amber	-1

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX Only	8270 (Semi-VOA)	DRO 8015				Air Bubbles (Y or N)
		X							X						
		X									X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
2-14-12	3:00	Robert Baker			
Date:	Time:	Relinquished by:	Received by:	2/15/12	0940

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

March 01, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC 2-14-12 OrderNo.: 1202506

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 1 sample(s) on 2/15/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1202506**

01-Mar-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC 2-14-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1202506-001	GAC Lead		2/14/2012 8:20:00 AM	2/15/2012 9:40:00 AM	Aqueous
1202506-001	GAC Lead		2/14/2012 8:20:00 AM	2/15/2012 9:40:00 AM	Aqueous

Analytical Report
Lab Order **1202506**
Date Reported: **3/1/2012**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 2-14-12
Lab ID: 1202506-001 **Matrix:** AQUEOUS

Client Sample ID: GAC Lead
Collection Date: 2/14/2012 8:20:00 AM
Received Date: 2/15/2012 9:40:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	2/17/2012 12:26:25 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	2/17/2012 12:26:25 PM
Surr: DNOP	106	69-152		%REC	1	2/17/2012 12:26:25 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **RAA**
Gasoline Range Organics (GRO)	0.052	0.050		mg/L	1	2/17/2012 8:07:07 PM
Surr: BFB	95.1	69.3-120		%REC	1	2/17/2012 8:07:07 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	5.9	1.0		µg/L	1	2/23/2012 5:53:43 PM
Toluene	ND	1.0		µg/L	1	2/23/2012 5:53:43 PM
Ethylbenzene	ND	1.0		µg/L	1	2/23/2012 5:53:43 PM
Xylenes, Total	ND	2.0		µg/L	1	2/23/2012 5:53:43 PM
Surr: 1,2-Dichloroethane-d4	97.3	70-130		%REC	1	2/23/2012 5:53:43 PM
Surr: 4-Bromofluorobenzene	107	70-130		%REC	1	2/23/2012 5:53:43 PM
Surr: Dibromofluoromethane	82.5	69.8-130		%REC	1	2/23/2012 5:53:43 PM
Surr: Toluene-d8	101	70-130		%REC	1	2/23/2012 5:53:43 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

WO#: **1202506**

"all Environmental Analysis Laboratory, Inc.

01-Mar-12

Client: Western Refining Southwest, Inc.
Project: GAC 2-14-12

Sample ID **MB-755**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **755**	RunNo: **992**
Prep Date: **2/17/2012**	Analysis Date: **2/17/2012**	SeqNo: **28979** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.54		0.5000		108	69	152			

Sample ID **LCS-755**	SampType: **LCS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **LCSW**	Batch ID: **755**	RunNo: **992**
Prep Date: **2/17/2012**	Analysis Date: **2/17/2012**	SeqNo: **28981** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0	106	74	157			
Surr: DNOP	0.27		0.2500		109	69	152			

Sample ID **1202506-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC Lead**	Batch ID: **755**	RunNo: **992**
Prep Date: **2/17/2012**	Analysis Date: **2/17/2012**	SeqNo: **29043** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
el Range Organics (DRO)	2.5	0.20	2.500	0	101	71	161			
Surr: DNOP	0.27		0.2500		110	69	152			

Sample ID **1202506-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC Lead**	Batch ID: **755**	RunNo: **992**
Prep Date: **2/17/2012**	Analysis Date: **2/17/2012**	SeqNo: **29045** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0	104	71	161	3.53	23	
Surr: DNOP	0.27		0.2500		107	69	152	0	0	

Qualifiers:

- (Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1202506**

01-Mar-12

Client: Western Refining Southwest, Inc.

Project: GAC 2-14-12

Sample ID **5ML-RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R1022**	RunNo: **1022**
Prep Date:	Analysis Date: **2/17/2012**	SeqNo: **29549** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	19		20.00		95.9	69.3	120			

Sample ID **2.5UG GRO LCS**	SampType: **LCS**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **LCSW**	Batch ID: **R1022**	RunNo: **1022**
Prep Date:	Analysis Date: **2/17/2012**	SeqNo: **29553** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.57	0.050	0.5000	0	114	101	123			
Surr: BFB	23		20.00		114	69.3	120			

Sample ID **2.5UG GRO LCSD**	SampType: **LCSD**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **LCSS02**	Batch ID: **R1022**	RunNo: **1022**
Prep Date:	Analysis Date: **2/17/2012**	SeqNo: **29554** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.58	0.050	0.5000	0	117	101	123	2.50	17.1	
Surr: BFB	20		20.00		102	69.3	120	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1202506**

Hall Environmental Analysis Laboratory, Inc.

01-Mar-12

Client: Western Refining Southwest, Inc.

Project: GAC 2-14-12

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R1112**	RunNo: **1112**
Prep Date:	Analysis Date: **2/23/2012**	SeqNo: **31734** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	9.7		10.00		97.3	70	130			
Surr: 4-Bromofluorobenzene	9.9		10.00		98.6	70	130			
Surr: Dibromofluoromethane	7.7		10.00		77.3	69.8	130			
Surr: Toluene-d8	10		10.00		101	70	130			

Sample ID **100ng lcs**	SampType: **LCS**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **LCSW**	Batch ID: **R1112**	RunNo: **1112**
Prep Date:	Analysis Date: **2/23/2012**	SeqNo: **31735** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	19	1.0	20.00	0	95.2	84.1	126			
Toluene	19	1.0	20.00	0	95.8	80	120			
Surr: 1,2-Dichloroethane-d4	9.6		10.00		95.5	70	130			
Surr: 4-Bromofluorobenzene	9.9		10.00		98.9	70	130			
Surr: Dibromofluoromethane	7.8		10.00		78.3	69.8	130			
Surr: Toluene-d8	10		10.00		101	70	130			

Qualifiers:

- X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1202506

Received by/date: LM 02/15/12

Logged By: Anne Thorne 2/15/2012 9:40:00 AM Anne Thorne

Completed By: Anne Thorne 2/15/2012 Anne Thorne

Reviewed By: MG 2/15/12

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? UPS

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
11. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)
Adjusted? _____
Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date _____
By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: _____
Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	3.8	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: 50 Road 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#: 505-632-3911

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other _____

☐ EDD (Type) _____

Turn-Around Time:
☒ Standard ☐ Rush _____

Project Name: GAC 2-14-12

Project #:

Project Manager:

Sampler: Bob + Terry

On Ice: ☒ Yes ☐ No

Sample Temperature: 4

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1202506	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX Only	8270 (Semi-VOA)	DRO 8015				Air Bubbles (Y or N)
2-14-12	8:20	H_2O	GAC lead	3-VOA	HCL	-1			X							X						
2-14-12	8:20	H_2O	GAC Lead	500 ml	Amber	-1			X							X						

Date: 2-14-12 Time: 3:00 Relinquished by: Robert Baker

Received by: [signature] Date: 2/15/12 Time: 0940

Date: Time: Relinquished by:

Received by: Date: Time:

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

March 22, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4166
FAX (505) 632-3911

RE: GAC-3-8-12 OrderNo.: 1203330

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 1 sample(s) on 3/9/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1203330**

22-Mar-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC-3-8-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1203330-001	GAC-Lead		3/8/2012 8:45:00 AM	3/9/2012 10:05:00 AM	Aqueous
1203330-001	GAC-Lead		3/8/2012 8:45:00 AM	3/9/2012 10:05:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC-3-8-12
Lab ID: 1203330-001 **Matrix:** AQUEOUS

Client Sample ID: GAC-Lead
Collection Date: 3/8/2012 8:45:00 AM
Received Date: 3/9/2012 10:05:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	3/13/2012 5:27:07 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	3/13/2012 5:27:07 PM
Surr: DNOP	103	69-152		%REC	1	3/13/2012 5:27:07 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	0.051	0.050		mg/L	1	3/14/2012 7:29:04 PM
Surr: BFB	80.1	69.3-120		%REC	1	3/14/2012 7:29:04 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	7.2	1.0		µg/L	1	3/13/2012 6:08:49 AM
Toluene	ND	1.0		µg/L	1	3/13/2012 6:08:49 AM
Ethylbenzene	ND	1.0		µg/L	1	3/13/2012 6:08:49 AM
Xylenes, Total	ND	2.0		µg/L	1	3/13/2012 6:08:49 AM
Surr: 1,2-Dichloroethane-d4	91.9	70-130		%REC	1	3/13/2012 6:08:49 AM
Surr: 4-Bromofluorobenzene	101	70-130		%REC	1	3/13/2012 6:08:49 AM
Surr: Dibromofluoromethane	79.2	69.8-130		%REC	1	3/13/2012 6:08:49 AM
Surr: Toluene-d8	98.0	70-130		%REC	1	3/13/2012 6:08:49 AM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

WO#: **1203330**

All Environmental Analysis Laboratory, Inc.

22-Mar-12

Client: Western Refining Southwest, Inc.
Project: GAC-3-8-12

Sample ID **MB-1059**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **1059**	RunNo: **1441**
Prep Date: **3/13/2012**	Analysis Date: **3/13/2012**	SeqNo: **40456** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.51		0.5000		102	69	152			

Sample ID **LCS-1059**	SampType: **LCS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **LCSW**	Batch ID: **1059**	RunNo: **1441**
Prep Date: **3/13/2012**	Analysis Date: **3/13/2012**	SeqNo: **40457** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.7	0.20	2.500	0	106	74	157			
Surr: DNOP	0.26		0.2500		106	69	152			

Sample ID **1203330-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC-Lead**	Batch ID: **1059**	RunNo: **1441**
Prep Date: **3/13/2012**	Analysis Date: **3/13/2012**	SeqNo: **40459** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
el Range Organics (DRO)	2.8	0.20	2.500	0	113	71	161			
Surr: DNOP	0.28		0.2500		111	69	152			

Sample ID **1203330-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC-Lead**	Batch ID: **1059**	RunNo: **1441**
Prep Date: **3/13/2012**	Analysis Date: **3/13/2012**	SeqNo: **40460** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0	104	71	161	8.43	23	
Surr: DNOP	0.27		0.2500		107	69	152	0	0	

Qualifiers:

- X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1203330**

22-Mar-12

Client: Western Refining Southwest, Inc.

Project: GAC-3-8-12

Sample ID **5ML-RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R1476**	RunNo: **1476**
Prep Date:	Analysis Date: **3/14/2012**	SeqNo: **41440** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	18		20.00		88.4	69.3	120			

Sample ID **2.5UG GRO LCS**	SampType: **LCS**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **LCSW**	Batch ID: **R1476**	RunNo: **1476**
Prep Date:	Analysis Date: **3/14/2012**	SeqNo: **41441** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.60	0.050	0.5000	0	120	101	123			
Surr: BFB	19		20.00		92.5	69.3	120			

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1203330**

all Environmental Analysis Laboratory, Inc.

22-Mar-12

Client: Western Refining Southwest, Inc.
Project: GAC-3-8-12

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R1414**	RunNo: **1414**
Prep Date:	Analysis Date: **3/12/2012**	SeqNo: **39712** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	8.9		10.00		88.9	70	130			
Surr: 4-Bromofluorobenzene	9.7		10.00		97.1	70	130			
Surr: Dibromofluoromethane	7.8		10.00		77.8	69.8	130			
Surr: Toluene-d8	9.9		10.00		98.6	70	130			

Sample ID **100ng lcs4**	SampType: **LCS**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **LCSW**	Batch ID: **R1414**	RunNo: **1414**
Prep Date:	Analysis Date: **3/12/2012**	SeqNo: **39713** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	20	1.0	20.00	0	99.9	84.1	126			
Toluene	21	1.0	20.00	0	104	80	120			
Surr: 1,2-Dichloroethane-d4	29		30.00		98.2	70	130			
Surr: 4-Bromofluorobenzene	29		30.00		95.1	70	130			
Surr: Dibromofluoromethane	24		30.00		79.3	69.8	130			
Surr: Toluene-d8	31		30.00		103	70	130			

Qualifiers:

- X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1203330

Received by/date: 03/09/12

Logged By: Ashley Gallegos 3/9/2012 10:05:00 AM

Completed By: Ashley Gallegos 3/9/2012 10:18:09 AM

Reviewed By: IO 03/09/12

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? UPS

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
11. VOA vials have zero headspace? Yes ☐ No ☐ No VOA Vials ☑
12. Were any sample containers received broken? Yes ☑ No ☐
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)

Adjusted? _____

Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date: _____

By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person

Regarding: _____

Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.0	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other _____

☐ EDD (Type) _____

Turn-Around Time:
☒ Standard ☐ Rush _____

Project Name:
GAC - 3-8-12

Project #:

Project Manager:

Sampler: Terry + Bob

On Ice: ☒ Yes

Sample Temperature: [redacted]

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	[redacted]	BTEX +MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX only	8270 (Semi-VOA)	DRO - 8015B				Air Bubbles (Y or N)
3-8-12	8:45	H_2O	GAC-Lead	3-VOA	HCl	-001			X							X						
			"	1-500ml	amber	-001												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
3-8-12	3:00	Robert Krakow		03/09/12	1005
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks:

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

April 19, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: GAC 2nd QTR 4-3-12 OrderNo.: 1204160

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 4/4/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1204160**

19-Apr-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC 2nd QTR 4-3-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1204160-001	GAC-LAG		4/3/2012 12:40:00 PM	4/4/2012 10:15:00 AM	Aqueous
1204160-001	GAC-LAG		4/3/2012 12:40:00 PM	4/4/2012 10:15:00 AM	Aqueous
1204160-002	GAC-Lead		4/3/2012 12:45:00 PM	4/4/2012 10:15:00 AM	Aqueous
1204160-002	GAC-Lead		4/3/2012 12:45:00 PM	4/4/2012 10:15:00 AM	Aqueous
1204160-003	GAC-inlet		4/3/2012 12:50:00 PM	4/4/2012 10:15:00 AM	Aqueous
1204160-003	GAC-inlet		4/3/2012 12:50:00 PM	4/4/2012 10:15:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 2nd QTR 4-3-12
Lab ID: 1204160-001 **Matrix:** AQUEOUS

Client Sample ID: GAC-LAG
Collection Date: 4/3/2012 12:40:00 PM
Received Date: 4/4/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/7/2012 6:33:48 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/7/2012 6:33:48 PM
Surr: DNOP	119	69-152		%REC	1	4/7/2012 6:33:48 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	4/13/2012 1:14:27 PM
Surr: BFB	87.5	69.3-120		%REC	1	4/13/2012 1:14:27 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	ND	1.0		µg/L	1	4/6/2012 4:36:37 PM
Toluene	ND	1.0		µg/L	1	4/6/2012 4:36:37 PM
Ethylbenzene	ND	1.0		µg/L	1	4/6/2012 4:36:37 PM
Xylenes, Total	ND	2.0		µg/L	1	4/6/2012 4:36:37 PM
Surr: 1,2-Dichloroethane-d4	91.0	70-130		%REC	1	4/6/2012 4:36:37 PM
Surr: 4-Bromofluorobenzene	106	70-130		%REC	1	4/6/2012 4:36:37 PM
Surr: Dibromofluoromethane	98.6	69.8-130		%REC	1	4/6/2012 4:36:37 PM
Surr: Toluene-d8	98.9	70-130		%REC	1	4/6/2012 4:36:37 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** GAC-Lead
Project: GAC 2nd QTR 4-3-12 **Collection Date:** 4/3/2012 12:45:00 PM
Lab ID: 1204160-002 **Matrix:** AQUEOUS **Received Date:** 4/4/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/7/2012 7:37:27 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/7/2012 7:37:27 PM
Surr: DNOP	119	69-152		%REC	1	4/7/2012 7:37:27 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	0.074	0.050		mg/L	1	4/10/2012 3:23:58 AM
Surr: BFB	88.6	69.3-120		%REC	1	4/10/2012 3:23:58 AM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	6.8	1.0		µg/L	1	4/6/2012 5:06:11 PM
Toluene	ND	1.0		µg/L	1	4/6/2012 5:06:11 PM
Ethylbenzene	ND	1.0		µg/L	1	4/6/2012 5:06:11 PM
Xylenes, Total	ND	2.0		µg/L	1	4/6/2012 5:06:11 PM
Surr: 1,2-Dichloroethane-d4	94.2	70-130		%REC	1	4/6/2012 5:06:11 PM
Surr: 4-Bromofluorobenzene	112	70-130		%REC	1	4/6/2012 5:06:11 PM
Surr: Dibromofluoromethane	98.8	69.8-130		%REC	1	4/6/2012 5:06:11 PM
Surr: Toluene-d8	101	70-130		%REC	1	4/6/2012 5:06:11 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 2nd QTR 4-3-12
Lab ID: 1204160-003 **Matrix:** AQUEOUS

Client Sample ID: GAC-inlet
Collection Date: 4/3/2012 12:50:00 PM
Received Date: 4/4/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	1.6	0.20		mg/L	1	4/7/2012 7:58:43 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/7/2012 7:58:43 PM
Surr: DNOP	120	69-152		%REC	1	4/7/2012 7:58:43 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	12	1.0		mg/L	20	4/10/2012 3:54:34 AM
Surr: BFB	92.6	69.3-120		%REC	20	4/10/2012 3:54:34 AM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	100	10		µg/L	10	4/6/2012 6:04:51 PM
Toluene	ND	10		µg/L	10	4/6/2012 6:04:51 PM
Ethylbenzene	950	100		µg/L	100	4/6/2012 5:35:31 PM
Xylenes, Total	2,400	200		µg/L	100	4/6/2012 5:35:31 PM
Surr: 1,2-Dichloroethane-d4	93.7	70-130		%REC	10	4/6/2012 6:04:51 PM
Surr: 4-Bromofluorobenzene	75.4	70-130		%REC	10	4/6/2012 6:04:51 PM
Surr: Dibromofluoromethane	98.9	69.8-130		%REC	10	4/6/2012 6:04:51 PM
Surr: Toluene-d8	101	70-130		%REC	10	4/6/2012 6:04:51 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

WO#: **1204160**

''all Environmental Analysis Laboratory, Inc.

19-Apr-12

Client: Western Refining Southwest, Inc.
Project: GAC 2nd QTR 4-3-12

Sample ID **MB-1413**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **1413**	RunNo: **1976**
Prep Date: **4/6/2012**	Analysis Date: **4/7/2012**	SeqNo: **55062** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.62		0.5000		123	69	152			

Sample ID **LCS-1413**	SampType: **LCS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **LCSW**	Batch ID: **1413**	RunNo: **1976**
Prep Date: **4/6/2012**	Analysis Date: **4/7/2012**	SeqNo: **55063** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.4	0.20	2.500	0	97.0	74	157			
Surr: DNOP	0.27		0.2500		109	69	152			

Sample ID **1204160-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC-LAG**	Batch ID: **1413**	RunNo: **1976**
Prep Date: **4/6/2012**	Analysis Date: **4/7/2012**	SeqNo: **55067** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
el Range Organics (DRO)	2.3	0.20	2.500	0	92.4	71	161			
Surr: DNOP	0.25		0.2500		102	69	152			

Sample ID **1204160-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC-LAG**	Batch ID: **1413**	RunNo: **1976**
Prep Date: **4/6/2012**	Analysis Date: **4/7/2012**	SeqNo: **55068** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0	104	71	161	11.4	23	
Surr: DNOP	0.29		0.2500		118	69	152	0	0	

Qualifiers:

- Ɛ Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1204160**

19-Apr-12

Client: Western Refining Southwest, Inc.

Project: GAC 2nd QTR 4-3-12

Sample ID **5ML RB**	SampType: **MBLK**			TestCode: **EPA Method 8015B: Gasoline Range**					
Client ID: **PBW**	Batch ID: **R2016**			RunNo: **2016**					
Prep Date:	Analysis Date: **4/9/2012**			SeqNo: **56151**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	14		20.00		70.2	69.3	120			

Sample ID **2.5UG GRO LCS**	SampType: **LCS**			TestCode: **EPA Method 8015B: Gasoline Range**					
Client ID: **LCSW**	Batch ID: **R2016**			RunNo: **2016**					
Prep Date:	Analysis Date: **4/9/2012**			SeqNo: **56152**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.57	0.050	0.5000	0	114	101	123			
Surr: BFB	22		20.00		109	69.3	120			

Sample ID **5ML RB**	SampType: **MBLK**			TestCode: **EPA Method 8015B: Gasoline Range**					
Client ID: **PBW**	Batch ID: **R2130**			RunNo: **2130**					
Prep Date:	Analysis Date: **4/13/2012**			SeqNo: **59020**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	14		20.00		71.8	69.3	120			

Sample ID **2.5UG GRO LCS**	SampType: **LCS**			TestCode: **EPA Method 8015B: Gasoline Range**					
Client ID: **LCSW**	Batch ID: **R2130**			RunNo: **2130**					
Prep Date:	Analysis Date: **4/13/2012**			SeqNo: **59021**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.51	0.050	0.5000	0	102	101	123			
Surr: BFB	19		20.00		95.8	69.3	120			

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1204160**

""all Environmental Analysis Laboratory, Inc.

19-Apr-12

Client: Western Refining Southwest, Inc.
Project: GAC 2nd QTR 4-3-12

Sample ID **100ng lcs**	SampType: **LCS**			TestCode: **EPA Method 8260: Volatiles Short List**					
Client ID: **LCSW**	Batch ID: **R1986**			RunNo: **1986**					
Prep Date:	Analysis Date: **4/6/2012**			SeqNo: **55511**		Units: **µg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	19	1.0	20.00	0	96.1	84.1	126			
Toluene	21	1.0	20.00	0	103	80	120			
Surr: 1,2-Dichloroethane-d4	9.4		10.00		94.5	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		114	70	130			
Surr: Dibromofluoromethane	10		10.00		101	69.8	130			
Surr: Toluene-d8	10		10.00		104	70	130			

Sample ID **1204160-003ams**	SampType: **MS**			TestCode: **EPA Method 8260: Volatiles Short List**					
Client ID: **GAC-inlet**	Batch ID: **R1986**			RunNo: **1986**					
Prep Date:	Analysis Date: **4/6/2012**			SeqNo: **55512**		Units: **µg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	300	10	200.0	104.7	98.2	71.1	135			
Toluene	200	10	200.0	5.428	97.6	74	121			
Surr: 1,2-Dichloroethane-d4	96		100.0		96.0	70	130			
Surr: 4-Bromofluorobenzene	77		100.0		76.8	70	130			
Surr: Dibromofluoromethane	100		100.0		103	69.8	130			
Surr: Toluene-d8	100		100.0		101	70	130			

Sample ID **1204160-003amsd**	SampType: **MSD**			TestCode: **EPA Method 8260: Volatiles Short List**					
Client ID: **GAC-inlet**	Batch ID: **R1986**			RunNo: **1986**					
Prep Date:	Analysis Date: **4/6/2012**			SeqNo: **55513**		Units: **µg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	300	10	200.0	104.7	95.6	71.1	135	1.72	21.9	
Toluene	200	10	200.0	5.428	95.7	74	121	1.88	18.5	
Surr: 1,2-Dichloroethane-d4	100		100.0		100	70	130	0	0	
Surr: 4-Bromofluorobenzene	80		100.0		80.3	70	130	0	0	
Surr: Dibromofluoromethane	100		100.0		103	69.8	130	0	0	
Surr: Toluene-d8	100		100.0		101	70	130	0	0	

Sample ID **b5**	SampType: **MBLK**			TestCode: **EPA Method 8260: Volatiles Short List**					
Client ID: **PBW**	Batch ID: **R1986**			RunNo: **1986**					
Prep Date:	Analysis Date: **4/6/2012**			SeqNo: **55534**		Units: **µg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	9.6		10.00		96.2	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		108	70	130			

Qualifiers:

- Y Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1204160**

19-Apr-12

Client: Western Refining Southwest, Inc.

Project: GAC 2nd QTR 4-3-12

Sample ID **b5**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R1986**	RunNo: **1986**
Prep Date:	Analysis Date: **4/6/2012**	SeqNo: **55534** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Surr: Dibromofluoromethane	9.8		10.00		97.8	69.8	130			
Surr: Toluene-d8	10		10.00		102	70	130			

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1204160

Received by/date: LM 04/04/12

Logged By: Michelle Garcia 4/4/2012 10:15:00 AM Michelle Garcia

Completed By: Michelle Garcia 4/4/2012 1:04:17 PM Michelle Garcia

Reviewed By: IO 04/05/12

Chain of Custody

1. Were seals intact?	Yes ☑	No ☐	Not Present ☐
2. Is Chain of Custody complete?	Yes ☑	No ☐	Not Present ☐
3. How was the sample delivered?	UPS		

Log In

4. Coolers are present? (see 19. for cooler specific information)	Yes ☑	No ☐	NA ☐
5. Was an attempt made to cool the samples?	Yes ☑	No ☐	NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C	Yes ☑	No ☐	NA ☐
7. Sample(s) in proper container(s)?	Yes ☑	No ☐	
8. Sufficient sample volume for indicated test(s)?	Yes ☑	No ☐	
9. Are samples (except VOA and ONG) properly preserved?	Yes ☑	No ☐	
10. Was preservative added to bottles?	Yes ☐	No ☑	NA ☐
11. VOA vials have zero headspace?	Yes ☐	No ☐	No VOA Vials ☑
12. Were any sample containers received broken?	Yes ☐	No ☑	
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes ☑	No ☐	
14. Are matrices correctly identified on Chain of Custody?	Yes ☑	No ☐	
15. Is it clear what analyses were requested?	Yes ☑	No ☐	
16. Were all holding times able to be met? (If no, notify customer for authorization.)	Yes ☑	No ☐	

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)

Adjusted? _____

Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date: _____

By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person

Regarding: _____

Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	3.3	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC 2nd QTR 4-3-12

Project #:

Project Manager:

Sampler: Terry

On Ice: ☒ Yes ☐ No

Sample Temperature:

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) Aromatics only BTEX	8270 (Semi-VOA)	80158 DRO				Air Bubbles (Y or N)
4-3-12	12:40	H_2O	GAC-Lag	3-VOA	HCl	-001			X							X						
				1-500ml	amber													X				
	12:45		GAC-Lead	3-VOA	HCl	-002			X							X						
				1-500ml	amber													X				
	12:50		GAC-INLET	3-VOA	HCl	-003			X							X						
				1-500ml	amber													X				

Date:	Time:	Relinquished by:	Received by:	Date Time	Remarks:
4-3-12	3:00	Robert Kraker		4/4/12 10:45	Per BK 8260 BTEX only /AT 04/05/12
Date:	Time:	Relinquished by:	Received by:	Date Time	

If ne y, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytic rt.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

May 25, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: GAC 5-8-12 OrderNo.: 1205417

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 1 sample(s) on 5/9/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1205417**

25-May-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC 5-8-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1205417-001	GAC -Lead		5/8/2012 8:15:00 AM	5/9/2012 10:30:00 AM	Aqueous
1205417-001	GAC -Lead		5/8/2012 8:15:00 AM	5/9/2012 10:30:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** GAC -Lead
Project: GAC 5-8-12 **Collection Date:** 5/8/2012 8:15:00 AM
Lab ID: 1205417-001 **Matrix:** AQUEOUS **Received Date:** 5/9/2012 10:30:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	5/11/2012 10:46:27 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/11/2012 10:46:27 AM
Surr: DNOP	120	69-152		%REC	1	5/11/2012 10:46:27 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	0.057	0.050		mg/L	1	5/14/2012 5:25:04 PM
Surr: BFB	76.2	69.3-120		%REC	1	5/14/2012 5:25:04 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **RAA**
Benzene	8.5	1.0		µg/L	1	5/11/2012 2:44:35 PM
Toluene	ND	1.0		µg/L	1	5/11/2012 2:44:35 PM
Ethylbenzene	ND	1.0		µg/L	1	5/11/2012 2:44:35 PM
Xylenes, Total	ND	2.0		µg/L	1	5/11/2012 2:44:35 PM
Surr: 1,2-Dichloroethane-d4	89.4	70-130		%REC	1	5/11/2012 2:44:35 PM
Surr: 4-Bromofluorobenzene	98.1	70-130		%REC	1	5/11/2012 2:44:35 PM
Surr: Dibromofluoromethane	88.9	69.8-130		%REC	1	5/11/2012 2:44:35 PM
Surr: Toluene-d8	96.4	70-130		%REC	1	5/11/2012 2:44:35 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205417**

25-May-12

Client: Western Refining Southwest, Inc.

Project: GAC 5-8-12

Sample ID **MB-1881**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **1881**	RunNo: **2710**
Prep Date: **5/10/2012**	Analysis Date: **5/11/2012**	SeqNo: **75463** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.54		0.5000		108	69	152			

Sample ID **LCS-1881**	SampType: **LCS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **LCSW**	Batch ID: **1881**	RunNo: **2710**
Prep Date: **5/10/2012**	Analysis Date: **5/11/2012**	SeqNo: **75464** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.0	0.20	2.500	0	122	74	157			
Surr: DNOP	0.28		0.2500		111	69	152			

Sample ID **1205417-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC -Lead**	Batch ID: **1881**	RunNo: **2710**
Prep Date: **5/10/2012**	Analysis Date: **5/11/2012**	SeqNo: **75489** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.0	0.20	2.500	0	118	71	161			
Surr: DNOP	0.29		0.2500		117	69	152			

Sample ID **1205417-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC -Lead**	Batch ID: **1881**	RunNo: **2710**
Prep Date: **5/10/2012**	Analysis Date: **5/11/2012**	SeqNo: **75492** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.9	0.20	2.500	0	116	71	161	1.74	23	
Surr: DNOP	0.28		0.2500		113	69	152	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1205417**

"all Environmental Analysis Laboratory, Inc.

25-May-12

Client: Western Refining Southwest, Inc.
Project: GAC 5-8-12

Sample ID **5ML-RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R2774**	RunNo: **2774**
Prep Date:	Analysis Date: **5/14/2012**	SeqNo: **77075** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	17		20.00		86.7	69.3	120			

Sample ID **2.5UG GRO LCS**	SampType: **LCS**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **LCSW**	Batch ID: **R2774**	RunNo: **2774**
Prep Date:	Analysis Date: **5/14/2012**	SeqNo: **77076** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.56	0.050	0.5000	0	112	101	123			
Surr: BFB	20		20.00		97.6	69.3	120			

Qualifiers:

- X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205417**

25-May-12

Client: Western Refining Southwest, Inc.

Project: GAC 5-8-12

Sample ID **5ml-rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R2736**	RunNo: **2736**
Prep Date:	Analysis Date: **5/11/2012**	SeqNo: **75969** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	8.9		10.00		88.8	70	130			
Surr: 4-Bromofluorobenzene	9.9		10.00		99.0	70	130			
Surr: Dibromofluoromethane	8.6		10.00		85.6	69.8	130			
Surr: Toluene-d8	9.5		10.00		95.3	70	130			

Sample ID **100ng lcs**	SampType: **LCS**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **LCSW**	Batch ID: **R2736**	RunNo: **2736**
Prep Date:	Analysis Date: **5/11/2012**	SeqNo: **75970** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	21	1.0	20.00	0	105	84.1	126			
Toluene	19	1.0	20.00	0	93.6	80	120			
Surr: 1,2-Dichloroethane-d4	8.7		10.00		87.1	70	130			
Surr: 4-Bromofluorobenzene	9.5		10.00		94.5	70	130			
Surr: Dibromofluoromethane	8.6		10.00		85.6	69.8	130			
Surr: Toluene-d8	9.2		10.00		92.3	70	130			

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **Western Refining Southwest, Inc Bloomfield** Work Order Number: **1205417**

Received by/date: 05/09/12

Logged By: **Lindsay Mangin** **5/9/2012 10:30:00 AM**

Completed By: **Lindsay Mangin** **5/9/2012 10:56:58 AM**

Reviewed By: 05/09/12

Chain of Custody

1. Were seals intact?	Yes ✔	No	Not Present
2. Is Chain of Custody complete?	Yes ✔	No	Not Present
3. How was the sample delivered?	UPS		

Log In

4. Coolers are present? (see 19. for cooler specific information)	Yes ✔	No	NA
5. Was an attempt made to cool the samples?	Yes ✔	No	NA
6. Were all samples received at a temperature of >0° C to 6.0°C	Yes ✔	No	NA
7. Sample(s) in proper container(s)?	Yes ✔	No	
8. Sufficient sample volume for indicated test(s)?	Yes ✔	No	
9. Are samples (except VOA and ONG) properly preserved?	Yes ✔	No	
10. Was preservative added to bottles?	Yes	No ✔	NA
11. VOA vials have zero headspace?	Yes ✔	No	No VOA Vials
12. Were any sample containers received broken?	Yes	No ✔	
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes ✔	No	# of preserved bottles checked for pH:
14. Are matrices correctly identified on Chain of Custody?	Yes ✔	No	(<2 or >12 unless noted)
15. Is it clear what analyses were requested?	Yes ✔	No	Adjusted?
16. Were all holding times able to be met? (If no, notify customer for authorization.)	Yes ✔	No	Checked by:

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes No NA ✔

Person Notified: Date:

By Whom: Via: eMail Phone Fax In Person

Regarding:

Client Instructions:

18. Additional remarks:

19. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	4.1	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: GAC 5-8-12

Project #:

Project Manager:

Sampler: Terry + Bob

On Ice: Yes

Sample Temperature:

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX only	8270 (Semi-VOA)	8015B DRO				Air Bubbles (Y or N)
5-8-12	8:15	H2O	GAC-Lead	3-VOA	HCl	-001			X							X						
	8:15			1-500ml	Amber													X				

Date:	Time:	Relinquished by:	Received by:	Date Time	Remarks:
5-8-12	3:20	Robert Knabon		05/09/12 1030	
Date:	Time:	Relinquished by:	Received by:	Date Time	

If ne[illegible], samples submitted to Hall Environmental may be subcontracted to other accredited laboratories serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytic[illegible]rt.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

June 22, 2012

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: GAC 6-4-12 OrderNo.: 1206105

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 1 sample(s) on 6/5/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1206105**

22-Jun-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC 6-4-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1206105-001	GAC Lead		6/4/2012 9:00:00 AM	6/5/2012 10:00:00 AM	Aqueous
1206105-001	GAC Lead		6/4/2012 9:00:00 AM	6/5/2012 10:00:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** GAC Lead
Project: GAC 6-4-12 **Collection Date:** 6/4/2012 9:00:00 AM
Lab ID: 1206105-001 **Matrix:** AQUEOUS **Received Date:** 6/5/2012 10:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	6/10/2012 3:33:03 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	6/10/2012 3:33:03 PM
Surr: DNOP	131	69-152		%REC	1	6/10/2012 3:33:03 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	0.073	0.050		mg/L	1	6/9/2012 2:01:25 AM
Surr: BFB	94.7	69.3-120		%REC	1	6/9/2012 2:01:25 AM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	11	1.0		µg/L	1	6/6/2012 11:13:31 AM
Toluene	ND	1.0		µg/L	1	6/6/2012 11:13:31 AM
Ethylbenzene	ND	1.0		µg/L	1	6/6/2012 11:13:31 AM
Xylenes, Total	ND	2.0		µg/L	1	6/6/2012 11:13:31 AM
Surr: 1,2-Dichloroethane-d4	100	70-130		%REC	1	6/6/2012 11:13:31 AM
Surr: 4-Bromofluorobenzene	102	70-130		%REC	1	6/6/2012 11:13:31 AM
Surr: Dibromofluoromethane	86.8	69.8-130		%REC	1	6/6/2012 11:13:31 AM
Surr: Toluene-d8	102	70-130		%REC	1	6/6/2012 11:13:31 AM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1206105**

22-Jun-12

Client: Western Refining Southwest, Inc.

Project: GAC 6-4-12

Sample ID **MB-2307**	SampType: **MBLK**			TestCode: **EPA Method 8015B: Diesel Range**					
Client ID: **PBW**	Batch ID: **2307**			RunNo: **3322**					
Prep Date: **6/8/2012**	Analysis Date: **6/10/2012**			SeqNo: **92546**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.67		0.5000		135	69	152			

Sample ID **1206105-001BMS**	SampType: **MS**			TestCode: **EPA Method 8015B: Diesel Range**					
Client ID: **GAC Lead**	Batch ID: **2307**			RunNo: **3322**					
Prep Date: **6/8/2012**	Analysis Date: **6/10/2012**			SeqNo: **92549**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.5	0.20	2.500	0	101	71	161			
Surr: DNOP	0.27		0.2500		108	69	152			

Sample ID **1206105-001BMSD**	SampType: **MSD**			TestCode: **EPA Method 8015B: Diesel Range**					
Client ID: **GAC Lead**	Batch ID: **2307**			RunNo: **3322**					
Prep Date: **6/8/2012**	Analysis Date: **6/10/2012**			SeqNo: **92550**		Units: **mg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.5	0.20	2.500	0	100	71	161	0.803	23	
Surr: DNOP	0.26		0.2500		102	69	152	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1206105**

Hall Environmental Analysis Laboratory, Inc.

22-Jun-12

Client: Western Refining Southwest, Inc.
Project: GAC 6-4-12

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R3317**	RunNo: **3317**
Prep Date:	Analysis Date: **6/8/2012**	SeqNo: **92323** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	18		20.00		92.2	69.3	120			

Qualifiers:

- C Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1206105**

22-Jun-12

Client: Western Refining Southwest, Inc.

Project: GAC 6-4-12

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R3260**	RunNo: **3260**
Prep Date:	Analysis Date: **6/6/2012**	SeqNo: **90554** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	10		10.00		101	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		106	70	130			
Surr: Dibromofluoromethane	8.3		10.00		83.5	69.8	130			
Surr: Toluene-d8	9.8		10.00		97.6	70	130			

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **Western Refining Southwest, Inc Bloomfield** Work Order Number: **1206105**

Received by/date: LM 06/05/12

Logged By: **Ashley Gallegos** **6/5/2012 10:00:00 AM** AG

Completed By: **Ashley Gallegos** **6/5/2012 10:42:33 AM** AG

Reviewed By: mg 06/05/12

Chain of Custody

1.	Were seals intact?	Yes		No	Not Present ✔
2.	Is Chain of Custody complete?	Yes	✔	No	Not Present
3.	How was the sample delivered?	UPS			

Log In

4.	Coolers are present? (see 19. for cooler specific information)	Yes	✔	No	NA
5.	Was an attempt made to cool the samples?	Yes	✔	No	NA
6.	Were all samples received at a temperature of >0° C to 6.0°C	Yes	✔	No	NA
7.	Sample(s) in proper container(s)?	Yes	✔	No	
8.	Sufficient sample volume for indicated test(s)?	Yes	✔	No	
9.	Are samples (except VOA and ONG) properly preserved?	Yes	✔	No	
10.	Was preservative added to bottles?	Yes		No ✔	NA
11.	VOA vials have zero headspace?	Yes	✔	No	No VOA Vials
12.	Were any sample containers received broken?	Yes		No ✔	
13.	Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes	✔	No	# of preserved bottles checked for pH:
14.	Are matrices correctly identified on Chain of Custody?	Yes	✔	No	(<2 or >12 unless noted)
15.	Is it clear what analyses were requested?	Yes	✔	No	Adjusted?
16.	Were all holding times able to be met? (If no, notify customer for authorization.)	Yes	✔	No	Checked by:

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes No NA ✔

Person Notified: _____ Date: _____

By Whom: _____ Via: eMail Phone Fax In Person

Regarding: _____

Client Instructions: _____

18. Additional remarks:

19. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	2.6	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC 6-4-12

Project #:

Project Manager:

Sampler: Bob

[redacted]

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	[redacted]	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions ($F, Cl, NO_3, NO_2, PO_4, SO_4$)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	8015B DRO				Air Bubbles (Y or N)
6-4-12	9:00	H2O	GAC-Lead	3-VOA	HCl	-001		[redacted]	X							X						
6-4-12	9:00	H2O	GAC-Lead	1-500ml	Amber	-001												X				

Date:	Time:	Relinquished by:	Received by:	Date Time
6-4-12	3:00	Robert Krakow	[signature]	06/05/12 1000
Date:	Time:	Relinquished by:	Received by:	Date Time

Remarks:

If nec samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. arves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytica

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

July 25, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: GAC 7-10-12 3rd QTR OrderNo.: 1207416

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 7/11/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1207416**

25-Jul-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC 7-10-12 3rd QTR

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1207416-001	GAC Lead		7/10/2012 8:55:00 AM	7/11/2012 9:30:00 AM	Aqueous
1207416-001	GAC Lead		7/10/2012 8:55:00 AM	7/11/2012 9:30:00 AM	Aqueous
1207416-002	GAC Laq		7/10/2012 8:50:00 AM	7/11/2012 9:30:00 AM	Aqueous
1207416-002	GAC Laq		7/10/2012 8:50:00 AM	7/11/2012 9:30:00 AM	Aqueous
1207416-003	GAC Inlet		7/10/2012 9:05:00 AM	7/11/2012 9:30:00 AM	Aqueous
1207416-003	GAC Inlet		7/10/2012 9:05:00 AM	7/11/2012 9:30:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** GAC Lead
Project: GAC 7-10-12 3rd QTR **Collection Date:** 7/10/2012 8:55:00 AM
Lab ID: 1207416-001 **Matrix:** AQUEOUS **Received Date:** 7/11/2012 9:30:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	7/16/2012 12:21:55 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	7/16/2012 12:21:55 PM
Surr: DNOP	150	69-152		%REC	1	7/16/2012 12:21:55 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	7/16/2012 5:57:08 PM
Surr: BFB	89.1	69.3-120		%REC	1	7/16/2012 5:57:08 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	1.0		µg/L	1	7/14/2012 6:52:06 PM
Toluene	ND	1.0		µg/L	1	7/14/2012 6:52:06 PM
Ethylbenzene	ND	1.0		µg/L	1	7/14/2012 6:52:06 PM
Xylenes, Total	ND	2.0		µg/L	1	7/14/2012 6:52:06 PM
Surr: 1,2-Dichloroethane-d4	96.4	70-130		%REC	1	7/14/2012 6:52:06 PM
Surr: 4-Bromofluorobenzene	106	70-130		%REC	1	7/14/2012 6:52:06 PM
Surr: Dibromofluoromethane	102	70-130		%REC	1	7/14/2012 6:52:06 PM
Surr: Toluene-d8	98.2	70-130		%REC	1	7/14/2012 6:52:06 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 7-10-12 3rd QTR
Lab ID: 1207416-002 **Matrix:** AQUEOUS

Client Sample ID: GAC Laq
Collection Date: 7/10/2012 8:50:00 AM
Received Date: 7/11/2012 9:30:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	7/16/2012 1:38:52 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	7/16/2012 1:38:52 PM
Surr: DNOP	147	69-152		%REC	1	7/16/2012 1:38:52 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	7/16/2012 6:27:20 PM
Surr: BFB	85.9	69.3-120		%REC	1	7/16/2012 6:27:20 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	1.0		µg/L	1	7/14/2012 7:21:40 PM
Toluene	ND	1.0		µg/L	1	7/14/2012 7:21:40 PM
Ethylbenzene	ND	1.0		µg/L	1	7/14/2012 7:21:40 PM
Xylenes, Total	ND	2.0		µg/L	1	7/14/2012 7:21:40 PM
Surr: 1,2-Dichloroethane-d4	100	70-130		%REC	1	7/14/2012 7:21:40 PM
Surr: 4-Bromofluorobenzene	106	70-130		%REC	1	7/14/2012 7:21:40 PM
Surr: Dibromofluoromethane	107	70-130		%REC	1	7/14/2012 7:21:40 PM
Surr: Toluene-d8	98.0	70-130		%REC	1	7/14/2012 7:21:40 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** GAC Inlet
Project: GAC 7-10-12 3rd QTR **Collection Date:** 7/10/2012 9:05:00 AM
Lab ID: 1207416-003 **Matrix:** AQUEOUS **Received Date:** 7/11/2012 9:30:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	2.0	0.20		mg/L	1	7/16/2012 2:04:30 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	7/16/2012 2:04:30 PM
Surr: DNOP	135	69-152		%REC	1	7/16/2012 2:04:30 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	9.0	1.0		mg/L	20	7/16/2012 6:57:33 PM
Surr: BFB	88.6	69.3-120		%REC	20	7/16/2012 6:57:33 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	51	10		µg/L	10	7/14/2012 7:51:08 PM
Toluene	ND	10		µg/L	10	7/14/2012 7:51:08 PM
Ethylbenzene	620	10		µg/L	10	7/14/2012 7:51:08 PM
Xylenes, Total	2400	100		µg/L	50	7/16/2012 1:31:37 PM
Surr: 1,2-Dichloroethane-d4	109	70-130		%REC	10	7/14/2012 7:51:08 PM
Surr: 4-Bromofluorobenzene	88.1	70-130		%REC	10	7/14/2012 7:51:08 PM
Surr: Dibromofluoromethane	124	70-130		%REC	10	7/14/2012 7:51:08 PM
Surr: Toluene-d8	105	70-130		%REC	10	7/14/2012 7:51:08 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1207416**

25-Jul-12

Client: Western Refining Southwest, Inc.

Project: GAC 7-10-12 3rd QTR

Sample ID **MB-2828**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **2828**	RunNo: **4043**
Prep Date: **7/16/2012**	Analysis Date: **7/16/2012**	SeqNo: **115723** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.74		0.5000		147	69	152			

Sample ID **1207416-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC Lead**	Batch ID: **2828**	RunNo: **4043**
Prep Date: **7/16/2012**	Analysis Date: **7/16/2012**	SeqNo: **115746** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.1	0.20	2.500	0	124	71	161			
Surr: DNOP	0.31		0.2500		123	69	152			

Sample ID **1207416-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC Lead**	Batch ID: **2828**	RunNo: **4043**
Prep Date: **7/16/2012**	Analysis Date: **7/16/2012**	SeqNo: **115827** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.1	0.20	2.500	0	122	71	161	1.52	23	
Surr: DNOP	0.29		0.2500		117	69	152	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1207416**

all Environmental Analysis Laboratory, Inc.

25-Jul-12

Client: Western Refining Southwest, Inc.
Project: GAC 7-10-12 3rd QTR

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**	
Client ID: **PBW**	Batch ID: **R4077**	RunNo: **4077**	
Prep Date:	Analysis Date: **7/16/2012**	SeqNo: **116765**	Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	18		20.00		89.4	69.3	120			

Qualifiers:

- C Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1207416**

25-Jul-12

Client: Western Refining Southwest, Inc.

Project: GAC 7-10-12 3rd QTR

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R4042**	RunNo: **4042**
Prep Date:	Analysis Date: **7/14/2012**	SeqNo: **115726** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	9.8		10.00		98.5	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		107	70	130			
Surr: Dibromofluoromethane	9.8		10.00		97.6	70	130			
Surr: Toluene-d8	10		10.00		102	70	130			

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R4068**	RunNo: **4068**
Prep Date:	Analysis Date: **7/16/2012**	SeqNo: **116458** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	9.8		10.00		98.4	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		106	70	130			
Surr: Dibromofluoromethane	11		10.00		107	70	130			
Surr: Toluene-d8	9.6		10.00		96.0	70	130			

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1207416

Received by/date: KG 07/11/12

Logged By: Lindsay Mangin 7/11/2012 9:30:00 AM

Completed By: Lindsay Mangin 7/11/2012 3:08:03 PM

Reviewed By: JT/MA 07/12/12

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? UPS

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
11. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)

Adjusted? _____

Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date: _____

By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person

Regarding: _____

Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.6	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: 3rd QTR GAC 7-10-12

Project #:

Project Manager:

Sampler: Bob

[redacted]

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type		BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO 8015B				Air Bubbles (Y or N)
7-10-12	8:55	H_2O	GAC-Lead	3-VOA	HCl	-001			X							X						
			" "	1-500ml	amber													X				
	8:50		GAC-LAG	3-VOA	HCl	-002			X							X						
			" "	1-500ml	amber													X				
	9:05		GAC-inlet	3-VOA	HCl	-003			X							X						
			" "	1-500ml	amber													X				
			~~TRIP BLANK~~	~~2 VOA~~	~~HCl~~	~~-004~~			~~X~~													

07/11/12

Date:	Time:	Relinquished by:	Received by:	Date	Time
7-10-12	3:07	Robert Krakow		07/11/12	0930
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks: Please Send Results in Excel Also
Trip Blank

If ne[cessar]y, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytic[al] rt.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

August 13, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: GAC -Lead 8-1-12 OrderNo.: 1208132

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 1 sample(s) on 8/2/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1208132**

13-Aug-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC -Lead 8-1-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1208132-001	Lead		8/1/2012 8:30:00 AM	8/2/2012 10:00:00 AM	Aqueous
1208132-001	Lead		8/1/2012 8:30:00 AM	8/2/2012 10:00:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Lead
Project: GAC -Lead 8-1-12 **Collection Date:** 8/1/2012 8:30:00 AM
Lab ID: 1208132-001 **Matrix:** AQUEOUS **Received Date:** 8/2/2012 10:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	8/6/2012 10:54:42 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	8/6/2012 10:54:42 AM
Surr: DNOP	124	69-152		%REC	1	8/6/2012 10:54:42 AM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	1.0		µg/L	1	8/7/2012 7:16:02 PM
Toluene	ND	1.0		µg/L	1	8/7/2012 7:16:02 PM
Ethylbenzene	ND	1.0		µg/L	1	8/7/2012 7:16:02 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	8/7/2012 7:16:02 PM
Xylenes, Total	ND	2.0		µg/L	1	8/7/2012 7:16:02 PM
Surr: 1,2-Dichloroethane-d4	93.2	70-130		%REC	1	8/7/2012 7:16:02 PM
Surr: 4-Bromofluorobenzene	99.8	70-130		%REC	1	8/7/2012 7:16:02 PM
Surr: Dibromofluoromethane	98.0	70-130		%REC	1	8/7/2012 7:16:02 PM
Surr: Toluene-d8	96.3	70-130		%REC	1	8/7/2012 7:16:02 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1208132**

13-Aug-12

Client: Western Refining Southwest, Inc.

Project: GAC -Lead 8-1-12

Sample ID **MB-3201**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **3201**	RunNo: **4664**
Prep Date: **8/6/2012**	Analysis Date: **8/6/2012**	SeqNo: **131309** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.61		0.5000		122	69	152			

Sample ID **1208132-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **Lead**	Batch ID: **3201**	RunNo: **4664**
Prep Date: **8/6/2012**	Analysis Date: **8/6/2012**	SeqNo: **131400** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.9	0.20	2.500	0	118	71	161			
Surr: DNOP	0.29		0.2500		117	69	152			

Sample ID **1208132-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **Lead**	Batch ID: **3201**	RunNo: **4664**
Prep Date: **8/6/2012**	Analysis Date: **8/6/2012**	SeqNo: **131407** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.7	0.20	2.500	0	109	71	161	7.32	23	
Surr: DNOP	0.28		0.2500		112	69	152	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1208132**

Hall Environmental Analysis Laboratory, Inc.

13-Aug-12

Client: Western Refining Southwest, Inc.
Project: GAC -Lead 8-1-12

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R4712**	RunNo: **4712**
Prep Date:	Analysis Date: **8/7/2012**	SeqNo: **133034** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	9.2		10.00		92.3	70	130			
Surr: 4-Bromofluorobenzene	9.9		10.00		99.0	70	130			
Surr: Dibromofluoromethane	9.9		10.00		99.2	70	130			
Surr: Toluene-d8	11		10.00		106	70	130			

Sample ID **1208132-001ams**	SampType: **MS**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **Lead**	Batch ID: **R4712**	RunNo: **4712**
Prep Date:	Analysis Date: **8/7/2012**	SeqNo: **133513** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	19	1.0	20.00	0	93.6	66.8	128			
Toluene	19	1.0	20.00	0	96.3	70	130			
Surr: 1,2-Dichloroethane-d4	9.2		10.00		92.4	70	130			
Surr: 4-Bromofluorobenzene	9.1		10.00		91.0	70	130			
Surr: Dibromofluoromethane	9.7		10.00		97.1	70	130			
Surr: Toluene-d8	9.0		10.00		89.7	70	130			

Sample ID **1208132-001amsd**	SampType: **MSD**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **Lead**	Batch ID: **R4712**	RunNo: **4712**
Prep Date:	Analysis Date: **8/7/2012**	SeqNo: **133514** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	19	1.0	20.00	0	97.1	66.8	128	3.67	16.7	
Toluene	21	1.0	20.00	0	104	70	130	7.69	18.7	
Surr: 1,2-Dichloroethane-d4	8.8		10.00		88.0	70	130	0	0	
Surr: 4-Bromofluorobenzene	9.6		10.00		95.8	70	130	0	0	
Surr: Dibromofluoromethane	9.1		10.00		91.2	70	130	0	0	
Surr: Toluene-d8	9.5		10.00		94.9	70	130	0	0	

Qualifiers:

- X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **Western Refining Southwest, Inc Bloomfield** Work Order Number: **1208132**

Received by/date: LG 08/02/12

Logged By: **Lindsay Mangin** 8/2/2012 10:00:00 AM

Completed By: **Lindsay Mangin** 8/2/2012 1:28:44 PM

Reviewed By: MG 08/02/12

Chain of Custody

1. Were seals intact?	Yes	No	Not Present ✔
2. Is Chain of Custody complete?	Yes ✔	No	Not Present
3. How was the sample delivered?	UPS		

Log In

4. Coolers are present? (see 19. for cooler specific information)	Yes ✔	No	NA
5. Was an attempt made to cool the samples?	Yes ✔	No	NA
6. Were all samples received at a temperature of >0° C to 6.0°C	Yes ✔	No	NA
7. Sample(s) in proper container(s)?	Yes ✔	No	
8. Sufficient sample volume for indicated test(s)?	Yes ✔	No	
9. Are samples (except VOA and ONG) properly preserved?	Yes ✔	No	
10. Was preservative added to bottles?	Yes	No ✔	NA
11. VOA vials have zero headspace?	Yes ✔	No	No VOA Vials
12. Were any sample containers received broken?	Yes ✔	No	
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes ✔	No	# of preserved bottles checked for pH:
14. Are matrices correctly identified on Chain of Custody?	Yes ✔	No	(<2 or >12 unless noted)
15. Is it clear what analyses were requested?	Yes ✔	No	Adjusted?
16. Were all holding times able to be met? (If no, notify customer for authorization.)	Yes ✔	No	Checked by:

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes No NA ✔

Person Notified: Date:

By Whom: Via: eMail Phone Fax In Person

Regarding:

Client Instructions:

18. Additional remarks:

19. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	5.3	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC - Lead 8-1-12 Baseline

Project #:

Project Manager:

Sampler: Bob

On Ice:

Sample Temperature:

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	8015B DRO				Air Bubbles (Y or N)
8-1-12	8:30	H_2O	Lead	3-VOA	HCl	-001										X						
		1	1	1-500ml	Amber	1												X				

Analysis Request

Date:	Time:	Relinquished by:	Received by:	Date	Time
8-1-12	3:00	Robert Krakow		08/02/12	10:00
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

September 20, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: GAC-Lead 9-5-12 OrderNo.: 1209179

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 1 sample(s) on 9/6/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1209179**

20-Sep-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC-Lead 9-5-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1209179-001	GAC-Lead		9/5/2012 7:30:00 AM	9/6/2012 10:00:00 AM	Aqueous
1209179-001	GAC-Lead		9/5/2012 7:30:00 AM	9/6/2012 10:00:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC-Lead
Project: GAC-Lead 9-5-12
Collection Date: 9/5/2012 7:30:00 AM
Lab ID: 1209179-001 **Matrix:** AQUEOUS **Received Date:** 9/6/2012 10:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	9/11/2012 10:49:58 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	9/11/2012 10:49:58 AM
Surr: DNOP	120	69-152		%REC	1	9/11/2012 10:49:58 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	0.017	0.050	J	mg/L	1	9/13/2012 3:12:59 PM
Surr: BFB	105	69.8-119		%REC	1	9/13/2012 3:12:59 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	ND	1.0		µg/L	1	9/10/2012 5:32:19 PM
Toluene	ND	1.0		µg/L	1	9/10/2012 5:32:19 PM
Ethylbenzene	ND	1.0		µg/L	1	9/10/2012 5:32:19 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	9/10/2012 5:32:19 PM
Xylenes, Total	ND	2.0		µg/L	1	9/10/2012 5:32:19 PM
Surr: 1,2-Dichloroethane-d4	100	70-130		%REC	1	9/10/2012 5:32:19 PM
Surr: 4-Bromofluorobenzene	96.6	70-130		%REC	1	9/10/2012 5:32:19 PM
Surr: Dibromofluoromethane	97.5	70-130		%REC	1	9/10/2012 5:32:19 PM
Surr: Toluene-d8	99.0	70-130		%REC	1	9/10/2012 5:32:19 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits
RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits

QC SUMMARY REPORT

WO#: **1209179**

all Environmental Analysis Laboratory, Inc.

20-Sep-12

Client: Western Refining Southwest, Inc.
Project: GAC-Lead 9-5-12

Sample ID **MB-3679**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **3679**	RunNo: **5423**
Prep Date: **9/10/2012**	Analysis Date: **9/11/2012**	SeqNo: **154865** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.55		0.5000		110	69	152			

Sample ID **1209179-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC-Lead**	Batch ID: **3679**	RunNo: **5423**
Prep Date: **9/10/2012**	Analysis Date: **9/11/2012**	SeqNo: **154872** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.5	0.20	2.500	0	101	71	161			
Surr: DNOP	0.26		0.2500		103	69	152			

Sample ID **1209179-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC-Lead**	Batch ID: **3679**	RunNo: **5423**
Prep Date: **9/10/2012**	Analysis Date: **9/11/2012**	SeqNo: **154874** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
el Range Organics (DRO)	2.6	0.20	2.500	0	105	71	161	4.08	23	
Surr: DNOP	0.25		0.2500		98.3	69	152	0	0	

Qualifiers:

- Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1209179**

20-Sep-12

Client: Western Refining Southwest, Inc.

Project: GAC-Lead 9-5-12

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R5522**	RunNo: **5522**
Prep Date:	Analysis Date: **9/13/2012**	SeqNo: **158006** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.021	0.050								J
Surr: BFB	18		20.00		91.2	69.8	119			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

"all Environmental Analysis Laboratory, Inc.

WO#: **1209179**

20-Sep-12

Client: Western Refining Southwest, Inc.

Project: GAC-Lead 9-5-12

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **PBW**	Batch ID: **R5522**	RunNo: **5522**
Prep Date:	Analysis Date: **9/13/2012**	SeqNo: **158020** Units: **%REC**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Surr: 4-Bromofluorobenzene	21		20.00		105	69.7	152			

Qualifiers:

	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1209179**

20-Sep-12

Client: Western Refining Southwest, Inc.

Project: GAC-Lead 9-5-12

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R5444**	RunNo: **5444**
Prep Date:	Analysis Date: **9/10/2012**	SeqNo: **155759** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	9.6		10.00		95.7	70	130			
Surr: 4-Bromofluorobenzene	9.2		10.00		92.0	70	130			
Surr: Dibromofluoromethane	9.9		10.00		99.5	70	130			
Surr: Toluene-d8	9.9		10.00		99.0	70	130			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

WO#: **1209179**

Hall Environmental Analysis Laboratory, Inc.

20-Sep-12

Client: Western Refining Southwest, Inc.
Project: GAC-Lead 9-5-12

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260B: VOLATILES**
Client ID: **PBW**	Batch ID: **R5444**	RunNo: **5444**
Prep Date:	Analysis Date: **9/10/2012**	SeqNo: **155479** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Tetrachloroethene (PCE)	ND	1.0								
Trichloroethene (TCE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	9.6		10.00		95.7	70	130			
Surr: 4-Bromofluorobenzene	9.2		10.00		92.0	70	130			
Surr: Dibromofluoromethane	9.9		10.00		99.5	70	130			
Surr: Toluene-d8	9.9		10.00		99.0	70	130			

Qualifiers:

	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1209179**

20-Sep-12

Client: Western Refining Southwest, Inc.

Project: GAC-Lead 9-5-12

Sample ID **b4**	SampType: **MBLK**	TestCode: **EPA Method 8260B: Volatiles, Table I**
Client ID: **PBW**	Batch ID: **R5444**	RunNo: **5444**
Prep Date:	Analysis Date: **9/10/2012**	SeqNo: **155757** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Ethylbenzene	ND	1.0								
Tetrachloroethene (PCE)	ND	0.50								
Toluene	ND	1.0								
Trichloroethene (TCE)	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	9.7		10.00		97.5	70	130			
Surr: 4-Bromofluorobenzene	9.0		10.00		89.9	70	130			
Surr: Dibromofluoromethane	10		10.00		101	70	130			
Surr: Toluene-d8	9.6		10.00		95.8	70	130			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1209179

Received by/date: LNM 09/06/12

Logged By: Ashley Gallegos 9/6/2012 10:00:00 AM

Completed By: Ashley Gallegos 9/6/2012 12:10:22 PM

Reviewed By: IO CR/06/12

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? FedEx

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
11. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)

Adjusted? _____

Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date: _____

By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person

Regarding: _____

Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	2.3	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: GAC-Lead 9-5-12

Project #:

Project Manager:

Sampler: Bob

On Ice: ☐ No

Sample Temperature: 2.5

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	[redacted]	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE [redacted]	[redacted]	8015B DRO				Air Bubbles (Y or N)
9-5-12	7:30	H_2O	GAC-Lead	3-VOA	HCl	-001			X							X						
\	\	\	"	1-500ml	amber	-001												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
9-5-12	3:00	Robert Krakow	[signature]	09/06/12	1000
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks:

If nec , samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. erves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytica

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

October 12, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: GAC Oct, 1-2012 OrderNo.: 1210157

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 3 sample(s) on 10/2/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1210157**

12-Oct-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC Oct, 1-2012

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1210157-001	GAC-Inlet		10/1/2012 8:40:00 AM	10/2/2012 10:05:00 AM	Aqueous
1210157-001	GAC-Inlet		10/1/2012 8:40:00 AM	10/2/2012 10:05:00 AM	Aqueous
1210157-002	GAC-Lead		10/1/2012 8:35:00 AM	10/2/2012 10:05:00 AM	Aqueous
1210157-002	GAC-Lead		10/1/2012 8:35:00 AM	10/2/2012 10:05:00 AM	Aqueous
1210157-003	GAC-Lag		10/1/2012 8:30:00 AM	10/2/2012 10:05:00 AM	Aqueous
1210157-003	GAC-Lag		10/1/2012 8:30:00 AM	10/2/2012 10:05:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** GAC-Inlet
Project: GAC Oct, 1-2012 **Collection Date:** 10/1/2012 8:40:00 AM
Lab ID: 1210157-001 **Matrix:** AQUEOUS **Received Date:** 10/2/2012 10:05:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	0.41	0.20		mg/L	1	10/4/2012 9:32:37 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	10/4/2012 9:32:37 AM
Surr: DNOP	126	69-152		%REC	1	10/4/2012 9:32:37 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	2.4	1.0		mg/L	20	10/5/2012 4:47:13 PM
Surr: BFB	96.4	69.8-119		%REC	20	10/5/2012 4:47:13 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **RAA**
Benzene	34	10		µg/L	10	10/3/2012 3:30:38 PM
Toluene	ND	10		µg/L	10	10/3/2012 3:30:38 PM
Ethylbenzene	560	10		µg/L	10	10/3/2012 3:30:38 PM
Methyl tert-butyl ether (MTBE)	ND	10		µg/L	10	10/3/2012 3:30:38 PM
Xylenes, Total	260	20		µg/L	10	10/3/2012 3:30:38 PM
Surr: 1,2-Dichloroethane-d4	93.6	70-130		%REC	10	10/3/2012 3:30:38 PM
Surr: 4-Bromofluorobenzene	84.2	70-130		%REC	10	10/3/2012 3:30:38 PM
Surr: Dibromofluoromethane	102	70-130		%REC	10	10/3/2012 3:30:38 PM
Surr: Toluene-d8	79.0	70-130		%REC	10	10/3/2012 3:30:38 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits
RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC Oct, 1-2012
Lab ID: 1210157-002 **Matrix:** AQUEOUS

Client Sample ID: GAC-Lead
Collection Date: 10/1/2012 8:35:00 AM
Received Date: 10/2/2012 10:05:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	10/4/2012 10:47:54 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	10/4/2012 10:47:54 AM
Surr: DNOP	121	69-152		%REC	1	10/4/2012 10:47:54 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	10/3/2012 6:44:14 PM
Surr: BFB	103	69.8-119		%REC	1	10/3/2012 6:44:14 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **RAA**
Benzene	ND	1.0		µg/L	1	10/3/2012 4:26:03 PM
Toluene	ND	1.0		µg/L	1	10/3/2012 4:26:03 PM
Ethylbenzene	ND	1.0		µg/L	1	10/3/2012 4:26:03 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	10/3/2012 4:26:03 PM
Xylenes, Total	ND	2.0		µg/L	1	10/3/2012 4:26:03 PM
Surr: 1,2-Dichloroethane-d4	90.5	70-130		%REC	1	10/3/2012 4:26:03 PM
Surr: 4-Bromofluorobenzene	84.9	70-130		%REC	1	10/3/2012 4:26:03 PM
Surr: Dibromofluoromethane	99.4	70-130		%REC	1	10/3/2012 4:26:03 PM
Surr: Toluene-d8	79.0	70-130		%REC	1	10/3/2012 4:26:03 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits
RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** GAC-Lag
Project: GAC Oct, 1-2012 **Collection Date:** 10/1/2012 8:30:00 AM
Lab ID: 1210157-003 **Matrix:** AQUEOUS **Received Date:** 10/2/2012 10:05:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	10/4/2012 11:13:01 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	10/4/2012 11:13:01 AM
Surr: DNOP	131	69-152		%REC	1	10/4/2012 11:13:01 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	10/3/2012 7:14:15 PM
Surr: BFB	115	69.8-119		%REC	1	10/3/2012 7:14:15 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **RAA**
Benzene	ND	1.0		µg/L	1	10/3/2012 4:53:47 PM
Toluene	ND	1.0		µg/L	1	10/3/2012 4:53:47 PM
Ethylbenzene	ND	1.0		µg/L	1	10/3/2012 4:53:47 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	10/3/2012 4:53:47 PM
Xylenes, Total	ND	2.0		µg/L	1	10/3/2012 4:53:47 PM
Surr: 1,2-Dichloroethane-d4	92.4	70-130		%REC	1	10/3/2012 4:53:47 PM
Surr: 4-Bromofluorobenzene	77.9	70-130		%REC	1	10/3/2012 4:53:47 PM
Surr: Dibromofluoromethane	96.5	70-130		%REC	1	10/3/2012 4:53:47 PM
Surr: Toluene-d8	81.2	70-130		%REC	1	10/3/2012 4:53:47 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits
RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1210157**

12-Oct-12

Client: Western Refining Southwest, Inc.

Project: GAC Oct, 1-2012

Sample ID **MB-4074**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **4074**	RunNo: **5964**
Prep Date: **10/3/2012**	Analysis Date: **10/4/2012**	SeqNo: **171910** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.60		0.5000		121	69	152			

Sample ID **1210157-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC-Inlet**	Batch ID: **4074**	RunNo: **5964**
Prep Date: **10/3/2012**	Analysis Date: **10/4/2012**	SeqNo: **172003** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0.4069	89.4	71	161			
Surr: DNOP	0.28		0.2500		114	69	152			

Sample ID **1210157-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC-Inlet**	Batch ID: **4074**	RunNo: **5964**
Prep Date: **10/3/2012**	Analysis Date: **10/4/2012**	SeqNo: **172004** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0.4069	89.6	71	161	0.204	23	
Surr: DNOP	0.29		0.2500		115	69	152	0	0	

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1210157**

12-Oct-12

Client: Western Refining Southwest, Inc.

Project: GAC Oct, 1-2012

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBS**	Batch ID: **R6020**	RunNo: **6020**
Prep Date:	Analysis Date: **10/5/2012**	SeqNo: **173460** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	5.0								
Surr: BFB	1000		1000		104	84	116			

Qualifiers:

- Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1210157**

12-Oct-12

Client: Western Refining Southwest, Inc.

Project: GAC Oct, 1-2012

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R5970**	RunNo: **5970**
Prep Date:	Analysis Date: **10/3/2012**	SeqNo: **171972** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	22		20.00		108	69.8	119			

Sample ID **1210157-001AMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **GAC-Inlet**	Batch ID: **R5970**	RunNo: **5970**
Prep Date:	Analysis Date: **10/3/2012**	SeqNo: **171977** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	190	20	200.0	7.040	92.8	63.5	131			
Surr: BFB	7600		8000		95.0	69.8	119			

Sample ID **1210157-001AMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **GAC-Inlet**	Batch ID: **R5970**	RunNo: **5970**
Prep Date:	Analysis Date: **10/3/2012**	SeqNo: **171978** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	190	20	200.0	7.040	94.0	63.5	131	1.16	16.7	
Surr: BFB	6900		8000		86.7	69.8	119	0	0	

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R6020**	RunNo: **6020**
Prep Date:	Analysis Date: **10/5/2012**	SeqNo: **173451** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	21		20.00		104	69.8	119			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

WO#: **1210157**

Hall Environmental Analysis Laboratory, Inc.

12-Oct-12

Client: Western Refining Southwest, Inc.

Project: GAC Oct, 1-2012

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **PBW**	Batch ID: **R5970**	RunNo: **5970**
Prep Date:	Analysis Date: **10/3/2012**	SeqNo: **171981** Units: **%REC**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Surr: 4-Bromofluorobenzene	21		20.00		105	69.7	152			

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8021B: Volatiles**
Client ID: **PBW**	Batch ID: **R6020**	RunNo: **6020**
Prep Date:	Analysis Date: **10/5/2012**	SeqNo: **173476** Units: **%REC**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Surr: 4-Bromofluorobenzene	21		20.00		107	69.7	152			

Qualifiers:

	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1210157**

12-Oct-12

Client: Western Refining Southwest, Inc.

Project: GAC Oct, 1-2012

Sample ID **5ml-rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R5958**	RunNo: **5958**
Prep Date:	Analysis Date: **10/3/2012**	SeqNo: **171756** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	8.3		10.00		82.9	70	130			
Surr: 4-Bromofluorobenzene	8.2		10.00		82.3	70	130			
Surr: Dibromofluoromethane	10		10.00		101	70	130			
Surr: Toluene-d8	8.0		10.00		80.2	70	130			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

WO#: **1210157**

"all Environmental Analysis Laboratory, Inc.

12-Oct-12

Client: Western Refining Southwest, Inc.
Project: GAC Oct, 1-2012

Sample ID **5ml-rb**	SampType: **MBLK**	TestCode: **EPA Method 8260B: VOLATILES**
Client ID: **PBW**	Batch ID: **R5958**	RunNo: **5958**
Prep Date:	Analysis Date: **10/3/2012**	SeqNo: **171737** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Tetrachloroethene (PCE)	ND	1.0								
Trichloroethene (TCE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	8.3		10.00		82.9	70	130			
Surr: 4-Bromofluorobenzene	8.2		10.00		82.3	70	130			
Surr: Dibromofluoromethane	10		10.00		101	70	130			
Surr: Toluene-d8	8.0		10.00		80.2	70	130			

Sample ID **b4**	SampType: **MBLK**	TestCode: **EPA Method 8260B: VOLATILES**
Client ID: **PBW**	Batch ID: **R5958**	RunNo: **5958**
Prep Date:	Analysis Date: **10/3/2012**	SeqNo: **171765** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
?ene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Tetrachloroethene (PCE)	ND	1.0								
Trichloroethene (TCE)	ND	1.0								
Xylenes, Total	ND	1.5								
Surr: 1,2-Dichloroethane-d4	8.1		10.00		80.9	70	130			
Surr: 4-Bromofluorobenzene	7.9		10.00		79.0	70	130			
Surr: Dibromofluoromethane	9.8		10.00		97.9	70	130			
Surr: Toluene-d8	7.8		10.00		78.4	70	130			

Qualifiers:

- Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1210157

Received by/date: AT 10/02/12

Logged By: Anne Thorne 10/2/2012 10:05:00 AM Anne Thorne

Completed By: Anne Thorne 10/3/2012 Anne Thorne

Reviewed By: MG 10/03/12

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? UPS

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
11. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)
Adjusted? _____
Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date _____
By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: _____
Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.5	Good	Yes			

Chain-of-Custody Record

Client: Westrern Refining

Mailing Address: #50 CR 4990
Bloomfeild, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC- [redacted] Oct 1 - 2012

Project #:

Project Manager:

Sampler: Matt + Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: [redacted]

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1204357	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO 8015B				Air Bubbles (Y or N)
10-1-12	8:40	H_2O	GAC-inlet	3-VOA	HCl	-001			X							X						
				1-500ml	amber	-001												X				
10-1-12	8:35		GAC-Lead	3-VOA		-002			X							X						
				1-500ml	amber	-002												X				
10-1-12	8:30		GAC-Lag	3-VOA		-003			X							X						
				1-500ml	amber	-003												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
10-1-12	3:00			10/2/12	1005
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

November 28, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: GAC 11-5-12 OrderNo.: 1211168

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 1 sample(s) on 11/6/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1211168**

28-Nov-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC 11-5-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1211168-001	GAC Lead		11/5/2012 11:30:00 AM	11/6/2012 10:00:00 AM	Aqueous
1211168-001	GAC Lead		11/5/2012 11:30:00 AM	11/6/2012 10:00:00 AM	Aqueous
1211168-001	GAC Lead		11/5/2012 11:30:00 AM	11/6/2012 10:00:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: GAC 11-5-12
Lab ID: 1211168-001 **Matrix:** AQUEOUS

Client Sample ID: GAC Lead
Collection Date: 11/5/2012 11:30:00 AM
Received Date: 11/6/2012 10:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	11/7/2012 6:15:45 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	11/7/2012 6:15:45 PM
Surr: DNOP	126	69-152		%REC	1	11/7/2012 6:15:45 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	11/9/2012 7:23:23 PM
Surr: BFB	109	51.9-148		%REC	1	11/9/2012 7:23:23 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **RAA**
Benzene	ND	1.0		µg/L	1	11/8/2012 4:53:26 PM
Toluene	ND	1.0		µg/L	1	11/8/2012 4:53:26 PM
Ethylbenzene	ND	1.0		µg/L	1	11/8/2012 4:53:26 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	11/8/2012 4:53:26 PM
Xylenes, Total	ND	2.0		µg/L	1	11/8/2012 4:53:26 PM
Surr: 1,2-Dichloroethane-d4	105	70-130		%REC	1	11/8/2012 4:53:26 PM
Surr: 4-Bromofluorobenzene	103	70-130		%REC	1	11/8/2012 4:53:26 PM
Surr: Dibromofluoromethane	66.9	70-130	S	%REC	1	11/8/2012 4:53:26 PM
Surr: Toluene-d8	85.4	70-130		%REC	1	11/8/2012 4:53:26 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits
RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits

QC SUMMARY REPORT

WO#: **1211168**

Hall Environmental Analysis Laboratory, Inc.

28-Nov-12

Client: Western Refining Southwest, Inc.
Project: GAC 11-5-12

Sample ID **MB-4714**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **4714**	RunNo: **6743**
Prep Date: **11/7/2012**	Analysis Date: **11/7/2012**	SeqNo: **195201** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.60		0.5000		120	69	152			

Sample ID **1211168-001CMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC Lead**	Batch ID: **4714**	RunNo: **6743**
Prep Date: **11/7/2012**	Analysis Date: **11/7/2012**	SeqNo: **195205** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.1	0.20	2.500	0	122	71	161			
Surr: DNOP	0.31		0.2500		123	69	152			

Sample ID **1211168-001CMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC Lead**	Batch ID: **4714**	RunNo: **6743**
Prep Date: **11/7/2012**	Analysis Date: **11/7/2012**	SeqNo: **195206** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
el Range Organics (DRO)	2.9	0.20	2.500	0	117	71	161	4.18	23	
Surr: DNOP	0.30		0.2500		118	69	152	0	0	

Qualifiers:

- Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1211168**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: GAC 11-5-12

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R6828**	RunNo: **6828**
Prep Date:	Analysis Date: **11/9/2012**	SeqNo: **197597** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	20		20.00		97.8	51.9	148			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

"all Environmental Analysis Laboratory, Inc.

WO#: **1211168**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: GAC 11-5-12

Sample ID **5ml-rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R6790**	RunNo: **6790**
Prep Date:	Analysis Date: **11/8/2012**	SeqNo: **196593** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	11		10.00		108	70	130			
Surr: 4-Bromofluorobenzene	9.6		10.00		96.0	70	130			
Surr: Dibromofluoromethane	7.1		10.00		71.5	70	130			
Surr: Toluene-d8	9.4		10.00		94.0	70	130			

Qualifiers:

	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **Western Refining Southwest, Inc Bloomfield** Work Order Number: **1211168**

Received by/date: 11/06/12

Logged By: **Ashley Gallegos** **11/6/2012 10:00:00 AM**

Completed By: **Ashley Gallegos** **11/6/2012 10:31:44 AM**

Reviewed By: 11/06/12

Chain of Custody

1. Were seals intact?	Yes	No	Not Present ✔	
2. Is Chain of Custody complete?	Yes ✔	No	Not Present	
3. How was the sample delivered?	UPS			

Log In

4. Coolers are present? (see 19. for cooler specific information)	Yes ✔	No	NA
5. Was an attempt made to cool the samples?	Yes ✔	No	NA
6. Were all samples received at a temperature of >0° C to 6.0°C	Yes ✔	No	NA
7. Sample(s) in proper container(s)?	Yes ✔	No	
8. Sufficient sample volume for indicated test(s)?	Yes ✔	No	
9. Are samples (except VOA and ONG) properly preserved?	Yes ✔	No	
10. Was preservative added to bottles?	Yes	No ✔	NA
11. VOA vials have zero headspace?	Yes ✔	No	No VOA Vials
12. Were any sample containers received broken?	Yes	No ✔	
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes ✔	No	# of preserved bottles checked for pH:
14. Are matrices correctly identified on Chain of Custody?	Yes ✔	No	(<2 or >12 unless noted)
15. Is it clear what analyses were requested?	Yes ✔	No	Adjusted?
16. Were all holding times able to be met? (If no, notify customer for authorization.)	Yes ✔	No	Checked by:

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes No NA ✔

Person Notified:		Date:	
By Whom:		Via: eMail Phone Fax In Person	
Regarding:			
Client Instructions:			

18. Additional remarks:

19. **Cooler Information**

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.8	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 Cr 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC - 11-5-12

Project #:

Project Manager:

Sampler: Bob

On Ice: Yes / No

Sample Temperature:

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	[redacted]	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	DRO - 8015B				Air Bubbles (Y or N)
1-5-12	11:30	H_2O	GAC [redacted] Lead	3-VOA	HCl	-001			X							X						
"	"	"	"	1-500ml	Amber	-001												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
1-5-12	3:00	Robert Krakow		11/06/12	1000
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

December 21, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: GAC 12-3-12 OrderNo.: 1212088

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 1 sample(s) on 12/4/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1212088**

21-Dec-12

CLIENT: Western Refining Southwest, Inc.
Project: GAC 12-3-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1212088-001	GAC		12/3/2012 10:00:00 AM	12/4/2012 10:05:00 AM	Aqueous
1212088-001	GAC		12/3/2012 10:00:00 AM	12/4/2012 10:05:00 AM	Aqueous
1212088-001	GAC		12/3/2012 10:00:00 AM	12/4/2012 10:05:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: GAC
Project: GAC 12-3-12
Collection Date: 12/3/2012 10:00:00 AM
Lab ID: 1212088-001 **Matrix:** AQUEOUS **Received Date:** 12/4/2012 10:05:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **MMD**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	12/10/2012 3:29:33 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	12/10/2012 3:29:33 PM
Surr: DNOP	155	69-152	S	%REC	1	12/10/2012 3:29:33 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	12/7/2012 1:48:01 PM
Surr: BFB	96.0	51.9-148		%REC	1	12/7/2012 1:48:01 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **RAA**
Benzene	ND	1.0		µg/L	1	12/6/2012 4:37:24 PM
Toluene	ND	1.0		µg/L	1	12/6/2012 4:37:24 PM
Ethylbenzene	ND	1.0		µg/L	1	12/6/2012 4:37:24 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	12/6/2012 4:37:24 PM
Xylenes, Total	ND	2.0		µg/L	1	12/6/2012 4:37:24 PM
Surr: 1,2-Dichloroethane-d4	89.4	70-130		%REC	1	12/6/2012 4:37:24 PM
Surr: 4-Bromofluorobenzene	97.6	70-130		%REC	1	12/6/2012 4:37:24 PM
Surr: Dibromofluoromethane	86.6	70-130		%REC	1	12/6/2012 4:37:24 PM
Surr: Toluene-d8	97.3	70-130		%REC	1	12/6/2012 4:37:24 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits
RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits

QC SUMMARY REPORT

"all Environmental Analysis Laboratory, Inc.

WO#: **1212088**

21-Dec-12

Client: Western Refining Southwest, Inc.

Project: GAC 12-3-12

Sample ID **MB-5143**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **5143**	RunNo: **7398**
Prep Date: **12/6/2012**	Analysis Date: **12/10/2012**	SeqNo: **214829** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.73		0.5000		146	69	152			

Sample ID **1212088-001CMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC**	Batch ID: **5143**	RunNo: **7398**
Prep Date: **12/6/2012**	Analysis Date: **12/10/2012**	SeqNo: **214855** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	3.2	0.20	2.500	0	129	60.1	146			
Surr: DNOP	0.30		0.2500		121	69	152			

Sample ID **1212088-001CMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **GAC**	Batch ID: **5143**	RunNo: **7398**
Prep Date: **12/6/2012**	Analysis Date: **12/10/2012**	SeqNo: **214860** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
el Range Organics (DRO)	4.2	0.20	2.500	0	168	60.1	146	26.3	20.5	SR
Surr: DNOP	0.36		0.2500		146	69	152	0	0	

Qualifiers:

- Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1212088**

21-Dec-12

Client: Western Refining Southwest, Inc.

Project: GAC 12-3-12

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R7391**	RunNo: **7391**
Prep Date:	Analysis Date: **12/7/2012**	SeqNo: **214089** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	19		20.00		95.6	51.9	148			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

WO#: **1212088**

"all Environmental Analysis Laboratory, Inc.

21-Dec-12

Client: Western Refining Southwest, Inc.
Project: GAC 12-3-12

Sample ID **5ml-rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R7346**	RunNo: **7346**
Prep Date:	Analysis Date: **12/6/2012**	SeqNo: **213237** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	9.0		10.00		90.0	70	130			
Surr: 4-Bromofluorobenzene	9.6		10.00		96.4	70	130			
Surr: Dibromofluoromethane	8.7		10.00		87.0	70	130			
Surr: Toluene-d8	9.9		10.00		99.0	70	130			

Qualifiers:

	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1212088

Received by/date: AG 12/04/12

Logged By: Lindsay Mangin 12/4/2012 10:05:00 AM

Completed By: Lindsay Mangin 12/4/2012 10:32:05 AM

Reviewed By: TO 12/04/2012

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? UPS

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
11. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)
Adjusted? _____
Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date: _____
By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: _____
Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.9	Good	Yes			

Chain-of-Custody Record

Client: Western Refinig

Mailing Address: #50 CR 4990
Bloomfield Nm 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name:
GAC 12-3-12

Project #:

Project Manager:

Sampler: Bob & MATT

On Ice: ☒ Yes ☐ No

Sample Temperature: 5

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1210054	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	8015B DRO Extended				Air Bubbles (Y or N)
12-3-12	10:00	H_2O	GAC	3-VOA	HCl	-001			X							X		X				
				1-500ml	Amber	1												X				

Date:	Time:	Relinquished by:	Received by:	Date	Time
12-3-12	3:00	Robert Krakow		12/3/12	1005
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks:

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

April 26, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: River Terrace, Low Flow 4-12-12 OrderNo.: 1204571

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 8 sample(s) on 4/13/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1204571**

26-Apr-12

CLIENT: Western Refining Southwest, Inc.
Project: River Terrace, Low Flow 4-12-12

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1204571-001	Tp-1		4/12/2012 10:20:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-001	Tp-1		4/12/2012 10:20:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-001	Tp-1		4/12/2012 10:20:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-002	Tp-2		4/12/2012 10:10:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-002	Tp-2		4/12/2012 10:10:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-002	Tp-2		4/12/2012 10:10:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-003	Tp-5		4/12/2012 10:35:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-003	Tp-5		4/12/2012 10:35:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-003	Tp-5		4/12/2012 10:35:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-004	Tp-6		4/12/2012 11:30:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-004	Tp-6		4/12/2012 11:30:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-004	Tp-6		4/12/2012 11:30:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-005	Tp-8		4/12/2012 11:00:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-005	Tp-8		4/12/2012 11:00:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-005	Tp-8		4/12/2012 11:00:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-006	Tp-9		4/12/2012 10:45:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-006	Tp-9		4/12/2012 10:45:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-006	Tp-9		4/12/2012 10:45:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-007	MW-49		4/12/2012 11:10:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-007	MW-49		4/12/2012 11:10:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-007	MW-49		4/12/2012 11:10:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-008	MW-49 D		4/12/2012 11:10:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-008	MW-49 D		4/12/2012 11:10:00 AM	4/13/2012 10:55:00 AM	Aqueous
1204571-008	MW-49 D		4/12/2012 11:10:00 AM	4/13/2012 10:55:00 AM	Aqueous

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-1
Project: River Terrace, Low Flow 4-12-12 **Collection Date:** 4/12/2012 10:20:00 AM
Lab ID: 1204571-001 **Matrix:** AQUEOUS **Received Date:** 4/13/2012 10:55:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	2.8	0.20		mg/L	1	4/17/2012 1:44:44 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/17/2012 1:44:44 PM
Surr: DNOP	132	69-152		%REC	1	4/17/2012 1:44:44 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	35	2.5		mg/L	50	4/17/2012 5:35:31 PM
Surr: BFB	99.7	69.3-120		%REC	50	4/17/2012 5:35:31 PM
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAG**
Lead	0.034	0.0050		mg/L	1	4/23/2012 3:46:09 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	3,500	50		µg/L	50	4/20/2012 5:03:32 PM
Toluene	ND	50		µg/L	50	4/20/2012 5:03:32 PM
Ethylbenzene	3,000	50		µg/L	50	4/20/2012 5:03:32 PM
Methyl tert-butyl ether (MTBE)	ND	50		µg/L	50	4/20/2012 5:03:32 PM
Xylenes, Total	7,900	100		µg/L	50	4/20/2012 5:03:32 PM
Surr: 1,2-Dichloroethane-d4	100	70-130		%REC	50	4/20/2012 5:03:32 PM
Surr: 4-Bromofluorobenzene	73.7	70-130		%REC	50	4/20/2012 5:03:32 PM
Surr: Dibromofluoromethane	89.2	69.8-130		%REC	50	4/20/2012 5:03:32 PM
Surr: Toluene-d8	102	70-130		%REC	50	4/20/2012 5:03:32 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-2
Project: River Terrace, Low Flow 4-12-12 **Collection Date:** 4/12/2012 10:10:00 AM
Lab ID: 1204571-002 **Matrix:** AQUEOUS **Received Date:** 4/13/2012 10:55:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	1.4	0.20		mg/L	1	4/17/2012 2:49:45 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/17/2012 2:49:45 PM
Surr: DNOP	120	69-152		%REC	1	4/17/2012 2:49:45 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	59	2.5		mg/L	50	4/17/2012 7:38:18 PM
Surr: BFB	110	69.3-120		%REC	50	4/17/2012 7:38:18 PM
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAG**
Lead	0.044	0.0050		mg/L	1	4/23/2012 3:48:07 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	86	50		µg/L	50	4/20/2012 7:07:02 PM
Toluene	ND	50		µg/L	50	4/20/2012 7:07:02 PM
Ethylbenzene	3,600	50		µg/L	50	4/20/2012 7:07:02 PM
Methyl tert-butyl ether (MTBE)	ND	50		µg/L	50	4/20/2012 7:07:02 PM
Xylenes, Total	25,000	400		µg/L	200	4/20/2012 6:37:56 PM
Surr: 1,2-Dichloroethane-d4	90.8	70-130		%REC	50	4/20/2012 7:07:02 PM
Surr: 4-Bromofluorobenzene	75.1	70-130		%REC	50	4/20/2012 7:07:02 PM
Surr: Dibromofluoromethane	80.8	69.8-130		%REC	50	4/20/2012 7:07:02 PM
Surr: Toluene-d8	99.4	70-130		%REC	50	4/20/2012 7:07:02 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-5
Project: River Terrace, Low Flow 4-12-12 **Collection Date:** 4/12/2012 10:35:00 AM
Lab ID: 1204571-003 **Matrix:** AQUEOUS **Received Date:** 4/13/2012 10:55:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	0.60	0.20		mg/L	1	4/17/2012 3:11:19 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/17/2012 3:11:19 PM
Surr: DNOP	125	69-152		%REC	1	4/17/2012 3:11:19 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	1.8	0.50		mg/L	10	4/17/2012 10:42:25 PM
Surr: BFB	99.0	69.3-120		%REC	10	4/17/2012 10:42:25 PM
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAG**
Lead	0.36	0.025		mg/L	5	4/23/2012 3:57:36 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	ND	5.0		µg/L	5	4/20/2012 7:36:04 PM
Toluene	ND	5.0		µg/L	5	4/20/2012 7:36:04 PM
Ethylbenzene	20	5.0		µg/L	5	4/20/2012 7:36:04 PM
Methyl tert-butyl ether (MTBE)	ND	5.0		µg/L	5	4/20/2012 7:36:04 PM
Xylenes, Total	410	10		µg/L	5	4/20/2012 7:36:04 PM
Surr: 1,2-Dichloroethane-d4	89.8	70-130		%REC	5	4/20/2012 7:36:04 PM
Surr: 4-Bromofluorobenzene	69.0	70-130	S	%REC	5	4/20/2012 7:36:04 PM
Surr: Dibromofluoromethane	84.6	69.8-130		%REC	5	4/20/2012 7:36:04 PM
Surr: Toluene-d8	99.2	70-130		%REC	5	4/20/2012 7:36:04 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-6
Project: River Terrace, Low Flow 4-12-12 **Collection Date:** 4/12/2012 11:30:00 AM
Lab ID: 1204571-004 **Matrix:** AQUEOUS **Received Date:** 4/13/2012 10:55:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/17/2012 3:33:03 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/17/2012 3:33:03 PM
Surr: DNOP	112	69-152		%REC	1	4/17/2012 3:33:03 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	4/17/2012 11:43:56 PM
Surr: BFB	82.9	69.3-120		%REC	1	4/17/2012 11:43:56 PM
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAG**
Lead	0.023	0.0050		mg/L	1	4/23/2012 3:59:45 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	ND	1.0		µg/L	1	4/20/2012 8:05:10 PM
Toluene	ND	1.0		µg/L	1	4/20/2012 8:05:10 PM
Ethylbenzene	ND	1.0		µg/L	1	4/20/2012 8:05:10 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/20/2012 8:05:10 PM
Xylenes, Total	ND	2.0		µg/L	1	4/20/2012 8:05:10 PM
Surr: 1,2-Dichloroethane-d4	90.4	70-130		%REC	1	4/20/2012 8:05:10 PM
Surr: 4-Bromofluorobenzene	108	70-130		%REC	1	4/20/2012 8:05:10 PM
Surr: Dibromofluoromethane	82.9	69.8-130		%REC	1	4/20/2012 8:05:10 PM
Surr: Toluene-d8	98.8	70-130		%REC	1	4/20/2012 8:05:10 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-8
Project: River Terrace, Low Flow 4-12-12 **Collection Date:** 4/12/2012 11:00:00 AM
Lab ID: 1204571-005 **Matrix:** AQUEOUS **Received Date:** 4/13/2012 10:55:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	0.83	0.20		mg/L	1	4/17/2012 4:16:18 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/17/2012 4:16:18 PM
Surr: DNOP	129	69-152		%REC	1	4/17/2012 4:16:18 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	0.41	0.25		mg/L	5	4/18/2012 12:14:30 AM
Surr: BFB	108	69.3-120		%REC	5	4/18/2012 12:14:30 AM
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAG**
Lead	0.019	0.0050		mg/L	1	4/23/2012 4:01:47 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	ND	5.0		µg/L	5	4/20/2012 8:34:29 PM
Toluene	ND	5.0		µg/L	5	4/20/2012 8:34:29 PM
Ethylbenzene	22	5.0		µg/L	5	4/20/2012 8:34:29 PM
Methyl tert-butyl ether (MTBE)	ND	5.0		µg/L	5	4/20/2012 8:34:29 PM
Xylenes, Total	69	10		µg/L	5	4/20/2012 8:34:29 PM
Surr: 1,2-Dichloroethane-d4	91.9	70-130		%REC	5	4/20/2012 8:34:29 PM
Surr: 4-Bromofluorobenzene	67.8	70-130	S	%REC	5	4/20/2012 8:34:29 PM
Surr: Dibromofluoromethane	85.0	69.8-130		%REC	5	4/20/2012 8:34:29 PM
Surr: Toluene-d8	97.1	70-130		%REC	5	4/20/2012 8:34:29 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-9
Project: River Terrace, Low Flow 4-12-12 **Collection Date:** 4/12/2012 10:45:00 AM
Lab ID: 1204571-006 **Matrix:** AQUEOUS **Received Date:** 4/13/2012 10:55:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/17/2012 4:37:51 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/17/2012 4:37:51 PM
Surr: DNOP	114	69-152		%REC	1	4/17/2012 4:37:51 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	4/18/2012 1:15:51 AM
Surr: BFB	104	69.3-120		%REC	1	4/18/2012 1:15:51 AM
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAG**
Lead	ND	0.0050		mg/L	1	4/23/2012 4:03:50 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	ND	1.0		µg/L	1	4/20/2012 9:03:38 PM
Toluene	ND	1.0		µg/L	1	4/20/2012 9:03:38 PM
Ethylbenzene	ND	1.0		µg/L	1	4/20/2012 9:03:38 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/20/2012 9:03:38 PM
Xylenes, Total	ND	2.0		µg/L	1	4/20/2012 9:03:38 PM
Surr: 1,2-Dichloroethane-d4	94.6	70-130		%REC	1	4/20/2012 9:03:38 PM
Surr: 4-Bromofluorobenzene	110	70-130		%REC	1	4/20/2012 9:03:38 PM
Surr: Dibromofluoromethane	84.6	69.8-130		%REC	1	4/20/2012 9:03:38 PM
Surr: Toluene-d8	98.8	70-130		%REC	1	4/20/2012 9:03:38 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** MW-49
Project: River Terrace, Low Flow 4-12-12 **Collection Date:** 4/12/2012 11:10:00 AM
Lab ID: 1204571-007 **Matrix:** AQUEOUS **Received Date:** 4/13/2012 10:55:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/17/2012 4:59:39 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/17/2012 4:59:39 PM
Surr: DNOP	128	69-152		%REC	1	4/17/2012 4:59:39 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	4/18/2012 1:46:34 AM
Surr: BFB	99.4	69.3-120		%REC	1	4/18/2012 1:46:34 AM
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAG**
Lead	ND	0.0050		mg/L	1	4/23/2012 4:05:48 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	ND	1.0		µg/L	1	4/20/2012 9:32:41 PM
Toluene	ND	1.0		µg/L	1	4/20/2012 9:32:41 PM
Ethylbenzene	ND	1.0		µg/L	1	4/20/2012 9:32:41 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/20/2012 9:32:41 PM
Xylenes, Total	ND	2.0		µg/L	1	4/20/2012 9:32:41 PM
Surr: 1,2-Dichloroethane-d4	92.8	70-130		%REC	1	4/20/2012 9:32:41 PM
Surr: 4-Bromofluorobenzene	105	70-130		%REC	1	4/20/2012 9:32:41 PM
Surr: Dibromofluoromethane	81.6	69.8-130		%REC	1	4/20/2012 9:32:41 PM
Surr: Toluene-d8	97.1	70-130		%REC	1	4/20/2012 9:32:41 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** MW-49 D
Project: River Terrace, Low Flow 4-12-12 **Collection Date:** 4/12/2012 11:10:00 AM
Lab ID: 1204571-008 **Matrix:** AQUEOUS **Received Date:** 4/13/2012 10:55:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	4/17/2012 5:21:24 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	4/17/2012 5:21:24 PM
Surr: DNOP	125	69-152		%REC	1	4/17/2012 5:21:24 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	4/18/2012 2:17:16 AM
Surr: BFB	98.7	69.3-120		%REC	1	4/18/2012 2:17:16 AM
EPA 6010B: TOTAL RECOVERABLE METALS						Analyst: **RAG**
Lead	ND	0.0050		mg/L	1	4/23/2012 4:07:47 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **MMS**
Benzene	ND	1.0		µg/L	1	4/20/2012 10:01:58 PM
Toluene	ND	1.0		µg/L	1	4/20/2012 10:01:58 PM
Ethylbenzene	ND	1.0		µg/L	1	4/20/2012 10:01:58 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	4/20/2012 10:01:58 PM
Xylenes, Total	ND	2.0		µg/L	1	4/20/2012 10:01:58 PM
Surr: 1,2-Dichloroethane-d4	91.0	70-130		%REC	1	4/20/2012 10:01:58 PM
Surr: 4-Bromofluorobenzene	100	70-130		%REC	1	4/20/2012 10:01:58 PM
Surr: Dibromofluoromethane	81.2	69.8-130		%REC	1	4/20/2012 10:01:58 PM
Surr: Toluene-d8	96.2	70-130		%REC	1	4/20/2012 10:01:58 PM

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- S Spike Recovery outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1204571**

26-Apr-12

Client: Western Refining Southwest, Inc.

Project: River Terrace, Low Flow 4-12-12

Sample ID **MB-1536**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **PBW**	Batch ID: **1536**	RunNo: **2170**
Prep Date: **4/16/2012**	Analysis Date: **4/17/2012**	SeqNo: **60463** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.61		0.5000		122	69	152			

Sample ID **LCS-1536**	SampType: **LCS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **LCSW**	Batch ID: **1536**	RunNo: **2170**
Prep Date: **4/16/2012**	Analysis Date: **4/17/2012**	SeqNo: **60477** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.4	0.20	2.500	0	96.3	74	157			
Surr: DNOP	0.27		0.2500		107	69	152			

Sample ID **1204571-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **Tp-1**	Batch ID: **1536**	RunNo: **2170**
Prep Date: **4/16/2012**	Analysis Date: **4/17/2012**	SeqNo: **60550** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	4.7	0.20	2.500	2.755	79.3	71	161			
Surr: DNOP	0.28		0.2500		114	69	152			

Sample ID **1204571-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**
Client ID: **Tp-1**	Batch ID: **1536**	RunNo: **2170**
Prep Date: **4/16/2012**	Analysis Date: **4/17/2012**	SeqNo: **60561** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	5.4	0.20	2.500	2.755	107	71	161	13.8	23	
Surr: DNOP	0.29		0.2500		118	69	152	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1204571**

˜all Environmental Analysis Laboratory, Inc.

26-Apr-12

Client: Western Refining Southwest, Inc.
Project: River Terrace, Low Flow 4-12-12

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R2198**	RunNo: **2198**
Prep Date:	Analysis Date: **4/17/2012**	SeqNo: **61206** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	19		20.00		94.0	69.3	120			

Sample ID **2.5UG GRO LCS**	SampType: **LCS**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **LCSW**	Batch ID: **R2198**	RunNo: **2198**
Prep Date:	Analysis Date: **4/17/2012**	SeqNo: **61208** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.52	0.050	0.5000	0	103	101	123			
Surr: BFB	20		20.00		102	69.3	120			

Sample ID **1204571-001AMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **Tp-1**	Batch ID: **R2198**	RunNo: **2198**
Prep Date:	Analysis Date: **4/17/2012**	SeqNo: **61226** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	57	2.5	25.00	35.49	87.0	75.4	121			
ırr: BFB	1,100		1,000		110	69.3	120			

Sample ID **1204571-001AMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **Tp-1**	Batch ID: **R2198**	RunNo: **2198**
Prep Date:	Analysis Date: **4/17/2012**	SeqNo: **61227** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	60	2.5	25.00	35.49	99.5	75.4	121	5.31	10.5	
Surr: BFB	1,200		1,000		118	69.3	120	0	0	

Qualifiers:

- ‹ Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1204571**

26-Apr-12

Client: Western Refining Southwest, Inc.

Project: River Terrace, Low Flow 4-12-12

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R2286**	RunNo: **2286**
Prep Date:	Analysis Date: **4/20/2012**	SeqNo: **63366** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	9.6		10.00		96.0	70	130			
Surr: 4-Bromofluorobenzene	10		10.00		101	70	130			
Surr: Dibromofluoromethane	8.3		10.00		82.8	69.8	130			
Surr: Toluene-d8	10		10.00		101	70	130			

Sample ID **100ng lcs**	SampType: **LCS**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **LCSW**	Batch ID: **R2286**	RunNo: **2286**
Prep Date:	Analysis Date: **4/20/2012**	SeqNo: **63367** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	18	1.0	20.00	0	91.2	84.1	126			
Toluene	19	1.0	20.00	0	94.8	80	120			
Surr: 1,2-Dichloroethane-d4	9.4		10.00		94.2	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		106	70	130			
Surr: Dibromofluoromethane	8.5		10.00		84.6	69.8	130			
Surr: Toluene-d8	9.8		10.00		98.4	70	130			

Sample ID **1204571-001ams**	SampType: **MS**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **Tp-1**	Batch ID: **R2286**	RunNo: **2286**
Prep Date:	Analysis Date: **4/20/2012**	SeqNo: **63368** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	4,100	50	1,000	3,454	60.3	71.1	135			S
Toluene	1,000	50	1,000	0	102	74	121			
Surr: 1,2-Dichloroethane-d4	440		500.0		87.5	70	130			
Surr: 4-Bromofluorobenzene	430		500.0		85.4	70	130			
Surr: Dibromofluoromethane	410		500.0		81.2	69.8	130			
Surr: Toluene-d8	520		500.0		104	70	130			

Sample ID **1204571-001amsd**	SampType: **MSD**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **Tp-1**	Batch ID: **R2286**	RunNo: **2286**
Prep Date:	Analysis Date: **4/20/2012**	SeqNo: **63369** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	3,900	50	1,000	3,454	47.2	71.1	135	3.28	21.9	S
Toluene	970	50	1,000	0	97.1	74	121	5.38	18.5	
Surr: 1,2-Dichloroethane-d4	420		500.0		84.5	70	130	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1204571**

all Environmental Analysis Laboratory, Inc.

26-Apr-12

Client: Western Refining Southwest, Inc.
Project: River Terrace, Low Flow 4-12-12

Sample ID **1204571-001amsd**	SampType: **MSD**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **Tp-1**	Batch ID: **R2286**	RunNo: **2286**
Prep Date:	Analysis Date: **4/20/2012**	SeqNo: **63369** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Surr: 4-Bromofluorobenzene	360		500.0		71.9	70	130	0	0	
Surr: Dibromofluoromethane	410		500.0		81.5	69.8	130	0	0	
Surr: Toluene-d8	500		500.0		100	70	130	0	0	

Qualifiers:

- ‹ Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1204571**

26-Apr-12

Client: Western Refining Southwest, Inc.

Project: River Terrace, Low Flow 4-12-12

Sample ID **MB-1583**	SampType: **MBLK**	TestCode: **EPA 6010B: Total Recoverable Metals**
Client ID: **PBW**	Batch ID: **1583**	RunNo: **2318**
Prep Date: **4/18/2012**	Analysis Date: **4/23/2012**	SeqNo: **64366** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Lead	ND	0.0050								

Sample ID **LCS-1583**	SampType: **LCS**	TestCode: **EPA 6010B: Total Recoverable Metals**
Client ID: **LCSW**	Batch ID: **1583**	RunNo: **2318**
Prep Date: **4/18/2012**	Analysis Date: **4/23/2012**	SeqNo: **64367** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Lead	0.49	0.0050	0.5000	0	97.8	80	120			

Sample ID **LCS-1583**	SampType: **LCSD**	TestCode: **EPA 6010B: Total Recoverable Metals**
Client ID: **LCSS02**	Batch ID: **1583**	RunNo: **2318**
Prep Date: **4/18/2012**	Analysis Date: **4/23/2012**	SeqNo: **64368** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Lead	0.49	0.0050	0.5000	0	98.8	80	120	0.997	20	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1204571

Received by/date: CM 04/13/12

Logged By: Anne Thorne 4/13/2012 10:55:00 AM Anne Thorne

Completed By: Anne Thorne 4/13/2012 Anne Thorne

Reviewed By: 04/13/12

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? UPS

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ ~~No ☑~~ NA ☐

002C, 003C, 004C - ADDED 1mL HNO_3 FOR ACCEPTABLE pH - 04/13/12

11. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: 8 (<2 or >12 unless noted)
Adjusted? YES
Checked by:

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: ____ Date ____
By Whom: ____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: ____
Client Instructions: ____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	2.4	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other

☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: 4-12-12
River Terrace, Low Flow

Project #:

Project Manager:

Sampler: Terry & Bob

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No.	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	8015B DRO	6010B/7470 pb only			Air Bubbles (Y or N)
4-12-12	10:20	H_2O	Tp-1	5-VOA	HCl	-001			X							X						
				1-500ml	amber	-001												X				
				1-500ml	HNO_3	-001													X			
	10:10		Tp-2	5-VOA	HCl	-002			X							X						
				1-500ml	amber	-002												X				
				1-500ml	HNO_3	-002													X			
	10:35		Tp-5	5-VOA	HCl	-003			X							X						
				1-500ml	amber	-003												X				
				1-500ml	HNO_3	-003													X			
	11:30		Tp-6	5-VOA	HCl	-004			X							X						
				1-500ml	amber	-004												X				
				1-500ml	HNO_3	-004													X			

Date:	Time:	Relinquished by:	Received by:	Date	Time
4-12-12	3:00	Robert Krakow			
Date:	Time:	Relinquished by:	Received by:	04/13/12	1055

Remarks: Please include Excel format

If nec. , samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytics t.

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other ______

☐ EDD (Type) ______

Turn-Around Time:
☒ Standard ☐ Rush ______

Project Name: River Terrace, Low Flow

Project #:

Project Manager:

Sampler: Terry + Bob

On Ice: ☒ Yes ☐ No

Sample Temperature: 1.0°

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1204571	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	8015B DRO	6010B/7470 pb only			Air Bubbles (Y or N)
1-12-12	11:00	H_2O	Tp-8	5-VOA	HCl	-005			X							X						
				1-500ml	amber	-005												X				
				1-500ml	HNO_3	-005													X			
	10:45		Tp-9	5-VOA	HCl	-006			X							X						
				1-500ml	amber	-006												X				
				1-500ml	HNO_3	-006													X			
	11:10		MW-49	5-VOA	HCl	-007			X							X						
				1-500ml	amber	-007												X				
				1-500ml	HNO_3	-007													X			
	11:10		MW-49 D	5-VOA	HCl	-008			X							X						
				1-500ml	amber	-008												X				
				1-500ml	HNO_3	-008													X			

Date:	Time:	Relinquished by:	Received by:	Date	Time
1-12-12	3:00	Robert Krakow	Michelle Garcia	04/13/12	1045
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks: please include Excel format

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

May 08, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: River Terrace Low Flow OrderNo.: 1204560

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 8 sample(s) on 4/13/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1204560**

08-May-12

CLIENT: Western Refining Southwest, Inc.
Project: River Terrace Low Flow

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1204560-001	Tp-1		4/12/2012 10:20:00 AM	4/13/2012 10:45:00 AM	Air
1204560-002	Tp-2		4/12/2012 10:10:00 AM	4/13/2012 10:45:00 AM	Air
1204560-003	Tp-5		4/12/2012 10:35:00 AM	4/13/2012 10:45:00 AM	Air
1204560-004	Tp-6		4/12/2012 11:30:00 AM	4/13/2012 10:45:00 AM	Air
1204560-005	Tp-8		4/12/2012 11:00:00 AM	4/13/2012 10:45:00 AM	Air
1204560-006	Tp-9		4/12/2012 10:45:00 AM	4/13/2012 10:45:00 AM	Air
1204560-007	MW-49		4/12/2012 11:10:00 AM	4/13/2012 10:45:00 AM	Air
1204560-008	MW-49D		4/12/2012 11:10:00 AM	4/13/2012 10:45:00 AM	Air

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: River Terrace Low Flow
Lab ID: 1204560-001 **Matrix:** AIR

Client Sample ID: Tp-1
Collection Date: 4/12/2012 10:20:00 AM
Received Date: 4/13/2012 10:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	19	5.0		µg/L	1	4/19/2012 4:09:30 PM
Surr: BFB	86.8	48.4-185		%REC	1	4/19/2012 4:09:30 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	2.0	0.10		µg/L	1	4/19/2012 4:09:30 PM
Toluene	ND	0.10		µg/L	1	4/19/2012 4:09:30 PM
Ethylbenzene	0.95	0.10		µg/L	1	4/19/2012 4:09:30 PM
Xylenes, Total	2.5	0.30		µg/L	1	4/19/2012 4:09:30 PM
Surr: 4-Bromofluorobenzene	95.2	74.5-131		%REC	1	4/19/2012 4:09:30 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-2
Project: River Terrace Low Flow **Collection Date:** 4/12/2012 10:10:00 AM
Lab ID: 1204560-002 **Matrix:** AIR **Received Date:** 4/13/2012 10:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/19/2012 3:42:23 PM
Surr: BFB	101	48.4-185		%REC	1	4/19/2012 3:42:23 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	4/19/2012 3:42:23 PM
Toluene	ND	0.10		µg/L	1	4/19/2012 3:42:23 PM
Ethylbenzene	ND	0.10		µg/L	1	4/19/2012 3:42:23 PM
Xylenes, Total	ND	0.30		µg/L	1	4/19/2012 3:42:23 PM
Surr: 4-Bromofluorobenzene	106	74.5-131		%REC	1	4/19/2012 3:42:23 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: River Terrace Low Flow
Lab ID: 1204560-003 **Matrix:** AIR

Client Sample ID: Tp-5
Collection Date: 4/12/2012 10:35:00 AM
Received Date: 4/13/2012 10:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/19/2012 5:03:49 PM
Surr: BFB	103	48.4-185		%REC	1	4/19/2012 5:03:49 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	4/19/2012 5:03:49 PM
Toluene	ND	0.10		µg/L	1	4/19/2012 5:03:49 PM
Ethylbenzene	ND	0.10		µg/L	1	4/19/2012 5:03:49 PM
Xylenes, Total	ND	0.30		µg/L	1	4/19/2012 5:03:49 PM
Surr: 4-Bromofluorobenzene	115	74.5-131		%REC	1	4/19/2012 5:03:49 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-6
Project: River Terrace Low Flow **Collection Date:** 4/12/2012 11:30:00 AM
Lab ID: 1204560-004 **Matrix:** AIR **Received Date:** 4/13/2012 10:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	6.8	5.0		µg/L	1	4/13/2012 2:56:56 PM
Surr: BFB	87.3	48.4-185		%REC	1	4/13/2012 2:56:56 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	4/13/2012 2:56:56 PM
Toluene	ND	0.10		µg/L	1	4/13/2012 2:56:56 PM
Ethylbenzene	ND	0.10		µg/L	1	4/13/2012 2:56:56 PM
Xylenes, Total	ND	0.30		µg/L	1	4/13/2012 2:56:56 PM
Surr: 4-Bromofluorobenzene	90.7	74.5-131		%REC	1	4/13/2012 2:56:56 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Project: River Terrace Low Flow
Lab ID: 1204560-005 **Matrix:** AIR

Client Sample ID: Tp-8
Collection Date: 4/12/2012 11:00:00 AM
Received Date: 4/13/2012 10:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/19/2012 5:31:05 PM
Surr: BFB	102	48.4-185		%REC	1	4/19/2012 5:31:05 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	4/19/2012 5:31:05 PM
Toluene	ND	0.10		µg/L	1	4/19/2012 5:31:05 PM
Ethylbenzene	ND	0.10		µg/L	1	4/19/2012 5:31:05 PM
Xylenes, Total	ND	0.30		µg/L	1	4/19/2012 5:31:05 PM
Surr: 4-Bromofluorobenzene	110	74.5-131		%REC	1	4/19/2012 5:31:05 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-9
Project: River Terrace Low Flow **Collection Date:** 4/12/2012 10:45:00 AM
Lab ID: 1204560-006 **Matrix:** AIR **Received Date:** 4/13/2012 10:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/20/2012 1:32:47 PM
Surr: BFB	84.7	48.4-185		%REC	1	4/20/2012 1:32:47 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	4/20/2012 1:32:47 PM
Toluene	ND	0.10		µg/L	1	4/20/2012 1:32:47 PM
Ethylbenzene	ND	0.10		µg/L	1	4/20/2012 1:32:47 PM
Xylenes, Total	ND	0.30		µg/L	1	4/20/2012 1:32:47 PM
Surr: 4-Bromofluorobenzene	89.8	74.5-131		%REC	1	4/20/2012 1:32:47 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: MW-49
Project: River Terrace Low Flow
Collection Date: 4/12/2012 11:10:00 AM
Lab ID: 1204560-007 **Matrix:** AIR **Received Date:** 4/13/2012 10:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/20/2012 2:27:01 PM
Surr: BFB	104	48.4-185		%REC	1	4/20/2012 2:27:01 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	4/20/2012 2:27:01 PM
Toluene	ND	0.10		µg/L	1	4/20/2012 2:27:01 PM
Ethylbenzene	ND	0.10		µg/L	1	4/20/2012 2:27:01 PM
Xylenes, Total	ND	0.30		µg/L	1	4/20/2012 2:27:01 PM
Surr: 4-Bromofluorobenzene	112	74.5-131		%REC	1	4/20/2012 2:27:01 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** MW-49D
Project: River Terrace Low Flow **Collection Date:** 4/12/2012 11:10:00 AM
Lab ID: 1204560-008 **Matrix:** AIR **Received Date:** 4/13/2012 10:45:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	4/20/2012 2:54:34 PM
Surr: BFB	102	48.4-185		%REC	1	4/20/2012 2:54:34 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	4/20/2012 2:54:34 PM
Toluene	ND	0.10		µg/L	1	4/20/2012 2:54:34 PM
Ethylbenzene	ND	0.10		µg/L	1	4/20/2012 2:54:34 PM
Xylenes, Total	ND	0.30		µg/L	1	4/20/2012 2:54:34 PM
Surr: 4-Bromofluorobenzene	109	74.5-131		%REC	1	4/20/2012 2:54:34 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits		

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1204560**

08-May-12

Client: Western Refining Southwest, Inc.

Project: River Terrace Low Flow

Sample ID **1204560-004A DUP**	SampType: **DUP**			TestCode: **EPA Method 8015B: Gasoline Range**					
Client ID: **Tp-6**	Batch ID: **R2130**			RunNo: **2130**					
Prep Date:	Analysis Date: **4/13/2012**			SeqNo: **59023**		Units: **µg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	6.6	5.0						2.09	24.2	
Surr: BFB	1,700		2,000		85.3	48.4	185	0	0	

Sample ID **1204560-001A DUP**	SampType: **DUP**			TestCode: **EPA Method 8015B: Gasoline Range**					
Client ID: **Tp-1**	Batch ID: **R2243**			RunNo: **2243**					
Prep Date:	Analysis Date: **4/19/2012**			SeqNo: **62877**		Units: **µg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	19	5.0						0.211	24.2	
Surr: BFB	2,100		2,000		107	48.4	185	0	0	

Sample ID **1204560-006A DUP**	SampType: **DUP**			TestCode: **EPA Method 8015B: Gasoline Range**					
Client ID: **Tp-9**	Batch ID: **R2302**			RunNo: **2302**					
Prep Date:	Analysis Date: **4/20/2012**			SeqNo: **63966**		Units: **µg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	5.0						0	24.2	
Surr: BFB	2,100		2,000		103	48.4	185	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1204560**

"all Environmental Analysis Laboratory, Inc.

08-May-12

Client: Western Refining Southwest, Inc.
Project: River Terrace Low Flow

Sample ID	1204560-004A DUP	SampType:	DUP		TestCode:	EPA Method 8021B: Volatiles				
Client ID:	Tp-6	Batch ID:	R2130		RunNo:	2130				
Prep Date:		Analysis Date:	4/13/2012		SeqNo:	59056	Units:	µg/L		
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	0.10						0	105	
Toluene	ND	0.10						0	34	
Ethylbenzene	ND	0.10						0	22.1	
Xylenes, Total	ND	0.30						0	21.9	
Surr: 4-Bromofluorobenzene	1.8		2.000		89.6	74.5	131	0	0	

Sample ID	1204560-001A DUP	SampType:	DUP		TestCode:	EPA Method 8021B: Volatiles				
Client ID:	Tp-1	Batch ID:	R2243		RunNo:	2243				
Prep Date:		Analysis Date:	4/19/2012		SeqNo:	62900	Units:	µg/L		
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	2.0	0.10						0.954	105	
Toluene	ND	0.10						0	34	
Ethylbenzene	0.98	0.10						3.26	22.1	
Xylenes, Total	2.6	0.30						4.36	21.9	
Surr: 4-Bromofluorobenzene	2.4		2.000		120	74.5	131	0	0	

mple ID	1204560-006A DUP	SampType:	DUP		TestCode:	EPA Method 8021B: Volatiles				
Client ID:	Tp-9	Batch ID:	R2302		RunNo:	2302				
Prep Date:		Analysis Date:	4/20/2012		SeqNo:	63997	Units:	µg/L		
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	0.10						0	105	
Toluene	ND	0.10						0	34	
Ethylbenzene	ND	0.10						0	22.1	
Xylenes, Total	ND	0.30						0	21.9	
Surr: 4-Bromofluorobenzene	2.2		2.000		111	74.5	131	0	0	

Qualifiers:

- Ɛ Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1204560

Received by/date: MG 04/13/12

Logged By: Anne Thorne 4/13/2012 10:45:00 AM Ann Thorne

Completed By: Anne Thorne 4/13/2012 Ann Thorne

Reviewed By: 04/13/12

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? UPS

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☐ No ☐ NA ☑
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☐ No ☐ NA ☑
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
11. VOA vials have zero headspace? Yes ☐ No ☐ No VOA Vials ☑
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)
Adjusted? _____
Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date _____
By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding: _____
Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1						

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other _____

☐ EDD (Type) _____

Turn-Around Time:
☒ Standard ☐ Rush _____

Project Name:
River Terrace Low Flow

Project #:

Project Manager:

Sampler:
On Ice: [redacted]
Sample Temperature: [redacted]

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No.	BTEX + [redacted] (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8270 (Semi-VOA)
~~AT~~ 04/13/12																	
04/12/12	1020	AIR	TP 1	Tedlar Bags		-001	X		X								
	1010		TP-2			-002	X		X								
	1035		TP-5			-003	X		X								
	1130		TP-6			-004	X		X								
	1100		TP-8			-005	X		X								
	1045		TP-9			-006	X		X								
	1110		~~FB~~ MW-49			-007	X		X								
↓	1110	↓	MW-49D			-008	X		X								

Date:	Time:	Relinquished by:	Received by:	Date	Time
4-12-12	3:00	Tony Shaw	Michelle Garcia	04/13/12	1045
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks: TP-6 - low volume / AT 04/13/12

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

June 22, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: 5-29-12 River Terrace High Flow OrderNo.: 1205B46

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 10 sample(s) on 5/30/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1205B46**
22-Jun-12

CLIENT: Western Refining Southwest, Inc.
Project: 5-29-12 River Terrace High Flow

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1205B46-001	Tp-1		5/29/2012 10:30:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-001	Tp-1		5/29/2012 10:30:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-001	Tp-1		5/29/2012 10:30:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-002	Tp-2		5/29/2012 10:15:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-002	Tp-2		5/29/2012 10:15:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-002	Tp-2		5/29/2012 10:15:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-003	Tp-5		5/29/2012 10:00:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-003	Tp-5		5/29/2012 10:00:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-003	Tp-5		5/29/2012 10:00:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-004	Tp-6		5/29/2012 11:00:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-004	Tp-6		5/29/2012 11:00:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-004	Tp-6		5/29/2012 11:00:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-005	field blank			5/30/2012 10:15:00 AM	Aqueous
1205B46-006	Tp-8		5/29/2012 12:30:00 PM	5/30/2012 10:15:00 AM	Aqueous
1205B46-006	Tp-8		5/29/2012 12:30:00 PM	5/30/2012 10:15:00 AM	Aqueous
1205B46-006	Tp-8		5/29/2012 12:30:00 PM	5/30/2012 10:15:00 AM	Aqueous
1205B46-007	Tp-8 D		5/29/2012 12:30:00 PM	5/30/2012 10:15:00 AM	Aqueous
1205B46-007	Tp-8 D		5/29/2012 12:30:00 PM	5/30/2012 10:15:00 AM	Aqueous
1205B46-007	Tp-8 D		5/29/2012 12:30:00 PM	5/30/2012 10:15:00 AM	Aqueous
1205B46-008	Tp-9		5/29/2012 12:00:00 PM	5/30/2012 10:15:00 AM	Aqueous
1205B46-008	Tp-9		5/29/2012 12:00:00 PM	5/30/2012 10:15:00 AM	Aqueous
1205B46-008	Tp-9		5/29/2012 12:00:00 PM	5/30/2012 10:15:00 AM	Aqueous
1205B46-009	MW-49		5/29/2012 11:15:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-009	MW-49		5/29/2012 11:15:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-009	MW-49		5/29/2012 11:15:00 AM	5/30/2012 10:15:00 AM	Aqueous
1205B46-010	Trip Blank			5/30/2012 10:15:00 AM	Trip Blank

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-1
Project: 5-29-12 River Terrace High Flow **Collection Date:** 5/29/2012 10:30:00 AM
Lab ID: 1205B46-001 **Matrix:** AQUEOUS **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	1.8	0.20		mg/L	1	5/31/2012 8:33:43 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/31/2012 8:33:43 AM
Surr: DNOP	144	69-152		%REC	1	5/31/2012 8:33:43 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	30	5.0		mg/L	100	6/2/2012 1:43:57 AM
Surr: BFB	104	69.3-120		%REC	100	6/2/2012 1:43:57 AM
200.8 ICPMS METALS:TOTAL						Analyst: **SNV**
Lead	0.026	0.0025	*	mg/L	2.5	6/18/2012 5:02:16 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	2700	50		µg/L	50	6/1/2012 2:22:26 PM
Toluene	ND	50		µg/L	50	6/1/2012 2:22:26 PM
Ethylbenzene	2500	50		µg/L	50	6/1/2012 2:22:26 PM
Methyl tert-butyl ether (MTBE)	ND	50		µg/L	50	6/1/2012 2:22:26 PM
Xylenes, Total	5700	100		µg/L	50	6/1/2012 2:22:26 PM
Surr: 1,2-Dichloroethane-d4	94.4	70-130		%REC	50	6/1/2012 2:22:26 PM
Surr: 4-Bromofluorobenzene	104	70-130		%REC	50	6/1/2012 2:22:26 PM
Surr: Dibromofluoromethane	84.0	69.8-130		%REC	50	6/1/2012 2:22:26 PM
Surr: Toluene-d8	99.0	70-130		%REC	50	6/1/2012 2:22:26 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-2
Project: 5-29-12 River Terrace High Flow **Collection Date:** 5/29/2012 10:15:00 AM
Lab ID: 1205B46-002 **Matrix:** AQUEOUS **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	0.80	0.20		mg/L	1	5/31/2012 10:19:28 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/31/2012 10:19:28 AM
Surr: DNOP	149	69-152		%REC	1	5/31/2012 10:19:28 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	40	10		mg/L	200	6/2/2012 2:14:35 AM
Surr: BFB	82.7	69.3-120		%REC	200	6/2/2012 2:14:35 AM
200.8 ICPMS METALS:TOTAL						Analyst: **SNV**
Lead	0.025	0.0025	*	mg/L	2.5	6/18/2012 5:06:12 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	59	50		µg/L	50	6/1/2012 3:23:08 PM
Toluene	ND	50		µg/L	50	6/1/2012 3:23:08 PM
Ethylbenzene	2200	50		µg/L	50	6/1/2012 3:23:08 PM
Methyl tert-butyl ether (MTBE)	ND	50		µg/L	50	6/1/2012 3:23:08 PM
Xylenes, Total	14000	200		µg/L	100	6/1/2012 11:33:49 PM
Surr: 1,2-Dichloroethane-d4	98.4	70-130		%REC	50	6/1/2012 3:23:08 PM
Surr: 4-Bromofluorobenzene	104	70-130		%REC	50	6/1/2012 3:23:08 PM
Surr: Dibromofluoromethane	83.1	69.8-130		%REC	50	6/1/2012 3:23:08 PM
Surr: Toluene-d8	96.9	70-130		%REC	50	6/1/2012 3:23:08 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-5
Project: 5-29-12 River Terrace High Flow **Collection Date:** 5/29/2012 10:00:00 AM
Lab ID: 1205B46-003 **Matrix:** AQUEOUS **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	1.1	0.20		mg/L	1	5/31/2012 10:41:09 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/31/2012 10:41:09 AM
Surr: DNOP	139	69-152		%REC	1	5/31/2012 10:41:09 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	4.2	0.50		mg/L	10	6/2/2012 2:45:17 AM
Surr: BFB	110	69.3-120		%REC	10	6/2/2012 2:45:17 AM
200.8 ICPMS METALS:TOTAL						Analyst: **SNV**
Lead	0.026	0.0025	*	mg/L	2.5	6/18/2012 5:10:08 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	5.0		µg/L	5	6/1/2012 4:28:53 PM
Toluene	ND	5.0		µg/L	5	6/1/2012 4:28:53 PM
Ethylbenzene	17	5.0		µg/L	5	6/1/2012 4:28:53 PM
Methyl tert-butyl ether (MTBE)	ND	5.0		µg/L	5	6/1/2012 4:28:53 PM
Xylenes, Total	450	10		µg/L	5	6/1/2012 4:28:53 PM
Surr: 1,2-Dichloroethane-d4	99.2	70-130		%REC	5	6/1/2012 4:28:53 PM
Surr: 4-Bromofluorobenzene	109	70-130		%REC	5	6/1/2012 4:28:53 PM
Surr: Dibromofluoromethane	87.6	69.8-130		%REC	5	6/1/2012 4:28:53 PM
Surr: Toluene-d8	100	70-130		%REC	5	6/1/2012 4:28:53 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-6
Project: 5-29-12 River Terrace High Flow **Collection Date:** 5/29/2012 11:00:00 AM
Lab ID: 1205B46-004 **Matrix:** AQUEOUS **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	5/31/2012 11:02:48 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/31/2012 11:02:48 AM
Surr: DNOP	144	69-152		%REC	1	5/31/2012 11:02:48 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	0.36	0.050		mg/L	1	6/2/2012 3:15:59 AM
Surr: BFB	105	69.3-120		%REC	1	6/2/2012 3:15:59 AM
200.8 ICPMS METALS:TOTAL						Analyst: **SNV**
Lead	0.024	0.0025	*	mg/L	2.5	6/18/2012 5:14:04 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	1.0		µg/L	1	6/1/2012 5:29:35 PM
Toluene	ND	1.0		µg/L	1	6/1/2012 5:29:35 PM
Ethylbenzene	ND	1.0		µg/L	1	6/1/2012 5:29:35 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	6/1/2012 5:29:35 PM
Xylenes, Total	ND	2.0		µg/L	1	6/1/2012 5:29:35 PM
Surr: 1,2-Dichloroethane-d4	103	70-130		%REC	1	6/1/2012 5:29:35 PM
Surr: 4-Bromofluorobenzene	103	70-130		%REC	1	6/1/2012 5:29:35 PM
Surr: Dibromofluoromethane	87.8	69.8-130		%REC	1	6/1/2012 5:29:35 PM
Surr: Toluene-d8	99.1	70-130		%REC	1	6/1/2012 5:29:35 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: field blank
Project: 5-29-12 River Terrace High Flow
Collection Date:
Lab ID: 1205B46-005 **Matrix:** AQUEOUS **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	6/2/2012 3:46:42 AM
Surr: BFB	91.0	69.3-120		%REC	1	6/2/2012 3:46:42 AM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	1.0		µg/L	1	6/1/2012 5:59:58 PM
Toluene	ND	1.0		µg/L	1	6/1/2012 5:59:58 PM
Ethylbenzene	ND	1.0		µg/L	1	6/1/2012 5:59:58 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	6/1/2012 5:59:58 PM
Xylenes, Total	ND	2.0		µg/L	1	6/1/2012 5:59:58 PM
Surr: 1,2-Dichloroethane-d4	106	70-130		%REC	1	6/1/2012 5:59:58 PM
Surr: 4-Bromofluorobenzene	105	70-130		%REC	1	6/1/2012 5:59:58 PM
Surr: Dibromofluoromethane	86.8	69.8-130		%REC	1	6/1/2012 5:59:58 PM
Surr: Toluene-d8	95.2	70-130		%REC	1	6/1/2012 5:59:58 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-8
Project: 5-29-12 River Terrace High Flow **Collection Date:** 5/29/2012 12:30:00 PM
Lab ID: 1205B46-006 **Matrix:** AQUEOUS **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	1.3	0.20		mg/L	1	5/31/2012 11:56:20 AM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/31/2012 11:56:20 AM
Surr: DNOP	141	69-152		%REC	1	5/31/2012 11:56:20 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	3.0	0.25		mg/L	5	6/2/2012 4:17:34 AM
Surr: BFB	100	69.3-120		%REC	5	6/2/2012 4:17:34 AM
200.8 ICPMS METALS:TOTAL						Analyst: **SNV**
Lead	0.055	0.0025	*	mg/L	2.5	6/18/2012 5:18:01 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	5.0		µg/L	5	6/1/2012 6:30:21 PM
Toluene	ND	5.0		µg/L	5	6/1/2012 6:30:21 PM
Ethylbenzene	19	5.0		µg/L	5	6/1/2012 6:30:21 PM
Methyl tert-butyl ether (MTBE)	ND	5.0		µg/L	5	6/1/2012 6:30:21 PM
Xylenes, Total	110	10		µg/L	5	6/1/2012 6:30:21 PM
Surr: 1,2-Dichloroethane-d4	106	70-130		%REC	5	6/1/2012 6:30:21 PM
Surr: 4-Bromofluorobenzene	103	70-130		%REC	5	6/1/2012 6:30:21 PM
Surr: Dibromofluoromethane	89.4	69.8-130		%REC	5	6/1/2012 6:30:21 PM
Surr: Toluene-d8	97.9	70-130		%REC	5	6/1/2012 6:30:21 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-8 D
Project: 5-29-12 River Terrace High Flow **Collection Date:** 5/29/2012 12:30:00 PM
Lab ID: 1205B46-007 **Matrix:** AQUEOUS **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	1.4	0.20		mg/L	1	5/31/2012 12:29:07 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/31/2012 12:29:07 PM
Surr: DNOP	157	69-152	S	%REC	1	5/31/2012 12:29:07 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	2.9	0.25		mg/L	5	6/2/2012 4:47:56 AM
Surr: BFB	101	69.3-120		%REC	5	6/2/2012 4:47:56 AM
200.8 ICPMS METALS:TOTAL						Analyst: **SNV**
Lead	0.045	0.0025	*	mg/L	2.5	6/18/2012 5:29:52 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	5.0		µg/L	5	6/1/2012 7:31:03 PM
Toluene	ND	5.0		µg/L	5	6/1/2012 7:31:03 PM
Ethylbenzene	18	5.0		µg/L	5	6/1/2012 7:31:03 PM
Methyl tert-butyl ether (MTBE)	ND	5.0		µg/L	5	6/1/2012 7:31:03 PM
Xylenes, Total	100	10		µg/L	5	6/1/2012 7:31:03 PM
Surr: 1,2-Dichloroethane-d4	102	70-130		%REC	5	6/1/2012 7:31:03 PM
Surr: 4-Bromofluorobenzene	106	70-130		%REC	5	6/1/2012 7:31:03 PM
Surr: Dibromofluoromethane	87.1	69.8-130		%REC	5	6/1/2012 7:31:03 PM
Surr: Toluene-d8	98.7	70-130		%REC	5	6/1/2012 7:31:03 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-9
Project: 5-29-12 River Terrace High Flow **Collection Date:** 5/29/2012 12:00:00 PM
Lab ID: 1205B46-008 **Matrix:** AQUEOUS **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	5/31/2012 12:50:51 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/31/2012 12:50:51 PM
Surr: DNOP	142	69-152		%REC	1	5/31/2012 12:50:51 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	6/2/2012 5:18:44 AM
Surr: BFB	97.7	69.3-120		%REC	1	6/2/2012 5:18:44 AM
200.8 ICPMS METALS:TOTAL						Analyst: **SNV**
Lead	ND	0.0025		mg/L	2.5	6/18/2012 5:33:48 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	1.0		µg/L	1	6/1/2012 8:31:40 PM
Toluene	ND	1.0		µg/L	1	6/1/2012 8:31:40 PM
Ethylbenzene	ND	1.0		µg/L	1	6/1/2012 8:31:40 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	6/1/2012 8:31:40 PM
Xylenes, Total	ND	2.0		µg/L	1	6/1/2012 8:31:40 PM
Surr: 1,2-Dichloroethane-d4	100	70-130		%REC	1	6/1/2012 8:31:40 PM
Surr: 4-Bromofluorobenzene	108	70-130		%REC	1	6/1/2012 8:31:40 PM
Surr: Dibromofluoromethane	86.0	69.8-130		%REC	1	6/1/2012 8:31:40 PM
Surr: Toluene-d8	102	70-130		%REC	1	6/1/2012 8:31:40 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** MW-49
Project: 5-29-12 River Terrace High Flow **Collection Date:** 5/29/2012 11:15:00 AM
Lab ID: 1205B46-009 **Matrix:** AQUEOUS **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE						Analyst: **JMP**
Diesel Range Organics (DRO)	ND	0.20		mg/L	1	5/31/2012 1:12:41 PM
Motor Oil Range Organics (MRO)	ND	2.5		mg/L	1	5/31/2012 1:12:41 PM
Surr: DNOP	139	69-152		%REC	1	5/31/2012 1:12:41 PM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	6/2/2012 5:49:25 AM
Surr: BFB	81.0	69.3-120		%REC	1	6/2/2012 5:49:25 AM
200.8 ICPMS METALS:TOTAL						Analyst: **SNV**
Lead	ND	0.0025		mg/L	2.5	6/18/2012 5:37:44 PM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	1.0		µg/L	1	6/1/2012 9:01:57 PM
Toluene	ND	1.0		µg/L	1	6/1/2012 9:01:57 PM
Ethylbenzene	ND	1.0		µg/L	1	6/1/2012 9:01:57 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	6/1/2012 9:01:57 PM
Xylenes, Total	ND	2.0		µg/L	1	6/1/2012 9:01:57 PM
Surr: 1,2-Dichloroethane-d4	106	70-130		%REC	1	6/1/2012 9:01:57 PM
Surr: 4-Bromofluorobenzene	110	70-130		%REC	1	6/1/2012 9:01:57 PM
Surr: Dibromofluoromethane	93.0	69.8-130		%REC	1	6/1/2012 9:01:57 PM
Surr: Toluene-d8	100	70-130		%REC	1	6/1/2012 9:01:57 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Trip Blank
Project: 5-29-12 River Terrace High Flow **Collection Date:**
Lab ID: 1205B46-010 **Matrix:** TRIP BLANK **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	0.050		mg/L	1	6/2/2012 6:20:06 AM
Surr: BFB	100	69.3-120		%REC	1	6/2/2012 6:20:06 AM
EPA METHOD 8260: VOLATILES SHORT LIST						Analyst: **JDJ**
Benzene	ND	1.0		µg/L	1	6/1/2012 9:32:21 PM
Toluene	ND	1.0		µg/L	1	6/1/2012 9:32:21 PM
Ethylbenzene	ND	1.0		µg/L	1	6/1/2012 9:32:21 PM
Methyl tert-butyl ether (MTBE)	ND	1.0		µg/L	1	6/1/2012 9:32:21 PM
Xylenes, Total	ND	2.0		µg/L	1	6/1/2012 9:32:21 PM
Surr: 1,2-Dichloroethane-d4	109	70-130		%REC	1	6/1/2012 9:32:21 PM
Surr: 4-Bromofluorobenzene	110	70-130		%REC	1	6/1/2012 9:32:21 PM
Surr: Dibromofluoromethane	90.4	69.8-130		%REC	1	6/1/2012 9:32:21 PM
Surr: Toluene-d8	100	70-130		%REC	1	6/1/2012 9:32:21 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205B46**

22-Jun-12

Client: Western Refining Southwest, Inc.

Project: 5-29-12 River Terrace High Flow

Sample ID **MB-2367**	SampType: **MBLK**	TestCode: **200.8 ICPMS Metals:Total**
Client ID: **PBW**	Batch ID: **2367**	RunNo: **3513**
Prep Date: **6/13/2012**	Analysis Date: **6/18/2012**	SeqNo: **98883** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Lead	ND	0.0025								

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1205B46**

''all Environmental Analysis Laboratory, Inc.

22-Jun-12

Client: Western Refining Southwest, Inc.
Project: 5-29-12 River Terrace High Flow

Sample ID **MB-2174**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Diesel Range**							
Client ID: **PBW**	Batch ID: **2174**	RunNo: **3106**							
Prep Date: **5/31/2012**	Analysis Date: **5/31/2012**	SeqNo: **85863**	Units: **mg/L**						
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	0.20								
Motor Oil Range Organics (MRO)	ND	2.5								
Surr: DNOP	0.74		0.5000		147	69	152			

Sample ID **LCS-2174**	SampType: **LCS**	TestCode: **EPA Method 8015B: Diesel Range**							
Client ID: **LCSW**	Batch ID: **2174**	RunNo: **3106**							
Prep Date: **5/31/2012**	Analysis Date: **5/31/2012**	SeqNo: **85864**	Units: **mg/L**						
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	2.6	0.20	2.500	0	104	74	157			
Surr: DNOP	0.30		0.2500		120	69	152			

Sample ID **1205B46-001BMS**	SampType: **MS**	TestCode: **EPA Method 8015B: Diesel Range**							
Client ID: **Tp-1**	Batch ID: **2174**	RunNo: **3106**							
Prep Date: **5/31/2012**	Analysis Date: **5/31/2012**	SeqNo: **86009**	Units: **mg/L**						
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
el Range Organics (DRO)	4.9	0.20	2.500	1.791	125	71	161			
Surr: DNOP	0.30		0.2500		120	69	152			

Sample ID **1205B46-001BMSD**	SampType: **MSD**	TestCode: **EPA Method 8015B: Diesel Range**							
Client ID: **Tp-1**	Batch ID: **2174**	RunNo: **3106**							
Prep Date: **5/31/2012**	Analysis Date: **5/31/2012**	SeqNo: **86188**	Units: **mg/L**						
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	5.0	0.20	2.500	1.791	130	71	161	2.44	23	
Surr: DNOP	0.30		0.2500		122	69	152	0	0	

Qualifiers:

- X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205B46**

22-Jun-12

Client: Western Refining Southwest, Inc.

Project: 5-29-12 River Terrace High Flow

Sample ID **5ML RB**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBW**	Batch ID: **R3175**	RunNo: **3175**
Prep Date:	Analysis Date: **6/1/2012**	SeqNo: **87777** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	0.050								
Surr: BFB	17		20.00		82.7	69.3	120			

Sample ID **2.5UG GRO LCS**	SampType: **LCS**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **LCSW**	Batch ID: **R3175**	RunNo: **3175**
Prep Date:	Analysis Date: **6/1/2012**	SeqNo: **87778** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	0.57	0.050	0.5000	0	114	101	123			
Surr: BFB	21		20.00		105	69.3	120			

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

WO#: **1205B46**

all Environmental Analysis Laboratory, Inc.

22-Jun-12

Client: Western Refining Southwest, Inc.
Project: 5-29-12 River Terrace High Flow

Sample ID **5ml rb**	SampType: **MBLK**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **PBW**	Batch ID: **R3172**	RunNo: **3172**
Prep Date:	Analysis Date: **6/1/2012**	SeqNo: **87628** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	1.0								
Toluene	ND	1.0								
Ethylbenzene	ND	1.0								
Methyl tert-butyl ether (MTBE)	ND	1.0								
Xylenes, Total	ND	2.0								
Surr: 1,2-Dichloroethane-d4	10		10.00		102	70	130			
Surr: 4-Bromofluorobenzene	10		10.00		102	70	130			
Surr: Dibromofluoromethane	8.6		10.00		86.1	69.8	130			
Surr: Toluene-d8	10		10.00		103	70	130			

Sample ID **100ng lcs**	SampType: **LCS**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **LCSW**	Batch ID: **R3172**	RunNo: **3172**
Prep Date:	Analysis Date: **6/1/2012**	SeqNo: **87629** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	21	1.0	20.00	0	104	84.1	126			
Toluene	20	1.0	20.00	0	102	80	120			
Surr: 1,2-Dichloroethane-d4	9.8		10.00		97.8	70	130			
Surr: 4-Bromofluorobenzene	11		10.00		105	70	130			
Surr: Dibromofluoromethane	8.3		10.00		83.3	69.8	130			
Surr: Toluene-d8	10		10.00		102	70	130			

Sample ID **1205b46-001ams**	SampType: **MS**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **Tp-1**	Batch ID: **R3172**	RunNo: **3172**
Prep Date:	Analysis Date: **6/1/2012**	SeqNo: **87630** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Toluene	930	50	1000	0	92.7	74	121			
Surr: 1,2-Dichloroethane-d4	480		500.0		96.3	70	130			
Surr: 4-Bromofluorobenzene	540		500.0		108	70	130			
Surr: Dibromofluoromethane	430		500.0		85.9	69.8	130			
Surr: Toluene-d8	500		500.0		99.3	70	130			

Sample ID **1205b46-001amsd**	SampType: **MSD**	TestCode: **EPA Method 8260: Volatiles Short List**
Client ID: **Tp-1**	Batch ID: **R3172**	RunNo: **3172**
Prep Date:	Analysis Date: **6/1/2012**	SeqNo: **87631** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Toluene	870	50	1000	0	87.3	74	121	6.01	18.5	
Surr: 1,2-Dichloroethane-d4	490		500.0		97.8	70	130	0	0	
Surr: 4-Bromofluorobenzene	510		500.0		103	70	130	0	0	
Surr: Dibromofluoromethane	430		500.0		85.5	69.8	130	0	0	

Qualifiers:

- X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205B46**

22-Jun-12

Client: Western Refining Southwest, Inc.

Project: 5-29-12 River Terrace High Flow

Sample ID	**1205b46-001amsd**	SampType: **MSD**		TestCode: **EPA Method 8260: Volatiles Short List**					
Client ID:	**Tp-1**	Batch ID: **R3172**		RunNo: **3172**					
Prep Date:		Analysis Date: **6/1/2012**		SeqNo: **87631**	Units: **µg/L**				
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Surr: Toluene-d8	490		500.0		97.1	70	130	0	0	

Qualifiers:

- */X Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1205B46

Received by/date: MG 05/30/12

Logged By: Michelle Garcia 5/30/2012 10:15:00 AM Michelle Garcia

Completed By: Michelle Garcia 5/30/2012 11:42:35 AM Michelle Garcia

Reviewed By: 05/30/12

Chain of Custody

1. Were seals intact? Yes ☐ No ☐ Not Present ☑
2. Is Chain of Custody complete? Yes ☑ No ☐ Not Present ☐
3. How was the sample delivered? UPS

Log In

4. Coolers are present? (see 19. for cooler specific information) Yes ☑ No ☐ NA ☐
5. Was an attempt made to cool the samples? Yes ☑ No ☐ NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C Yes ☑ No ☐ NA ☐
7. Sample(s) in proper container(s)? Yes ☑ No ☐
8. Sufficient sample volume for indicated test(s)? Yes ☑ No ☐
9. Are samples (except VOA and ONG) properly preserved? Yes ☑ No ☐
10. Was preservative added to bottles? Yes ☐ No ☑ NA ☐
-001 - ADDED 1mL HNO_3 FOR ACCEPTABLE pH - 05/30/12
11. VOA vials have zero headspace? Yes ☑ No ☐ No VOA Vials ☐
12. Were any sample containers received broken? Yes ☐ No ☑
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody) Yes ☑ No ☐
14. Are matrices correctly identified on Chain of Custody? Yes ☑ No ☐
15. Is it clear what analyses were requested? Yes ☑ No ☐
16. Were all holding times able to be met? (If no, notify customer for authorization.) Yes ☑ No ☐

# of preserved bottles checked for pH: 8 (<2 or >12 unless noted)
Adjusted? YES
Checked by:

Special Handling (If applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: Date:
By Whom: Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person
Regarding:
Client Instructions:

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.0	Good	Yes			

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other _____

☐ EDD (Type) _____

Turn-Around Time:
☒ Standard ☐ Rush _____

Project Name: 5-29-12
River Terrace High Flow

Project #:

Project Manager:

Sampler: Bob

On Ice: ☐ Yes

Sample Temperature: [redacted]

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type		BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO3,NO2,PO4,SO4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	80158 DRO	Total Metals - Pb only			Air Bubbles (Y or N)
5-29-12	10:30	H2O	Tp-1	5-VOA	HCl	-001			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3														X			
	10:15		Tp-2	5-VOA	HCl	-002			X							X						
				1-500ml	Amber													X				
				1-500ml	HNO3														X			
	10:00		Tp-5	~~5-500ml~~ VOA	HCl	-003			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3														X			
	11:00		Tp-6	5-VOA	HCl	-004			X							X						
				1-500ml	amber													X				
				1-500ml	HNO3														X			

Date:	Time:	Relinquished by:	Received by:	Date	Time
			Michelle Garcia	05/30/12	10:15
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks: Please Also Send Results IN Excel
~~Trip BLANK - 006~~ 05/30/12
Field BLANK - 005

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)

Accreditation
☐ NELAP ☐ Other _____

☐ EDD (Type) _____

Turn-Around Time:
☒ Standard ☐ Rush _____

Project Name: 5-29-12 River Terrace High Flow

Project #:

Project Manager:

Sampler: Bob

Sample Temperature:

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Analysis Request

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type		BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	8015B DRO	Total Metals - pb only			Air Bubbles (Y or N)
5-29-12	12:30	H_2O	Tp-8	5-VOA	HCl	-006			X							X						
				1-500ml	amber													X				
				1-500ml	HNO_3														X			
	12:30		Tp-8 D	5-VOA	HCl	-007			X							X						
				1-500ml	amber													X				
				1-500ml	HNO_3														X			
	12:00		Tp-9	5-VOA	HCl	-008			X							X						
				1-500ml	amber													X				
				1-500ml	HNO_3														X			
	11:15	[redacted]	MW-49	5-VOA	HCl	-009			X							X						
				1-500ml	amber													X				
				1-500ml	HNO_3														X			

Date:	Time:	Relinquished by:	Received by:	Date	Time
29-12	3:00	Robert Krakow	Michelle Garcia	05/30/12	10:15
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks: Also send Results in Excel
Trip Blank -010

HALL
ENVIRONMENTAL
ANALYSIS
LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

June 22, 2012

Kelly Robinson

Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: 5-29-12 River Terrace High Flow Air OrderNo.: 1205B59

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 8 sample(s) on 5/30/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Workorder Sample Summary

WO#: **1205B59**
22-Jun-12

CLIENT: Western Refining Southwest, Inc.
Project: 5-29-12 River Terrace High Flow Air

Lab SampleID	Client Sample ID	Tag No	Date Collected	Date Received	Matrix
1205B59-001	Tp-1		5/29/2012 9:15:00 AM	5/30/2012 10:15:00 AM	Air
1205B59-002	Tp-2		5/29/2012 7:30:00 AM	5/30/2012 10:15:00 AM	Air
1205B59-003	Tp-5		5/29/2012 7:40:00 AM	5/30/2012 10:15:00 AM	Air
1205B59-004	Tp-6		5/29/2012 8:30:00 AM	5/30/2012 10:15:00 AM	Air
1205B59-005	Tp-8		5/29/2012 8:00:00 AM	5/30/2012 10:15:00 AM	Air
1205B59-006	Tp-8D		5/29/2012 8:00:00 AM	5/30/2012 10:15:00 AM	Air
1205B59-007	Tp-9		5/29/2012 8:45:00 AM	5/30/2012 10:15:00 AM	Air
1205B59-008	MW-49		5/29/2012 9:30:00 AM	5/30/2012 10:15:00 AM	Air

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: Tp-1
Project: 5-29-12 River Terrace High Flow Air
Collection Date: 5/29/2012 9:15:00 AM
Lab ID: 1205B59-001 **Matrix:** AIR
Received Date: 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	190	25		µg/L	5	6/5/2012 1:34:32 PM
Surr: BFB	109	48.4-185		%REC	5	6/5/2012 1:34:32 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	12	0.50		µg/L	5	6/5/2012 1:34:32 PM
Toluene	ND	0.50		µg/L	5	6/5/2012 1:34:32 PM
Ethylbenzene	12	0.50		µg/L	5	6/5/2012 1:34:32 PM
Xylenes, Total	26	1.5		µg/L	5	6/5/2012 1:34:32 PM
Surr: 4-Bromofluorobenzene	106	74.5-131		%REC	5	6/5/2012 1:34:32 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-2
Project: 5-29-12 River Terrace High Flow Air **Collection Date:** 5/29/2012 7:30:00 AM
Lab ID: 1205B59-002 **Matrix:** AIR **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	6/5/2012 12:05:53 PM
Surr: BFB	92.5	48.4-185		%REC	1	6/5/2012 12:05:53 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	6/5/2012 12:05:53 PM
Toluene	ND	0.10		µg/L	1	6/5/2012 12:05:53 PM
Ethylbenzene	ND	0.10		µg/L	1	6/5/2012 12:05:53 PM
Xylenes, Total	ND	0.30		µg/L	1	6/5/2012 12:05:53 PM
Surr: 4-Bromofluorobenzene	94.4	74.5-131		%REC	1	6/5/2012 12:05:53 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: Tp-5
Project: 5-29-12 River Terrace High Flow Air
Collection Date: 5/29/2012 7:40:00 AM
Lab ID: 1205B59-003 **Matrix:** AIR
Received Date: 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	6/5/2012 2:28:47 PM
Surr: BFB	99.8	48.4-185		%REC	1	6/5/2012 2:28:47 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	6/5/2012 2:28:47 PM
Toluene	ND	0.10		µg/L	1	6/5/2012 2:28:47 PM
Ethylbenzene	ND	0.10		µg/L	1	6/5/2012 2:28:47 PM
Xylenes, Total	ND	0.30		µg/L	1	6/5/2012 2:28:47 PM
Surr: 4-Bromofluorobenzene	102	74.5-131		%REC	1	6/5/2012 2:28:47 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** Tp-6
Project: 5-29-12 River Terrace High Flow Air **Collection Date:** 5/29/2012 8:30:00 AM
Lab ID: 1205B59-004 **Matrix:** AIR **Received Date:** 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	7.9	5.0		µg/L	1	6/5/2012 2:55:56 PM
Surr: BFB	81.7	48.4-185		%REC	1	6/5/2012 2:55:56 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	6/5/2012 2:55:56 PM
Toluene	ND	0.10		µg/L	1	6/5/2012 2:55:56 PM
Ethylbenzene	ND	0.10		µg/L	1	6/5/2012 2:55:56 PM
Xylenes, Total	ND	0.30		µg/L	1	6/5/2012 2:55:56 PM
Surr: 4-Bromofluorobenzene	80.3	74.5-131		%REC	1	6/5/2012 2:55:56 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: Tp-8
Project: 5-29-12 River Terrace High Flow Air
Collection Date: 5/29/2012 8:00:00 AM
Lab ID: 1205B59-005 **Matrix:** AIR
Received Date: 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	5/30/2012 2:45:03 PM
Surr: BFB	77.1	48.4-185		%REC	1	5/30/2012 2:45:03 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	5/30/2012 2:45:03 PM
Toluene	ND	0.10		µg/L	1	5/30/2012 2:45:03 PM
Ethylbenzene	ND	0.10		µg/L	1	5/30/2012 2:45:03 PM
Xylenes, Total	ND	0.30		µg/L	1	5/30/2012 2:45:03 PM
Surr: 4-Bromofluorobenzene	73.4	74.5-131	S	%REC	1	5/30/2012 2:45:03 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: Tp-8D
Project: 5-29-12 River Terrace High Flow Air
Collection Date: 5/29/2012 8:00:00 AM
Lab ID: 1205B59-006
Matrix: AIR
Received Date: 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	6.6	5.0		µg/L	1	6/5/2012 3:23:06 PM
Surr: BFB	82.9	48.4-185		%REC	1	6/5/2012 3:23:06 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	6/5/2012 3:23:06 PM
Toluene	ND	0.10		µg/L	1	6/5/2012 3:23:06 PM
Ethylbenzene	ND	0.10		µg/L	1	6/5/2012 3:23:06 PM
Xylenes, Total	0.33	0.30		µg/L	1	6/5/2012 3:23:06 PM
Surr: 4-Bromofluorobenzene	82.2	74.5-131		%REC	1	6/5/2012 3:23:06 PM

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: Tp-9
Project: 5-29-12 River Terrace High Flow Air
Collection Date: 5/29/2012 8:45:00 AM
Lab ID: 1205B59-007 **Matrix:** AIR
Received Date: 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	6/5/2012 3:50:19 PM
Surr: BFB	82.1	48.4-185		%REC	1	6/5/2012 3:50:19 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	6/5/2012 3:50:19 PM
Toluene	ND	0.10		µg/L	1	6/5/2012 3:50:19 PM
Ethylbenzene	ND	0.10		µg/L	1	6/5/2012 3:50:19 PM
Xylenes, Total	ND	0.30		µg/L	1	6/5/2012 3:50:19 PM
Surr: 4-Bromofluorobenzene	80.4	74.5-131		%REC	1	6/5/2012 3:50:19 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: MW-49
Project: 5-29-12 River Terrace High Flow Air
Collection Date: 5/29/2012 9:30:00 AM
Lab ID: 1205B59-008 **Matrix:** AIR
Received Date: 5/30/2012 10:15:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	ND	5.0		µg/L	1	6/5/2012 4:17:31 PM
Surr: BFB	107	48.4-185		%REC	1	6/5/2012 4:17:31 PM
EPA METHOD 8021B: VOLATILES						Analyst: **NSB**
Benzene	ND	0.10		µg/L	1	6/5/2012 4:17:31 PM
Toluene	ND	0.10		µg/L	1	6/5/2012 4:17:31 PM
Ethylbenzene	ND	0.10		µg/L	1	6/5/2012 4:17:31 PM
Xylenes, Total	ND	0.30		µg/L	1	6/5/2012 4:17:31 PM
Surr: 4-Bromofluorobenzene	106	74.5-131		%REC	1	6/5/2012 4:17:31 PM

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit
S	Spike Recovery outside accepted recovery limits	U	Samples with CalcVal < MDL

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205B59**

22-Jun-12

Client: Western Refining Southwest, Inc.

Project: 5-29-12 River Terrace High Flow Air

Sample ID **1205B59-005ADUP**	SampType: **DUP**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **Tp-8**	Batch ID: **R3111**	RunNo: **3111**
Prep Date:	Analysis Date: **5/30/2012**	SeqNo: **86041** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	5.0						0	24.2	
Surr: BFB	1900		2000		95.2	48.4	185	0	0	

Sample ID **1205B59-001ADUP**	SampType: **DUP**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **Tp-1**	Batch ID: **R3233**	RunNo: **3233**
Prep Date:	Analysis Date: **6/5/2012**	SeqNo: **89774** Units: **µg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	180	25						7.65	24.2	
Surr: BFB	10000		10000		102	48.4	185	0	0	

Qualifiers:

*/X	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
R	RPD outside accepted recovery limits	RL	Reporting Detection Limit

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1205B59**

22-Jun-12

Client: Western Refining Southwest, Inc.

Project: 5-29-12 River Terrace High Flow Air

Sample ID **1205B59-005ADUP**	SampType: **DUP**			TestCode: **EPA Method 8021B: Volatiles**					
Client ID: **Tp-8**	Batch ID: **R3111**			RunNo: **3111**					
Prep Date:	Analysis Date: **5/30/2012**			SeqNo: **86057**		Units: **µg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	ND	0.10						0	105	
Toluene	ND	0.10						0	34	
Ethylbenzene	ND	0.10						0	22.1	
Xylenes, Total	ND	0.30						0	21.9	
Surr: 4-Bromofluorobenzene	1.8		2.000		92.5	74.5	131	0	0	

Sample ID **1205B59-001ADUP**	SampType: **DUP**			TestCode: **EPA Method 8021B: Volatiles**					
Client ID: **Tp-1**	Batch ID: **R3233**			RunNo: **3233**					
Prep Date:	Analysis Date: **6/5/2012**			SeqNo: **89790**		Units: **µg/L**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	11	0.50						4.29	105	
Toluene	ND	0.50						0	34	
Ethylbenzene	11	0.50						7.35	22.1	
Xylenes, Total	23	1.5						9.32	21.9	
Surr: 4-Bromofluorobenzene	9.9		10.00		98.7	74.5	131	0	0	

Qualifiers:

- K Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- R RPD outside accepted recovery limits
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- RL Reporting Detection Limit

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: **Western Refining Southwest, Inc Bloomfield** Work Order Number: **1205B59**

Received by/date: MG 05/30/12

Logged By: **Michelle Garcia** **5/30/2012 10:15:00 AM** Michelle Garcia

Completed By: **Michelle Garcia** **5/30/2012 1:39:19 PM** Michelle Garcia

Reviewed By: IO 05/30/12

Chain of Custody

1. Were seals intact?	Yes		No	Not Present ✔
2. Is Chain of Custody complete?	Yes	✔	No	Not Present
3. How was the sample delivered?	UPS			

Log In

4. Coolers are present? (see 19. for cooler specific information)	Yes		No	NA ✔
5. Was an attempt made to cool the samples?	Yes	✔	No	NA
6. Were all samples received at a temperature of >0° C to 6.0°C	Yes		No	NA ✔
7. Sample(s) in proper container(s)?	Yes	✔	No	
8. Sufficient sample volume for indicated test(s)?	Yes	✔	No	
9. Are samples (except VOA and ONG) properly preserved?	Yes	✔	No	
10. Was preservative added to bottles?	Yes		No ✔	NA
11. VOA vials have zero headspace?	Yes		No	No VOA Vials ✔
12. Were any sample containers received broken?	Yes		No ✔	
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes	✔	No	# of preserved bottles checked for pH:
14. Are matrices correctly identified on Chain of Custody?	Yes	✔	No	(<2 or >12 unless noted)
15. Is it clear what analyses were requested?	Yes	✔	No	Adjusted?
16. Were all holding times able to be met? (If no, notify customer for authorization.)	Yes	✔	No	Checked by:

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes No NA ✔

Person Notified: _____ Date: _____

By Whom: _____ Via: eMail Phone Fax In Person

Regarding: _____

Client Instructions: _____

18. Additional remarks:

19. **Cooler Information**

Chain-of-Custody Record

Client: Western Refining

Mailing Address: #50 CR 4990
Bloomfield, NM 87413

Phone #: 505-632-4135

email or Fax#:

QA/QC Package:
☐ Standard ☒ Level 4 (Full Validation)
☐ Other
☐ EDD (Type)

Turn-Around Time:
☒ Standard ☐ Rush

Project Name: 5-29-12 River Terrace High Flow Air

Project #:

Project Manager:

Sampler: Bob

On Ice: ☐ Yes ☐ No

Sample Temperature:

HALL ENVIRONMENTAL ANALYSIS LABORATORY
www.hallenvironmental.com
4901 Hawkins NE - Albuquerque, NM 87109
Tel. 505-345-3975 Fax 505-345-4107

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	HEAL No. 1203859	BTEX + [redacted] (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/[redacted])	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA)	8270 (Semi-VOA)	Air Bubbles (Y or N)
5-29-12	9:15	Air	Tp-1	1-Tedlar Bag		-001	X		X									
	7:30		Tp-2			-002	X		X									
	7:40		Tp-5			-003	X		X									
	8:30		Tp-6			-004	X		X									
	8:00		Tp-8			-005	X		X									
	8:00		Tp-8D			-006	X		X									
	8:45		Tp-9			-007	X		X									
	9:30		MW-49			-008	X		X									
						~~-009~~												

Date	Time	Relinquished by:	Received by:	Date	Time
5-29-12	3:00	Robert Kraker	Michelle Garcia	05/30/12	10:15
Date:	Time:	Relinquished by:	Received by:	Date	Time

Remarks: Please Send Results in Excel

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

November 28, 2012

Kelly Robinson
Western Refining Southwest, Inc.
#50 CR 4990
Bloomfield, NM 87413
TEL: (505) 632-4135
FAX (505) 632-3911

RE: River Terrace Exc. 11-5-12 OrderNo.: 1211182

Dear Kelly Robinson:

Hall Environmental Analysis Laboratory received 2 sample(s) on 11/6/2012 for the analyses presented in the following report.

These were analyzed according to EPA procedures or equivalent. To access our accredited tests please go to www.hallenvironmental.com or the state specific web sites. See the sample checklist and/or the Chain of Custody for information regarding the sample receipt temperature and preservation. Data qualifiers or a narrative will be provided if the sample analysis or analytical quality control parameters require a flag. All samples are reported as received unless otherwise indicated. Lab measurement of analytes considered field parameters that require analysis within 15 minutes of sampling such as pH and residual chlorine are qualified as being analyzed outside of the recommended holding time.

Please don't hesitate to contact HEAL for any additional information or clarifications.

Sincerely,

Andy Freeman
Laboratory Manager
4901 Hawkins NE
Albuquerque, NM 87109

Analytical Report
Lab Order **1211182**
Date Reported: **11/28/2012**

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: East pile
Project: River Terrace Exc. 11-5-12
Collection Date: 11/5/2012 12:45:00 PM
Lab ID: 1211182-001 **Matrix:** SOIL **Received Date:** 11/6/2012 10:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE ORGANICS						Analyst: **JMP**
Diesel Range Organics (DRO)	990	10		mg/Kg	1	11/7/2012 7:56:23 AM
Motor Oil Range Organics (MRO)	ND	50		mg/Kg	1	11/7/2012 7:56:23 AM
Surr: DNOP	95.4	77.6-140		%REC	1	11/7/2012 7:56:23 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	130	97		mg/Kg	20	11/8/2012 2:32:30 AM
Surr: BFB	122	84-116	S	%REC	20	11/8/2012 2:32:30 AM
EPA METHOD 8310: PAHS						Analyst: **SCC**
Naphthalene	9.3	1.2		mg/Kg	1	11/9/2012 12:45:25 PM
1-Methylnaphthalene	7.8	1.2		mg/Kg	1	11/9/2012 12:45:25 PM
2-Methylnaphthalene	9.5	1.2		mg/Kg	1	11/9/2012 12:45:25 PM
Acenaphthylene	ND	1.2		mg/Kg	1	11/9/2012 12:45:25 PM
Acenaphthene	ND	1.2		mg/Kg	1	11/9/2012 12:45:25 PM
Fluorene	0.22	0.15		mg/Kg	1	11/9/2012 12:45:25 PM
Phenanthrene	0.65	0.074		mg/Kg	1	11/9/2012 12:45:25 PM
Anthracene	ND	0.074		mg/Kg	1	11/9/2012 12:45:25 PM
Fluoranthene	ND	0.099		mg/Kg	1	11/9/2012 12:45:25 PM
Pyrene	ND	0.12		mg/Kg	1	11/9/2012 12:45:25 PM
Benz(a)anthracene	ND	0.049		mg/Kg	1	11/9/2012 12:45:25 PM
Chrysene	0.076	0.054		mg/Kg	1	11/9/2012 12:45:25 PM
Benzo(b)fluoranthene	ND	0.049		mg/Kg	1	11/9/2012 12:45:25 PM
Benzo(k)fluoranthene	ND	0.049		mg/Kg	1	11/9/2012 12:45:25 PM
Benzo(a)pyrene	ND	0.049		mg/Kg	1	11/9/2012 12:45:25 PM
Dibenz(a,h)anthracene	ND	0.049		mg/Kg	1	11/9/2012 12:45:25 PM
Benzo(g,h,i)perylene	ND	0.049		mg/Kg	1	11/9/2012 12:45:25 PM
Indeno(1,2,3-cd)pyrene	ND	0.049		mg/Kg	1	11/9/2012 12:45:25 PM
Surr: Benzo(e)pyrene	85.2	35.9-103		%REC	1	11/9/2012 12:45:25 PM
MERCURY, TCLP						Analyst: **IDC**
Mercury	ND	0.020		mg/L	1	11/8/2012 1:02:47 PM
EPA METHOD 6010B: TCLP METALS						Analyst: **JLF**
Arsenic	ND	5.0		mg/L	1	11/15/2012 9:30:31 AM
Barium	ND	100		mg/L	5	11/15/2012 9:44:26 AM
Cadmium	ND	1.0		mg/L	1	11/15/2012 9:30:31 AM
Chromium	ND	5.0		mg/L	1	11/15/2012 9:30:31 AM
Lead	ND	5.0		mg/L	1	11/15/2012 9:30:31 AM
Selenium	ND	1.0		mg/L	1	11/15/2012 9:30:31 AM
Silver	ND	5.0		mg/L	1	11/15/2012 9:30:31 AM
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst: **RAA**
Methyl tert-butyl ether (MTBE)	ND	2.4		mg/Kg	50	11/8/2012 8:34:47 PM
Benzene	ND	2.4		mg/Kg	50	11/8/2012 8:34:47 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits
RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc.
Client Sample ID: East pile
Project: River Terrace Exc. 11-5-12
Collection Date: 11/5/2012 12:45:00 PM
Lab ID: 1211182-001 **Matrix:** SOIL **Received Date:** 11/6/2012 10:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst: **RAA**
Toluene	ND	2.4		mg/Kg	50	11/8/2012 8:34:47 PM
Ethylbenzene	ND	2.4		mg/Kg	50	11/8/2012 8:34:47 PM
Xylenes, Total	12	4.9		mg/Kg	50	11/8/2012 8:34:47 PM
Surr: 1,2-Dichloroethane-d4	98.9	70-130		%REC	50	11/8/2012 8:34:47 PM
Surr: 4-Bromofluorobenzene	89.4	70-130		%REC	50	11/8/2012 8:34:47 PM
Surr: Dibromofluoromethane	72.3	70-130		%REC	50	11/8/2012 8:34:47 PM
Surr: Toluene-d8	90.2	70-130		%REC	50	11/8/2012 8:34:47 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits
RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** North pile
Project: River Terrace Exc. 11-5-12 **Collection Date:** 11/5/2012 12:50:00 PM
Lab ID: 1211182-002 **Matrix:** SOIL **Received Date:** 11/6/2012 10:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8015B: DIESEL RANGE ORGANICS						Analyst: **JMP**
Diesel Range Organics (DRO)	190	9.8		mg/Kg	1	11/7/2012 8:20:41 AM
Motor Oil Range Organics (MRO)	ND	49		mg/Kg	1	11/7/2012 8:20:41 AM
Surr: DNOP	94.2	77.6-140		%REC	1	11/7/2012 8:20:41 AM
EPA METHOD 8015B: GASOLINE RANGE						Analyst: **NSB**
Gasoline Range Organics (GRO)	28	9.6		mg/Kg	2	11/8/2012 3:01:11 AM
Surr: BFB	237	84-116	S	%REC	2	11/8/2012 3:01:11 AM
EPA METHOD 8310: PAHS						Analyst: **SCC**
Naphthalene	ND	0.62		mg/Kg	1	11/9/2012 2:13:18 PM
1-Methylnaphthalene	0.63	0.62		mg/Kg	1	11/9/2012 2:13:18 PM
2-Methylnaphthalene	ND	0.62		mg/Kg	1	11/9/2012 2:13:18 PM
Acenaphthylene	ND	0.62		mg/Kg	1	11/9/2012 2:13:18 PM
Acenaphthene	ND	0.62		mg/Kg	1	11/9/2012 2:13:18 PM
Fluorene	ND	0.075		mg/Kg	1	11/9/2012 2:13:18 PM
Phenanthrene	0.14	0.037		mg/Kg	1	11/9/2012 2:13:18 PM
Anthracene	ND	0.037		mg/Kg	1	11/9/2012 2:13:18 PM
Fluoranthene	ND	0.050		mg/Kg	1	11/9/2012 2:13:18 PM
Pyrene	ND	0.062		mg/Kg	1	11/9/2012 2:13:18 PM
Benz(a)anthracene	ND	0.025		mg/Kg	1	11/9/2012 2:13:18 PM
Chrysene	0.029	0.027		mg/Kg	1	11/9/2012 2:13:18 PM
Benzo(b)fluoranthene	ND	0.025		mg/Kg	1	11/9/2012 2:13:18 PM
Benzo(k)fluoranthene	ND	0.025		mg/Kg	1	11/9/2012 2:13:18 PM
Benzo(a)pyrene	ND	0.025		mg/Kg	1	11/9/2012 2:13:18 PM
Dibenz(a,h)anthracene	ND	0.025		mg/Kg	1	11/9/2012 2:13:18 PM
Benzo(g,h,i)perylene	ND	0.025		mg/Kg	1	11/9/2012 2:13:18 PM
Indeno(1,2,3-cd)pyrene	ND	0.025		mg/Kg	1	11/9/2012 2:13:18 PM
Surr: Benzo(e)pyrene	83.6	35.9-103		%REC	1	11/9/2012 2:13:18 PM
MERCURY, TCLP						Analyst: **IDC**
Mercury	ND	0.020		mg/L	1	11/8/2012 1:04:32 PM
EPA METHOD 6010B: TCLP METALS						Analyst: **JLF**
Arsenic	ND	5.0		mg/L	1	11/15/2012 9:56:38 AM
Barium	ND	100		mg/L	1	11/15/2012 9:56:38 AM
Cadmium	ND	1.0		mg/L	1	11/15/2012 9:56:38 AM
Chromium	ND	5.0		mg/L	1	11/15/2012 9:56:38 AM
Lead	ND	5.0		mg/L	1	11/15/2012 9:56:38 AM
Selenium	ND	1.0		mg/L	1	11/15/2012 9:56:38 AM
Silver	ND	5.0		mg/L	1	11/15/2012 9:56:38 AM
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst: **RAA**
Methyl tert-butyl ether (MTBE)	ND	0.24		mg/Kg	5	11/8/2012 9:30:02 PM
Benzene	ND	0.24		mg/Kg	5	11/8/2012 9:30:02 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits
RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits

Hall Environmental Analysis Laboratory, Inc.

CLIENT: Western Refining Southwest, Inc. **Client Sample ID:** North pile
Project: River Terrace Exc. 11-5-12 **Collection Date:** 11/5/2012 12:50:00 PM
Lab ID: 1211182-002 **Matrix:** SOIL **Received Date:** 11/6/2012 10:00:00 AM

Analyses	Result	RL	Qual	Units	DF	Date Analyzed
EPA METHOD 8260B: VOLATILES SHORT LIST						Analyst: **RAA**
Toluene	ND	0.24		mg/Kg	5	11/8/2012 9:30:02 PM
Ethylbenzene	ND	0.24		mg/Kg	5	11/8/2012 9:30:02 PM
Xylenes, Total	ND	0.48		mg/Kg	5	11/8/2012 9:30:02 PM
Surr: 1,2-Dichloroethane-d4	105	70-130		%REC	5	11/8/2012 9:30:02 PM
Surr: 4-Bromofluorobenzene	93.8	70-130		%REC	5	11/8/2012 9:30:02 PM
Surr: Dibromofluoromethane	66.2	70-130	S	%REC	5	11/8/2012 9:30:02 PM
Surr: Toluene-d8	81.6	70-130		%REC	5	11/8/2012 9:30:02 PM

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits
RL	Reporting Detection Limit	S	Spike Recovery outside accepted recovery limits

Anatek Labs, Inc.

1282 Alturas Drive • Moscow, ID 83843 • (208) 883-2839 • Fax (208) 882-9246 • email moscow@anateklabs.com
504 E Sprague Ste. D • Spokane WA 99202 • (509) 838-3999 • Fax (509) 838-4433 • email spokane@anateklabs.com

Client: HALL ENVIRONMENTAL ANALYSIS LAB
Address: 4901 HAWKINS NE SUITE D
ALBUQUERQUE, NM 87109
Attn: ANDY FREEMAN

Batch #: 121108019
Project Name: 1211182

Analytical Results Report

Sample Number 121108019-001 **Sampling Date** 11/5/2012 **Date/Time Received** 11/8/2012 10:43 A
Client Sample ID 1211182-001B / EAST PILE **Sampling Time** 12:45 PM
Matrix Soil **Sample Location**
Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Cyanide (reactive)	ND	mg/Kg	0.3	11/21/2012	JTT	SW846 CH7	
Ignitability	Negative			11/9/2012	JWC	EPA 1030	
pH	7.55	ph Units		11/9/2012	ETL	EPA 9045	
Reactive sulfide	165	mg/kg	150	11/14/2012	JTT	SW846 CH7	
%moisture	9.6	Percent		11/13/2012	CRW	%moisture	

Sample Number 121108019-002 **Sampling Date** 11/5/2012 **Date/Time Received** 11/8/2012 10:43 A
Client Sample ID 1211182-002B / NORTH PILE **Sampling Time** 12:50 PM
Matrix Soil **Sample Location**
Comments

Parameter	Result	Units	PQL	Analysis Date	Analyst	Method	Qualifier
Cyanide (reactive)	ND	mg/Kg	0.3	11/21/2012	JTT	SW846 CH7	
Ignitability	Negative			11/9/2012	JWC	EPA 1030	
pH	7.74	ph Units		11/9/2012	ETL	EPA 9045	
Reactive sulfide	33.2	mg/kg	30	11/14/2012	JTT	SW846 CH7	
%moisture	11	Percent		11/13/2012	CRW	%moisture	

Authorized Signature

John Coddington, Lab Manager

MCL EPA's Maximum Contaminant Level
ND Not Detected
PQL Practical Quantitation Limit

This report shall not be reproduced except in full, without the written approval of the laboratory.
The results reported relate only to the samples indicated.
Soil/solid results are reported on a dry-weight basis unless otherwise noted.

Certifications held by Anatek Labs ID: EPA:ID00013; AZ:0701; CO:ID00013; FL(NELAP):E87893; ID:ID00013; IN:C-ID-01; KY:90142; MT:CERT0028; NM: ID00013; OR:ID200001-002; WA:C595
Certifications held by Anatek Labs WA: EPA:WA00169; ID:WA00169; WA:C585; MT:Cert0095

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1211182**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: River Terrace Exc. 11-5-12

Sample ID **MB-4692**	SampType: **MBLK**			TestCode: **EPA Method 8015B: Diesel Range Organics**					
Client ID: **PBS**	Batch ID: **4692**			RunNo: **6702**					
Prep Date: **11/6/2012**	Analysis Date: **11/6/2012**			SeqNo: **194018**		Units: **mg/Kg**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	ND	10								
Motor Oil Range Organics (MRO)	ND	50								
Surr: DNOP	9.4		10.00		93.9	77.6	140			

Sample ID **LCS-4692**	SampType: **LCS**			TestCode: **EPA Method 8015B: Diesel Range Organics**					
Client ID: **LCSS**	Batch ID: **4692**			RunNo: **6702**					
Prep Date: **11/6/2012**	Analysis Date: **11/6/2012**			SeqNo: **194019**		Units: **mg/Kg**			
Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Diesel Range Organics (DRO)	47	10	50.00	0	93.7	52.6	130			
Surr: DNOP	4.1		5.000		82.2	77.6	140			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1211182**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: River Terrace Exc. 11-5-12

Sample ID **MB-4693**	SampType: **MBLK**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **PBS**	Batch ID: **4693**	RunNo: **6754**
Prep Date: **11/6/2012**	Analysis Date: **11/7/2012**	SeqNo: **195543** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	ND	5.0								
Surr: BFB	950		1000		94.5	84	116			

Sample ID **LCS-4693**	SampType: **LCS**	TestCode: **EPA Method 8015B: Gasoline Range**
Client ID: **LCSS**	Batch ID: **4693**	RunNo: **6754**
Prep Date: **11/6/2012**	Analysis Date: **11/7/2012**	SeqNo: **195544** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Gasoline Range Organics (GRO)	25	5.0	25.00	0	98.8	74	117			
Surr: BFB	1000		1000		101	84	116			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1211182**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: River Terrace Exc. 11-5-12

Sample ID **mb-4693**	SampType: **MBLK**	TestCode: **EPA Method 8260B: Volatiles Short List**
Client ID: **PBS**	Batch ID: **4693**	RunNo: **6748**
Prep Date: **11/6/2012**	Analysis Date: **11/7/2012**	SeqNo: **195471** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Methyl tert-butyl ether (MTBE)	ND	0.050								
Benzene	ND	0.050								
Toluene	ND	0.050								
Ethylbenzene	ND	0.050								
Xylenes, Total	ND	0.10								
Surr: 1,2-Dichloroethane-d4	0.51		0.5000		103	70	130			
Surr: 4-Bromofluorobenzene	0.46		0.5000		92.3	70	130			
Surr: Dibromofluoromethane	0.36		0.5000		72.0	70	130			
Surr: Toluene-d8	0.42		0.5000		83.7	70	130			

Sample ID **lcs-4693**	SampType: **LCS**	TestCode: **EPA Method 8260B: Volatiles Short List**
Client ID: **LCSS**	Batch ID: **4693**	RunNo: **6748**
Prep Date: **11/6/2012**	Analysis Date: **11/7/2012**	SeqNo: **195476** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzene	1.0	0.050	1.000	0	101	70	130			
Toluene	0.94	0.050	1.000	0	93.8	80	120			
Surr: 1,2-Dichloroethane-d4	0.50		0.5000		99.8	70	130			
Surr: 4-Bromofluorobenzene	0.48		0.5000		95.8	70	130			
Surr: Dibromofluoromethane	0.38		0.5000		76.8	70	130			
Surr: Toluene-d8	0.41		0.5000		82.8	70	130			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- ND Not Detected at the Reporting Limit
- P Sample pH greater than 2
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1211182**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: River Terrace Exc. 11-5-12

Sample ID **MB-4718**	SampType: **MBLK**	TestCode: **EPA Method 8310: PAHs**
Client ID: **PBS**	Batch ID: **4718**	RunNo: **6775**
Prep Date: **11/7/2012**	Analysis Date: **11/9/2012**	SeqNo: **195926** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Naphthalene	ND	0.25								
1-Methylnaphthalene	ND	0.25								
2-Methylnaphthalene	ND	0.25								
Acenaphthylene	ND	0.25								
Acenaphthene	ND	0.25								
Fluorene	ND	0.030								
Phenanthrene	ND	0.015								
Anthracene	ND	0.015								
Fluoranthene	ND	0.020								
Pyrene	ND	0.025								
Benz(a)anthracene	ND	0.010								
Chrysene	ND	0.011								
Benzo(b)fluoranthene	ND	0.010								
Benzo(k)fluoranthene	ND	0.010								
Benzo(a)pyrene	ND	0.010								
Dibenz(a,h)anthracene	ND	0.010								
Benzo(g,h,i)perylene	ND	0.010								
Indeno(1,2,3-cd)pyrene	ND	0.010								
Surr: Benzo(e)pyrene	0.44		0.5000		88.1	35.9	103			

Sample ID **LCS-4718**	SampType: **LCS**	TestCode: **EPA Method 8310: PAHs**
Client ID: **LCSS**	Batch ID: **4718**	RunNo: **6775**
Prep Date: **11/7/2012**	Analysis Date: **11/9/2012**	SeqNo: **196278** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Naphthalene	1.4	0.25	2.000	0	68.2	32.4	87			
1-Methylnaphthalene	1.4	0.25	2.000	0	71.2	36.9	86.9			
2-Methylnaphthalene	1.4	0.25	2.000	0	70.6	34.4	87.4			
Acenaphthylene	1.4	0.25	2.000	0	70.6	38.9	84.7			
Acenaphthene	1.5	0.25	2.000	0	72.6	41.7	83.4			
Fluorene	0.12	0.030	0.2000	0	61.9	27.8	72.5			
Phenanthrene	0.068	0.015	0.1006	0	67.3	31.9	79.1			
Anthracene	0.068	0.015	0.1006	0	67.3	38.8	81.2			
Fluoranthene	0.14	0.020	0.2006	0	68.7	40.9	86			
Pyrene	0.13	0.025	0.2000	0	63.9	21.4	90.4			
Benz(a)anthracene	0.012	0.010	0.02000	0	61.3	40.9	92.3			
Chrysene	0.058	0.011	0.1006	0	57.4	35.3	86.6			
Benzo(b)fluoranthene	0.020	0.010	0.02500	0	81.0	42.9	98.1			
Benzo(k)fluoranthene	0.010	0.010	0.01250	0	82.0	50.6	99			
Benzo(a)pyrene	ND	0.010	0.01250	0	78.0	39.4	105			
Dibenz(a,h)anthracene	0.019	0.010	0.02500	0	76.0	40.5	100			

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1211182**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: River Terrace Exc. 11-5-12

Sample ID **LCS-4718**	SampType: **LCS**	TestCode: **EPA Method 8310: PAHs**
Client ID: **LCSS**	Batch ID: **4718**	RunNo: **6775**
Prep Date: **11/7/2012**	Analysis Date: **11/9/2012**	SeqNo: **196278** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Benzo(g,h,i)perylene	0.019	0.010	0.02500	0	76.0	39.4	90.3			
Indeno(1,2,3-cd)pyrene	0.036	0.010	0.05002	0	72.5	39.3	94.7			
Surr: Benzo(e)pyrene	0.42		0.5000		83.1	35.9	103			

Sample ID **1211182-001AMS**	SampType: **MS**	TestCode: **EPA Method 8310: PAHs**
Client ID: **East pile**	Batch ID: **4718**	RunNo: **6775**
Prep Date: **11/7/2012**	Analysis Date: **11/9/2012**	SeqNo: **196910** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Naphthalene	16	1.2	10.00	9.299	67.9	42.9	109			E
1-Methylnaphthalene	15	1.2	10.00	7.813	71.8	45	117			
2-Methylnaphthalene	17	1.2	10.00	9.484	71.0	41.3	109			E
Acenaphthylene	9.3	1.2	10.00	0	93.3	36.1	118			
Acenaphthene	7.9	1.2	10.00	0	79.3	42.1	117			
Fluorene	0.90	0.15	1.000	0.2192	68.3	10.2	103			
Phenanthrene	1.0	0.075	0.5030	0.6478	77.0	25.5	113			E
Anthracene	0.40	0.075	0.5030	0	80.0	38.3	108			
Fluoranthene	0.84	0.10	1.003	0	83.6	28.4	121			
Pyrene	0.84	0.12	1.000	0.1207	71.7	23.6	115			
Benz(a)anthracene	0.090	0.050	0.1000	0.02709	62.9	17.5	126			
Chrysene	0.41	0.055	0.5030	0.07635	65.6	39.7	110			
Benzo(b)fluoranthene	0.12	0.050	0.1250	0.01108	86.1	38.7	114			
Benzo(k)fluoranthene	0.059	0.050	0.06250	0.003695	88.1	30.5	132			
Benzo(a)pyrene	0.061	0.050	0.06250	0.006158	88.1	43.1	115			
Dibenz(a,h)anthracene	0.11	0.050	0.1250	0	89.0	38.7	122			
Benzo(g,h,i)perylene	0.13	0.050	0.1250	0.02586	82.3	36.2	121			
Indeno(1,2,3-cd)pyrene	0.22	0.050	0.2501	0	88.5	42.5	122			
Surr: Benzo(e)pyrene	2.1		2.500		82.2	35.9	103			

Sample ID **1211182-001AMSD**	SampType: **MSD**	TestCode: **EPA Method 8310: PAHs**
Client ID: **East pile**	Batch ID: **4718**	RunNo: **6775**
Prep Date: **11/7/2012**	Analysis Date: **11/9/2012**	SeqNo: **196911** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Naphthalene	16	1.2	9.975	9.299	71.9	42.9	109	2.37	20	E
1-Methylnaphthalene	15	1.2	9.975	7.813	76.4	45	117	2.88	20	E
2-Methylnaphthalene	17	1.2	9.975	9.484	75.3	41.3	109	2.46	20	E
Acenaphthylene	9.6	1.2	9.975	0	96.6	36.1	118	3.19	20	
Acenaphthene	8.1	1.2	9.975	0	81.4	42.1	117	2.41	20	
Fluorene	0.90	0.15	0.9975	0.2192	68.5	10.2	103	0.0269	20	
Phenanthrene	1.1	0.075	0.5017	0.6478	84.9	25.5	113	3.66	20	E
Anthracene	0.40	0.075	0.5017	0	80.0	38.3	108	0.250	20	

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1211182**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: River Terrace Exc. 11-5-12

Sample ID **1211182-001AMSD**	SampType: **MSD**	TestCode: **EPA Method 8310: PAHs**
Client ID: **East pile**	Batch ID: **4718**	RunNo: **6775**
Prep Date: **11/7/2012**	Analysis Date: **11/9/2012**	SeqNo: **196911** Units: **mg/Kg**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Fluoranthene	0.86	0.10	1.000	0	86.4	28.4	121	2.98	20	
Pyrene	0.85	0.12	0.9975	0.1207	73.0	23.6	115	1.38	20	
Benz(a)anthracene	0.091	0.050	0.09975	0.02709	64.1	17.5	126	1.13	20	
Chrysene	0.42	0.055	0.5017	0.07635	67.5	39.7	110	2.18	20	
Benzo(b)fluoranthene	0.12	0.050	0.1247	0.01108	89.1	38.7	114	2.86	20	
Benzo(k)fluoranthene	0.062	0.050	0.06234	0.003695	94.1	30.5	132	5.94	20	
Benzo(a)pyrene	0.064	0.050	0.06234	0.006158	92.1	43.1	115	3.75	20	
Dibenz(a,h)anthracene	0.11	0.050	0.1247	0	91.0	38.7	122	1.97	20	
Benzo(g,h,i)perylene	0.13	0.050	0.1247	0.02586	83.3	36.2	121	0.717	20	
Indeno(1,2,3-cd)pyrene	0.22	0.050	0.2495	0	89.5	42.5	122	0.874	20	
Surr: Benzo(e)pyrene	2.1		2.494		84.2	35.9	103	0	20	

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1211182**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: River Terrace Exc. 11-5-12

Sample ID **MB-4723**	SampType: **MBLK**	TestCode: **MERCURY, TCLP**
Client ID: **PBW**	Batch ID: **4723**	RunNo: **6766**
Prep Date: **11/7/2012**	Analysis Date: **11/8/2012**	SeqNo: **195762** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	ND	0.020								

Sample ID **LCS-4723**	SampType: **LCS**	TestCode: **MERCURY, TCLP**
Client ID: **LCSW**	Batch ID: **4723**	RunNo: **6766**
Prep Date: **11/7/2012**	Analysis Date: **11/8/2012**	SeqNo: **195763** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	ND	0.020	0.005000	0	103	80	120			

Sample ID **1211182-002AMS**	SampType: **MS**	TestCode: **MERCURY, TCLP**
Client ID: **North pile**	Batch ID: **4723**	RunNo: **6766**
Prep Date: **11/7/2012**	Analysis Date: **11/8/2012**	SeqNo: **195771** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	ND	0.020	0.005000	0	100	75	125			

Sample ID **1211182-002AMSD**	SampType: **MSD**	TestCode: **MERCURY, TCLP**
Client ID: **North pile**	Batch ID: **4723**	RunNo: **6766**
Prep Date: **11/7/2012**	Analysis Date: **11/8/2012**	SeqNo: **195774** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Mercury	ND	0.020	0.005000	0	101	75	125	0	20	

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- B Analyte detected in the associated Method Blank
- E Value above quantitation range
- H Holding times for preparation or analysis exceeded
- J Analyte detected below quantitation limits
- ND Not Detected at the Reporting Limit
- P Sample pH greater than 2
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1211182**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: River Terrace Exc. 11-5-12

Sample ID **MB-4818**	SampType: **MBLK**	TestCode: **EPA Method 6010B: TCLP Metals**
Client ID: **PBW**	Batch ID: **4818**	RunNo: **6914**
Prep Date: **11/14/2012**	Analysis Date: **11/15/2012**	SeqNo: **200174** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	ND	5.0								
Barium	ND	100								
Cadmium	ND	1.0								
Chromium	ND	5.0								
Lead	ND	5.0								
Selenium	ND	1.0								
Silver	ND	5.0								

Sample ID **LCS-4818**	SampType: **LCS**	TestCode: **EPA Method 6010B: TCLP Metals**
Client ID: **LCSW**	Batch ID: **4818**	RunNo: **6914**
Prep Date: **11/14/2012**	Analysis Date: **11/15/2012**	SeqNo: **200175** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	ND	5.0	0.5000	0	112	80	120			
Barium	ND	100	0.5000	0	98.0	80	120			
Cadmium	ND	1.0	0.5000	0	102	80	120			
Chromium	ND	5.0	0.5000	0	97.2	80	120			
Lead	ND	5.0	0.5000	0	95.7	80	120			
Selenium	ND	1.0	0.5000	0	108	80	120			
Silver	ND	5.0	0.1000	0	104	80	120			

Sample ID **1211182-001AMS**	SampType: **MS**	TestCode: **EPA Method 6010B: TCLP Metals**
Client ID: **East pile**	Batch ID: **4818**	RunNo: **6914**
Prep Date: **11/14/2012**	Analysis Date: **11/15/2012**	SeqNo: **200180** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	ND	5.0	0.5000	0	105	75	125			
Cadmium	ND	1.0	0.5000	0	99.7	75	125			
Chromium	ND	5.0	0.5000	0	93.3	75	125			
Lead	ND	5.0	0.5000	0.1287	91.7	75	125			
Selenium	ND	1.0	0.5000	0	104	75	125			
Silver	ND	5.0	0.1000	0	100	75	125			

Sample ID **1211182-001AMSD**	SampType: **MSD**	TestCode: **EPA Method 6010B: TCLP Metals**
Client ID: **East pile**	Batch ID: **4818**	RunNo: **6914**
Prep Date: **11/14/2012**	Analysis Date: **11/15/2012**	SeqNo: **200181** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Arsenic	ND	5.0	0.5000	0	106	75	125	0	20	
Cadmium	ND	1.0	0.5000	0	100	75	125	0	20	
Chromium	ND	5.0	0.5000	0	93.8	75	125	0	20	
Lead	ND	5.0	0.5000	0.1287	92.4	75	125	0	20	

Qualifiers:

- * Value exceeds Maximum Contaminant Level.
- E Value above quantitation range
- J Analyte detected below quantitation limits
- P Sample pH greater than 2
- B Analyte detected in the associated Method Blank
- H Holding times for preparation or analysis exceeded
- ND Not Detected at the Reporting Limit
- R RPD outside accepted recovery limits

QC SUMMARY REPORT

Hall Environmental Analysis Laboratory, Inc.

WO#: **1211182**

28-Nov-12

Client: Western Refining Southwest, Inc.

Project: River Terrace Exc. 11-5-12

Sample ID **1211182-001AMSD**	SampType: **MSD**	TestCode: **EPA Method 6010B: TCLP Metals**
Client ID: **East pile**	Batch ID: **4818**	RunNo: **6914**
Prep Date: **11/14/2012**	Analysis Date: **11/15/2012**	SeqNo: **200181** Units: **mg/L**

Analyte	Result	PQL	SPK value	SPK Ref Val	%REC	LowLimit	HighLimit	%RPD	RPDLimit	Qual
Selenium	ND	1.0	0.5000	0	109	75	125	0	20	
Silver	ND	5.0	0.1000	0	101	75	125	0	20	

Qualifiers:

*	Value exceeds Maximum Contaminant Level.	B	Analyte detected in the associated Method Blank
E	Value above quantitation range	H	Holding times for preparation or analysis exceeded
J	Analyte detected below quantitation limits	ND	Not Detected at the Reporting Limit
P	Sample pH greater than 2	R	RPD outside accepted recovery limits

HALL ENVIRONMENTAL ANALYSIS LABORATORY

Hall Environmental Analysis Laboratory
4901 Hawkins NE
Albuquerque, NM 87109
TEL: 505-345-3975 FAX: 505-345-4107
Website: www.hallenvironmental.com

Sample Log-In Check List

Client Name: Western Refining Southwest, Inc Bloomfield Work Order Number: 1211182

Received by/date: LM 11/06/12

Logged By: Michelle Garcia 11/6/2012 10:00:00 AM Michelle Garcia

Completed By: Michelle Garcia 11/6/2012 11:18:25 AM Michelle Garcia

Reviewed By: 11/06/12

Chain of Custody

1. Were seals intact?	Yes ☐	No ☐	Not Present ☑
2. Is Chain of Custody complete?	Yes ☑	No ☐	Not Present ☐
3. How was the sample delivered?	UPS		

Log In

4. Coolers are present? (see 19. for cooler specific information)	Yes ☑	No ☐	NA ☐
5. Was an attempt made to cool the samples?	Yes ☑	No ☐	NA ☐
6. Were all samples received at a temperature of >0° C to 6.0°C	Yes ☑	No ☐	NA ☐
7. Sample(s) in proper container(s)?	Yes ☑	No ☐	
8. Sufficient sample volume for indicated test(s)?	Yes ☑	No ☐	
9. Are samples (except VOA and ONG) properly preserved?	Yes ☑	No ☐	
10. Was preservative added to bottles?	Yes ☐	No ☑	NA ☐
11. VOA vials have zero headspace?	Yes ☐	No ☐	No VOA Vials ☑
12. Were any sample containers received broken?	Yes ☐	No ☑	
13. Does paperwork match bottle labels? (Note discrepancies on chain of custody)	Yes ☑	No ☐	
14. Are matrices correctly identified on Chain of Custody?	Yes ☑	No ☐	
15. Is it clear what analyses were requested?	Yes ☑	No ☐	
16. Were all holding times able to be met? (If no, notify customer for authorization.)	Yes ☑	No ☐	

# of preserved bottles checked for pH: _____ (<2 or >12 unless noted)

Adjusted? _____

Checked by: _____

Special Handling (if applicable)

17. Was client notified of all discrepancies with this order? Yes ☐ No ☐ NA ☑

Person Notified: _____ Date: _____

By Whom: _____ Via: ☐ eMail ☐ Phone ☐ Fax ☐ In Person

Regarding: _____

Client Instructions: _____

18. Additional remarks:

19. Cooler Information

Cooler No	Temp °C	Condition	Seal Intact	Seal No	Seal Date	Signed By
1	1.8	Good	Yes			

Chain-of-Custody Record

HALL ENVIRONMENTAL ANALYSIS LABORATORY

www.hallenvironmental.com

4901 Hawkins NE - Albuquerque, NM 87109

Tel. 505-345-3975 Fax 505-345-4107

Client: Western Refining	Turn-Around Time: ☒ Standard ☐ Rush
Mailing Address: #50 CR 4990 Bloomfeidl NM 87413	Project Name: River Terrace Exc. 11-5-12
Phone #: 505-632-4135	Project #:
email or Fax#:	Project Manager: Kelly Robinson mg 11/14
QA/QC Package: ☒ Standard ☐ Level 4 (Full Validation)	Sampler: MTT & Bob
Accreditation ☐ NELAP ☐ Other	On Ice: [redacted]
☐ EDD (Type)	Sample Temperature: [redacted]

Date	Time	Matrix	Sample Request ID	Container Type and #	Preservative Type	[redacted]	BTEX + MTBE + TMB's (8021)	BTEX + MTBE + TPH (Gas only)	TPH Method 8015B (Gas/Diesel)	TPH (Method 418.1)	EDB (Method 504.1)	8310 (PNA or PAH)	RCRA 8 Metals TCLP only	Anions (F,Cl,NO_3,NO_2,PO_4,SO_4)	8081 Pesticides / 8082 PCB's	8260B (VOA) BTEX, MTBE only	8270 (Semi-VOA)	TCLP	PAH			Air Bubbles (Y or N)
11-5-12	12:45	Soil	East pile	1-8g Jar		-001			X				X			X		X	X			
11-5-12	12:50	Soil	North pile	1-8g Jar		-002			X				X			X		X	X			

Date:	Time:	Relinquished by:	Received by:	Date	Time
11-5-12		Robert Krakow			
Date:	Time:	Relinquished by:	Received by:	Date	Time
				11/6/12	1000

Remarks: Verified analysis request with Bob. mg 11/14

If necessary, samples submitted to Hall Environmental may be subcontracted to other accredited laboratories. This serves as notice of this possibility. Any sub-contracted data will be clearly notated on the analytical report.