FINAL REMEDIAL INVESTIGATION REPORT

MILWAUKEE ROUNDHOUSE

DEER LODGE, MONTANA

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List of Acronyms

ABI	Asbestos Building Inspector
ACM	asbestos-containing material
AHERA	Asbestos Hazard and Emergency Response Act
BTEX	benzene, toluene, ethylbenzene, xylenes
CFR OU	Clark Fork River Operable Unit
CECRA	Comprehensive Environmental Cleanup and Responsibility Act
cfs	cubic feet per second
CMSPP	Chicago, Milwaukee, St. Paul, and Pacific
COC	chain of custody
COPC	contaminant of potential concern
CSM	conceptual site model
CWAIC	Clean Water Act Information Center
DEQ	Department of Environmental Quality
DHHS	Department of Health and Human Services
DO	dissolved oxygen
DQO	data quality objectives
DRO	diesel-range organics
DSR	Data Summary Report
EM	electromagnetic
EPA	Environmental Protection Agency
ERA	ecological risk assessment
ft	foot or feet
ft bgs	feet below ground surface

List of Acronyms (cont.)

gpm	gallon per minute
GPR	ground penetrating radar
GPS	Global Positioning System
GRO	gasoline-range organics
GWIC	Ground Water Information Center
HHRA	Human Health Risk Assessment
HSA	hollow-stem auger
IARC	International Agency for Research on Cancer
IDW	investigation derived waste
LNAPL	light non-aqueous phase liquid
LUST	leaking underground storage tank
LVP	large volume purge
MBMG	Montana Bureau of Mines and Geology
MCA	Montana Code Annotated
MDL	Method Detection Limits
mL	milliliter
MRA	Milwaukee Roundhouse Area
MRH	Milwaukee Roundhouse
MRL	Method Reporting Limits
msl	mean sea level
MTBE	methyl tert-butyl ether
MTNHP	Montana Natural Heritage Program
NAVD 88	North American Vertical Datum of 1988

List of Acronyms (cont.)

NWI	National Wetlands Inventory
ORP	oxidation/reduction potential
OWS	oil water separator
PAH	polycyclic aromatic hydrocarbons
PCB	polychlorinated biphenyls
PID	photoionization detector
PLM	polarized light microscopic
ppm	parts per million
PRA	Passenger Refueling Area
PVC	polyvinyl chloride
QA/QC	quality assurance/quality control
ROC	Report on Carcinogens
RI	Remedial Investigation
RIWP	Remedial Investigation Work Plan
RL	reporting limits
SL	screening level
SOP	standard operating procedure
SPLP	synthetic precipitation leaching procedure
SRS	Site Response Section
START	Superfund Technical Assistance and Response Team
SU	standard units
SVOC	semi-volatile organic compounds
TCE	trichloroethene

List of Acronyms (cont.)

TCLP	toxicity characteristic leaching procedure
TEM	transmission electron microscopy
USCS	Unified Soil Classification System
USGS	United States Geological Survey
UST	underground storage tank
VI	vapor intrusion
VOC	volatile organic compounds

1.0 INTRODUCTION

This Remedial Investigation (RI) Report for the Milwaukee Roundhouse (MRH) Comprehensive Environmental Cleanup and Responsibility Act (CECRA) Facility (Facility) was prepared for the Montana Department of Environmental Quality (DEQ). The MRH Facility is listed on Montana's CECRA Priority List as a high priority. DEQ has contracted with Trihydro Corporation for the purpose of preparing the Remedial Investigation Work Plan (RIWP), conducting the RI, and preparing the RI Report. The purpose of this RI Report is to outline the procedures used for the collection and analysis of environmental samples and discuss the nature and extent of contamination at the MRH Facility in Deer Lodge, Montana.

1.1 REPORT ORGANIZATION

This Report is organized into sections that describe in detail the Facility background, the means and methods used to obtain the information necessary to meet the RI objectives, the quality, and usability of data, the results of the investigation, and the nature and extent of contamination at the MRH Facility.

Accordingly, the RI Report is comprised of the following sections:

- Section 2 – Facility History & Previous Investigations
- Section 3 – Historical Investigation Data Gaps & Data Quality Objectives
- Section 4 – Remedial Investigation Preparation and Design
- Section 5 – Sample Methods
- Section 6 – Sample Documentation, Handling and Management
- Section 7 – Decontamination and Investigative-Derived Waste
- Section 8 – Field Observations and Deviations From Work Plan
- Section 9 – Analytical Program
- Section 10 – Physical Characteristics of the Study Area
- Section 11 – Contaminants of Potential Concern Evaluation
- Section 12 – Nature & Extent of Contamination – Milwaukee Roundhouse Area
- Section 13 – Nature & Extent of Contamination – Passenger Refueling Area

- Section 14 – Contaminant Fate and Transport
- Section 15 – Conclusions and Recommendations

1.2 PURPOSE AND OBJECTIVES

The primary objective of the RI is to evaluate the nature and extent of contamination in soil, sediment, surface water, groundwater, and soil gas at the Facility using historical data and data collected under this RI. The RI was also intended to assess potential source areas to provide an evaluation of the fate and transport of contaminants originating from those source areas. Additional objectives of the RI are to provide data to support human health and ecological risk assessments and provide data to support feasibility analysis of cleanup alternatives. To achieve these objectives, groundwater, surface water, sediment, surface soil, subsurface soil, and soil gas samples were collected and analyzed. In addition, other tasks including locational surveys, site visits/inspections, aquifer testing, wetland delineation, and installation of test pits were performed during the RI.

1.3 FACILITY DESCRIPTION

The MRH Facility is located on the western edge of the City of Deer Lodge in Powell County, Montana (Figure 1-1). The MRH Facility is comprised of a northern area and a southern area, divided by the Clark Fork River, residences, and businesses. The MRH Facility is further described in Section 10.0, Physical Characteristics of the Study Area. For purposes of this RI, the southern part of the Facility is termed the Milwaukee Roundhouse Area (MRA) where historical roundhouse activities were conducted. The northern part of the Facility is termed the Passenger Refueling Area (PRA) where refueling operations occurred and the passenger depot was located.

The MRA is located primarily in the Northwest ¼ of Section 4, Township 7 North, Range 9 West (approximately 46.392464 North latitude, 112.740364 West longitude) at 4,538 feet (ft) in elevation above mean sea level (msl). Approximate MRA property boundaries and other site features are shown on Figure 1-2. The PRA is located at approximately 46.400294 North latitude, 112.739297 West longitude at 4,518 ft in elevation above msl, located in the Southwest ¼ of Section 33, Township 8 North, Range 9 West. Approximate PRA property boundaries and other site features are shown on Figure 1-3.

2.0 FACILITY HISTORY AND PREVIOUS INVESTIGATIONS

2.1 FACILITY HISTORY

The MRH Facility is the location of the former Chicago, Milwaukee, St. Paul, and Pacific (CMSPP) Railroad facility that serviced steam, electric, and diesel locomotive engines from 1908 to 1980. This facility served as the headquarters for the CMSPP Railroad's Rocky Mountain Division. The operational history and property ownership is discussed in the Data Summary Report (DSR) (DEQ 2013).

The railroad used a roundhouse and supporting infrastructure to maintain and service engines. The roundhouse was built in 1908 in the central area of what is now termed the MRA. Railroad roundhouses include a turntable and circular or semi-circular building which enables turn-around, repair, and storage of locomotive engines. The CMSPP Railroad performed locomotive engine and railroad car servicing which included storage, refueling, repair, and parts fabrication (including forging) for locomotive trains. Maintenance activities included boiler washing and repair, wreck repair, fabrication, routine car repair, and electric locomotive maintenance (Tetra Tech EMI [TTEMI] 2011). The roundhouse included drop pits below the floor surface for repairing and rebuilding freight cars, tank cars, and locomotives.

The infrastructure to support the engine maintenance was built in proximity to the roundhouse on the MRA. The MRH Facility contained above-ground and underground fuel storage tanks, pipelines, underground utility corridors, an Oil and Dope house ("dope" is a general term for a viscous chemical used in an industrial operation), a power house, depot, and other structures that supported railroad operations. According to historical schematics, the MRH Facility also included a blacksmith workshop (forge) for parts fabrication, a blacksmith and tank shop, and a wood working shop. Due to the electrification of the Milwaukee Railroad line from Harlowton, Montana to Avery, Idaho, electrical transformers may have also been present on the Facility (DEQ 2013).

The PRA portion of the Facility is north of the MRA and connected to the MRA through a track that ran south to north over the Clark Fork River. The PRA was a passenger refueling area that included a passenger depot, office, and refueling facilities for mainline transport. The PRA also contained above-ground and underground storage tanks, pipelines, and underground utility corridors. There was a historical power plant associated with the railroad and a former bulk plant located on the western part of the PRA. Figures 2-1 and 2-2 show key historical features overlaid on the current site aerial photographs.

Operations at the MRH Facility resulted in chemical impacts to soil, sediment, surface water, and groundwater. Contaminants of potential concern (COPCs) detected during previous investigations conducted from 1987 to 2012 include petroleum hydrocarbons, metals, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), volatile organic compounds (VOCs), and asbestos. Prior to the RI, DEQ indicated that additional, unidentified COPCs may exist at the MRH Facility and the impact of operations conducted after the bankruptcy of CMSPP in 1980 was unknown (DEQ 2013). Currently, ownership of the former CMSPP property includes BNSF Railway Company (BNSF), Powell County, the city of Deer Lodge, Sun Mountain Lumber, small businesses, and private individuals. The Clark Fork River Operable Unit (CFR OU), which is part of the Milltown Reservoir/Clark Fork Federal Superfund Site, is adjacent to portions of the MRH Facility. Work is being conducted within the CFR OU to address cadmium, copper, zinc, lead, and arsenic. This work is a separate project and not part of the MRH Facility RI. Figures 2-3 and 2-4 show the boundaries of the CFR OU. Some historic samples and RI samples across various media types in conjunction with sampling related to the MRH were found to be within the boundaries of the CFR OU. While discussed in this RI, these areas are not part of the MRH Facility. The sample locations from within the CFR OU boundaries are shown on Figure 2-3 and 2-4.

2.2 PREVIOUS INVESTIGATIONS AND ACTIONS

A number of investigations, interim actions, and response actions have been conducted at both the MRA and PRA portions of the MRH Facility from 1987 through 2012. These investigations and interim actions include the following:

- 1987 – Hydrometrics: Preliminary characterization of MRA identified Bunker C and confirmed presence of petroleum contamination.
- 1988 – Hydrometrics: Investigation at MRA to attempt to delineate extent of petroleum contamination.
- 1989 – Hydrometrics: Characterization of MRA fuel containment and feasibility of remedial options.
- 1990 – MSE: Additional investigation at MRA.
- 1991 – Ecology and Environment Inc.: Prescore report for ranking of Facility according to the Environmental Protection Agency (EPA) hazard ranking system. Based on previous data, no new data collected.
- 1993 – Pioneer Technical Services (Pioneer): Expanded federal superfund investigation at MRA and PRA for further evaluation using EPA's hazard ranking system.
- 1995 – City of Deer Lodge: Underground storage tank (UST) removal, City removed four USTs at PRA, 1000 gallon diesel, 1000 gallon gasoline, two 500 gallon gasoline tanks.
- 1995 – DEQ: Leaking underground storage tank (LUST) test pit investigation, DEQ completed two test pits at the PRA to assess petroleum contamination.

- 1997 – Pioneer: Investigation of Montana Exposure-Based Environmental Monitoring Data Summary Report for Inorganic Data Report included samples within the PRA campground (KOA) area on City of Deer Lodge property and within the trestle area of the MRA. The majority of the samples from this investigation fall within the CFR OU.
- 1998 – CMC Heartland Partners: Groundwater sampling.
- 1999 – Atlatl: Conducted removal action of a sump that was discharging into Tin Cup Joe Creek at the MRA.
- 2000 – Pioneer: Groundwater investigation at the MRA.
- 2000 – DEQ and City of Deer Lodge: Test pit investigation at PRA to assess petroleum contamination.
- 2003 – Tetra Tech: Work plan for City of Deer Lodge for interim remedial actions and groundwater assessment. Removal actions included sump structure, underground fuel piping, UST, fuel pump house foundation, and contaminated soil.
- 2005 – KirK Engineering: Groundwater sampling at the MRA.
- 2005 – KirK Engineering: Test pit investigation at the MRA.
- 2007 – KirK engineering: Asbestos sampling, sediment sampling from Tin Cup Joe Creek.
- 2009 – Tetra Tech: Phase I environmental site assessment at the PRA, summary of previous investigations, no new data collected.
- 2010 – Tetra Tech: Additional characterization investigation at MRA included surface water samples, test pits, surface soil, and sediment.
- 2011 – Tetra Tech: Targeted brownfield assessment for additional characterization at PRA to characterize nature and extent of petroleum and metals contamination.
- 2011 – KirK Engineering: Construction completion report detailing 2010 limited interim action to excavate metals contaminated soil and place in onsite repository.
- 2011 – Tetra Tech: Summary report of Human Health Risk Assessment (HHRA) for the MRA portion of the site, with a focus on the only Powell County property in the northern portion of the MRA. The HHRA was based on surface samples from 2005 to 2011, prior to 2011 removal actions in the northern MRA area, but after 2010 removal actions. The HHRA calculated cancer and non-cancer risk and determined that the northern MRA did not have any elevated risks associated with surface soil exposure to historical results, but that the southern portion of the Powell County's property had elevated cancer and non-cancer risk associated with two COCs: arsenic and lead.

- 2011 – EPA: Installed additional groundwater monitoring wells, product recovery trench, and product recovery wells at PRA.
- 2011 – KirK Engineering: Surface water sampling at MRA.
- 2011 – EPA: Electromagnetic survey to identify Bunker C tank at the MRA.
- 2011 – EPA: Excavation of Bunker C fuel tank and adjacent petroleum contaminated soils.
- 2012 – URS: Completed a removal report detailing the 2011 EPA Superfund Technical Assistance and Response Team (START) demolition of the Bunker C tank.
- 2012 – EPA and URS: Removed petroleum impacted soil near the confluence of Tin Cup Joe Creek and the Clark Fork River under the EPA START Contract.
- 2012 – Morrison and Maierle, Inc.: Installed two additional sentry monitoring wells for the Second Street municipal water well and conducted groundwater sampling of eight sentry wells.

The investigations, actions, and their findings are discussed in detail in the DSR (DEQ 2013). These previous investigations were primarily focused on metals impacts in surface soil, and interim and response actions generally focused on light non-aqueous phase liquid (LNAPL) hydrocarbons. These past investigations and actions were used to help develop the initial conceptual site model (CSM) discussed in the RIWP (Trihydro 2014). The resultant data gaps were the basis for the sampling performed during the RI.

2.3 DATA SUMMARY REPORT

DEQ completed a DSR in 2013 (DEQ 2013) that summarizes and evaluates existing environmental information to identify what additional data should be gathered to complete a remedial investigation for the Milwaukee Roundhouse Facility. The DSR summarizes historical assessment and interim actions and identifies data gaps that exist in characterizing the nature and extent of contamination. The DSR presents information including: legal descriptions; summary of physical characteristics; owners and operators; history of Facility operations; description of previous investigations and removal actions; comprehensive data summary of previous investigations; comparison of data to applicable screening levels; characteristics and concentrations of hazardous substances and analysis of usability of data; a format for data compilation; and a comprehensive assessment of data gaps to be addressed during RI.

Based on the findings presented in previous investigation reports and the resulting data gaps, DEQ determined that further investigation of the MRH Facility was warranted because there is a potential threat to human health and the environment. The data gaps identified are included in Section 3.0 of this report.

3.0 DATA GAPS AND RI DATA QUALITY OBJECTIVES

The DEQ-generated DSR assessed the historical investigations and results, and specified environmental information needed to complete a remedial investigation for the Milwaukee Roundhouse Facility. Based on the findings presented in previous investigation reports and the resulting data gaps, DEQ determined that further investigation of the MRH Facility was warranted because there is a potential threat to human health and the environment. Subsequently, data quality objectives (DQOs) were established for collection of additional data.

3.1 PRE-RI DATA GAPS

As summarized in Section 2.2, there have been numerous historical investigations conducted on the Facility. Some of these investigations were very focused in intent and action while others were performed with a broader scope. Historical data is useful and was evaluated to determine if there were data gaps in assessing RI objectives. Data gaps for physical characteristics and environmental setting, nature and extent of contamination, and fate and transport of contaminants of potential concern (COPCs) were evaluated and summarized in the DSR. The data gaps identified in the DSR include:

- PRA and MRA Surface and Subsurface Soil
  - Horizontal and vertical extents of surface and subsurface soil contamination due to the limited number of historical samples
  - Vertical extent of metals contamination as historical analysis for metals was primarily in surface soil
  - Characterization around former Roundhouse structures at the MRA due to limited historical sampling
- Vapor Intrusion (VI)
  - Potential for VI not previously evaluated
- Groundwater
  - Lack of seasonal groundwater data (both elevations and concentrations)
  - Groundwater flow data including limited hydraulic conductivity data
- Sediment
  - Sediments in Tin Cup Joe Creek and Cottonwood Creek were only partially characterized due to limited analytical data

- Potential subsurface sources
    - Incomplete information for much of Facility's underground structures including their historical usage and potential releases
    - Presence and condition of the UST associated with Standard Oil Bulk Plant at PRA
    - The potential for fuel pipeline and diesel unloading points at the PRA to be contaminant sources
    - The potential for the pipeline and sewer corridors at the MRA to be contaminant sources
- MRA petroleum and solvent contamination
    - Extent of diesel, Bunker C, and solvent contamination at the MRA required further definition
- PRA free product plume delineation
- Sample data and additional COPCs
    - Some historical analytical detection limits are above current contaminant screening levels
    - Potential for asbestos containing materials
    - Potential for PCB contamination

3.2 RI DATA QUALITY OBJECTIVES

DQOs identify the study objective, define the most appropriate data to collect and the conditions under which to collect the data, and specify limits on decision errors that were used as the basis for establishing the quantity and quality of data needed to support decision-making. The DQOs were defined in the RIWP (Trihydro 2014). DQOs were used to develop the RI program and provided specificity to the framework in which data was collected and the requirements that data needed to meet in order to achieve the general objectives of the RI:

- Evaluate the nature and extent of contamination in soil, sediment, surface water, groundwater, and soil gas, (including identifying potential source areas and the fate and transport of contaminants) using historical data and data collected under this RI.
- Provide data to support human health and ecological risk assessment.
- Provide preliminary data that may be used to evaluate cleanup options.

DQOs specific to the nature and extent of contamination are as follows:

- Collect additional data from environmental media including soil, groundwater, soil vapor, sediment, and surface water to further define the nature and extent of contamination at the MRA and PRA. This included horizontal and vertical delineation.
- Analyze samples for a comprehensive list of potential contaminants.
- Collect background samples for soil, sediment, surface water, and groundwater.
- Further investigate the nature and extent of LNAPL.
- Characterize the physical parameters of the unconfined aquifer.
- Investigate the presence of asbestos at the Facility.

DQOs specific to risk assessment are as follows:

- Characterize the nature and extent of contamination adequately to begin risk assessment, if appropriate.
- Characterize the various potential habitats present at the Facility so that ecological risk could be assessed if appropriate.
- Investigate the presence of animals and vegetation at the Facility and whether threatened or endangered species might live at the Facility.

DQOs specific to evaluation of cleanup alternatives and contaminant fate and transport are as follows:

- Characterize the physical parameters of the soil types present (i.e., fraction of and total organic carbon (TOC), bulk density, soil moisture, soil pH, and particle size analysis) which will affect contaminant fate and transport.
- Collect data to characterize natural attenuation processes.
- More completely characterize the nature and extent of contamination to allow for development of cleanup alternatives as part of a feasibility study.

3.3 RI COMPONENTS IMPLEMENTED TO ACHIEVE DATA QUALITY OBJECTIVES

To understand and assess the achievement of DQOs with respect to the RI, the DQOs were divided into categories dependent on their data end use. The desired DQO performance criteria are discussed below for DQOs associated with contamination nature and extent, risk assessment, and cleanup alternatives and fate and transport.

3.3.1 DATA QUALITY OBJECTIVES RELATED TO NATURE AND EXTENT OF CONTAMINATION

The DQO for the nature and extent of contamination focuses on minimizing sampling and measurement errors, which lead to decision errors. The following activities met the nature and extent DQO and control errors:

a) Sampling locations were selected based on knowledge of site history, existence of historical infrastructure, and previous sampling data.

b) A sampling approach using both grid and biased sampling elements was used. A standardized 100 foot by 100 foot grid was used to provide samples representative of the site. Additional biased sample locations were selected based on historical data, field observations, and knowledge of known and potential source areas.

c) Sample locations were selected to further delineate areas of concern identified in previous investigations, expand analyses that may have had limited quantity or quality issues, and investigate areas that were not previously investigated.

d) The groundwater sampling design used existing wells in source areas and downgradient areas and was optimized by locating new monitoring wells immediately downgradient of suspected source or contaminated areas.

e) Soil and groundwater samples were collected following procedures from the approved RIWP (Trihydro 2014) and analyzed using EPA-approved methods. Laboratory reporting limits (RLs) were sufficiently low enough to evaluate screening levels (SLs) except in cases discussed in Sections 12 and 13; in most cases RLs greater than SLs were known prior to sampling due to laboratory limitations.

3.3.2 DATA QUALITY OBJECTIVES RELATED TO RISK ASSESSMENT

The DQO for assessing risk at the Facility focuses on having sufficient soil and groundwater data of appropriate quality to be able to support human health and ecological risk assessment evaluations. The following activities met the risk-based DQO:

a) Eight to ten random (grid) samples were collected for each area (MRA and PRA) to statistically and spatially characterize exposures expected for a chronic scenario. More than 10 grids were sampled at each area. Approximately 90 and 40 grids were sampled at the MRA and PRA, respectively.

b) For groundwater investigation, samples were collected twice from each well to provide a reasonable characterization of the concentration at each exposure point. Existing wells were sampled in April and August 2014 to allow for seasonal variation. New wells installed in June 2014 were sampled upon completion in June and again during the August groundwater sampling event.

c) Decision errors were minimized through use of EPA-approved analytical methods and quality assurance/quality control (QA/QC) sampling. Results generated the highest quality data possible with RLs less than SLs whenever possible. Samples were analyzed using EPA-approved methods by accredited laboratories. QA/QC samples were collected as appropriate following the approved standard operating procedures described in the RIWP. Equipment blanks were collected daily and one blind duplicate was collected per every twenty regular samples. Tier II data validation was completed on RI data and discussed further in Section 12. Several analytes in each medium had RLs greater than SLs. These analytes were evaluated on a case by case basis and discussed further in Sections 12 and 13; in most cases RLs greater than SLs were known prior to sampling due to laboratory limitations.

3.3.3 DATA QUALITY OBJECTIVES RELATED TO EVALUATING CLEANUP ALTERNATIVES AND FATE AND TRANSPORT

The DQO for evaluating cleanup alternatives and fate and transport of contaminants also focuses on having sufficient soil and groundwater data related to the evaluation of cleanup alternatives. The following RI activities met the cleanup alternative/fate and transport DQO:

a) The minimum number of samples for analysis of physical soil parameters conditions, (i.e. TOC, soil bulk density, soil moisture, particle size analysis, and pH) was considered three at each the MRA and PRA. The RI included seven samples for soil parameters from the MRA and ten from the PRA.

b) A minimum of two groundwater sampling events was required and met. Two groundwater sampling events in April (new monitoring wells were sampled in June) and August 2014 to evaluate seasonal variations.

c) The RIWP called for groundwater from at least six wells at each area (MRA and PRA) to be evaluated for MNA parameters. The objective was met since ten groundwater samples were collected for MNA parameters at the MRA and eight were collected at the PRA.

4.0 REMEDIAL INVESTIGATION PREPARATION AND DESIGN

4.1 PRE-SAMPLING ACTIVITIES

4.1.1 GEOPHYSICAL INVESTIGATION

A geophysical survey of the PRA and MRA was planned to locate known infrastructure, infrastructure suspected to be present based on historical information, and unknown infrastructure. Typically electromagnetic (EM) conductivity instruments measure the ground conductivity of the subsurface (rocks, soil, and groundwater) and detect anomalous and ferromagnetic objects. Another common geophysical evaluation, ground penetrating radar (GPR), can delineate landfills and pathways for contaminant flow, as well as conduct hydrogeologic investigations such as water table mapping. A geophysical survey was included in the investigation to help in locating infrastructure that is known or suspected to be present, but for which the exact location was unclear.

Geolex Inc. (Geolex) was contracted to perform the geophysical survey. After completing a site visit, Geolex recommended a limited geophysical survey with EM along the north-south elevated area of the PRA to help delineate buried utilities and underground structures. Geolex recommended against performing a geophysical survey at the MRA using either EM or ground penetrating radar techniques, as large amounts of metal debris at and near the surface would likely cause significant interference with readings making data unusable.

Geolex conducted the geophysical survey in April 2014 in limited areas at the PRA using the EM-61MKII with a Trimble PRO XT receiver. The depth of investigation with an EM-61 for metal objects varies based on soil and other conditions, but is generally 5 to 10 feet below ground surface (ft bgs). The survey was performed to help identify the northern and southern extents of a fuel line, suspected USTs at the historical Standard Oil bulk plant, and an additional suspected UST. Significant amounts of metal debris stockpiled on the surface at the PRA generated interference with the survey and limited the extent of the survey. The geophysical survey at the PRA confirmed that the fuel line extended beyond what had previously been identified as the extents of the line and identified the UST just west of the elevated MRH railway bench. Trihydro was able to use this information to help adjust test pit locations at the PRA to investigate these underground structures. Geophysical results are shown on Figure 4-1. Appendix A includes the geophysical report from Geolex.

4.1.2 UTILITY CLEARANCE

Utility clearances were conducted at all locations, including surface soil sample locations, at which intrusive activity was planned, prior to that activity. The Montana One Call center was contacted after locations were preliminarily physically located in the field. A fiber optic line at the PRA received special attention with regard to clearance. As required, borings were moved to be greater than 10 ft from known underground utility locations. Borings were not located within 20 ft of an overhead utility or power line. Additionally, clearance of boreholes was based on local utility information, maps, and discussions with city/county representatives and/or property owners, as applicable. Pathfinder Utility Locating (Pathfinder), a private utility locator, was used to locate historical and private utilities at the PRA and the southern MRA. Pathfinder worked with city representatives to locate sewers and water lines at the PRA.

Some soil boring locations, especially in the southern MRA, were moved as utilities in the area could not be accurately located. Revised boring locations were evaluated as to whether they would meet the sampling objectives, and approved by DEQ. Most revised locations were moved less than 20 feet, but some were moved into adjacent grids.

4.2 SAMPLING PROGRAM DESIGN

The sampling program was designed to address data gaps identified in the DSR. It was based on a systematic, comprehensive approach to sampling the potentially impacted areas for a selected range of analytes, taking into account the previous sampling performed at the Facility. Previous samples and site history were used to target specific locations, or to reduce the sampling density or analyte list in portions of the Facility. Samples were collected for different media based on previous samples and observations as well as the characteristics of potential contamination. In media with no previous sampling such as soil vapor, the sampling approach was to investigate the areas with the greatest potential risks based on land use/building location rather than to completely delineate potential impacts. This optimized investigation resources to most effectively address existing and potential risks at the Facility.

4.2.1 BACKGROUND SOIL SAMPLES

Background surface soil samples were collected at four locations (two each at the MRA and PRA) in areas not expected to be impacted by historical releases or activities at the MRH Facility (Figures 4-2 and 4-3). Representative background soil sample locations were based on review of aerial photographs and current Facility conditions to select presumably natural, undisturbed, or non-industrialized areas such as pastures. Because of the uncertainties with whether background soil distant from the Facility is truly representative, background sample locations were selected relatively close to the Facility, but yet where Facility impacts are not expected to be present. Background soil samples were submitted for laboratory analysis of semi-volatile organic compounds (SVOCs) and metals.

4.2.2 SURFACE SOIL SAMPLES

A total of 320 surface soil samples were collected during the RI (180 samples from the MRA and 140 samples from the PRA). Surface soil samples were primarily collected based on a grid system (Figures 4-2 and 4-3). The 100 ft by 100 ft grids were used given the size of the Facility to provide a representative sample, and so that a risk assessment could be performed using the data. Sampling was focused on the portions of the Facility known or suspected to be contaminated based on previous sampling data and historical knowledge. Fewer samples were collected in the perimeter of operational areas, as well as those areas where interim removal actions have occurred. Surface soil samples were also collected from test pits that were generally associated with infrastructure or potential sources to get a complete constituent profile of the soil column.

4.2.3 LITHOLOGIC SAMPLES

Lithology was logged at each soil boring, monitoring well, and test pit. Additional lithology logging locations were selected within the grid system to provide data on extent of fill, extent of LNAPL, and other soil conditions. Lithology logging locations were occasionally sampled for laboratory chemical analysis based on the criteria identified in the RIWP (Trihydro 2014) with approval from DEQ.

4.2.4 SUBSURFACE SOIL SAMPLES

A total of 194 subsurface soil samples were collected during the RI: 125 samples from the MRA and 69 samples from the PRA. Subsurface soil samples were primarily collected using the same grid system as the surface soil samples (Figures 4-4 and 4-5). Historical subsurface sampling data was limited, so subsurface samples collected during this RI were intended to investigate the nature and extent of contamination in the subsurface soil. Sampling was focused on the portions of the Facility known or suspected to be contaminated based on previous sampling data and historical knowledge. Fewer samples were collected in the perimeter of operational areas, as well as those areas where interim removal actions have occurred. Subsurface soil samples were also collected from test pits that were generally associated with infrastructure or potential sources to get a complete constituent profile of the soil column.

4.2.5 GROUNDWATER SAMPLES

A total of 38 monitoring wells were sampled: 19 wells at the MRA and 19 wells at the PRA. Groundwater samples were collected from existing wells in addition to new wells installed to provide better facility-wide delineation of contamination. Sample locations were selected to establish upgradient contaminant concentrations, investigate potential sources, and to provide additional delineation for previously known groundwater impacts (Figures 4-6 and 4-7). Wells were also sampled for additional analytes that had not previously been analyzed. A total of 15 monitoring wells were installed during the RI: 7 wells at the MRA and 8 wells at the PRA. Groundwater samples were collected during three sampling events: existing wells were sampled in April 2014, new wells were sampled in June 2014, and each of the wells sampled in April and June was sampled again in August 2014.

4.2.6 SOIL GAS SAMPLES

Five soil gas probes were installed at four locations at the MRA, and five soil gas probes were installed at four locations at the PRA. However, due to high groundwater conditions and based on DEQ guidance (DEQ 2011), only three soil gas probes were sampled at the MRA and two soil gas probes were sampled at the PRA. Soil gas sample locations were selected based on their proximity to potential receptors (i.e., residences and occupied buildings) as well as potential sources (Figures 4-6 and 4-7). Since soil gas had not previously been sampled at the Facility, soil gas sample locations were not intended to fully delineate potential soil gas impacts, but were intended to identify if impacts could be affecting potential receptors.

4.2.7 SEDIMENT AND SURFACE WATER SAMPLES

A total of 20 sediment and 9 surface water samples were collected during the RI (10 sediment and 5 surface water samples from the MRA and 10 sediment and 4 surface water samples from the PRA). Sediment samples were collected to better characterize contamination in sediment in Tin Cup Joe Creek and Cottonwood Creek (Figures 4-8 and 4-9). Limited previous sediment samples had been collected, but did not include analysis for a comprehensive list of contaminants. Also, the possibility of sediment mobilization during high flow events led to uncertainty as to whether previous sample results represent existing sediment conditions. Surface water samples were collected to correlate with sediment concentrations, as well as to establish upstream background contaminant concentrations.

4.2.8 DOMESTIC WATER SAMPLES

Two domestic water wells outside the MRA were sampled (Figure 4-6). Well GW-7_MR93 is located upgradient of the MRA. The other well, GW-5_MR93, is located downgradient of the Bunker C area on the west side of Tin Cup Joe Creek. Access to both private wells was obtained by DEQ through contact with the individual property owners. The sample for GW-7_MR93 was collected from an outside spigot. The pump for GW-5_MR93 was not operational so the sample was collected using a peristaltic pump. The depth to water from the top of casing was 6.51 feet for GW-5_MR93 and tubing was inserted to a depth of approximately 30 ft from the top of casing. Samples were collected before any treatment systems in the water system. At both well locations, water was purged until the pH and specific conductance parameters stabilized for 3 successive readings of pH +/- 0.1 S.U. and specific conductance +/- 5%. Stabilization of both wells occurred within 20 minutes. Both wells were sampled for the standard suite of analytes as identified in Appendix B of the RIWP (Trihydro 2014).

4.2.9 LOCATIONAL SURVEYS

Surface soil, subsurface soil, test pits/trenches, and opportunistic sample locations were located in the field before and after sample collection with a mapping-grade Global Positioning System (GPS) unit. Mapping-grade GPS locates generally provide sub-foot horizontal accuracy. Vertical accuracy was not required for these locations.

Monitoring wells and soil gas probes were surveyed by Stahly Engineering and Associates, a PLS licensed surveyor in the State of Montana. Surveys were conducted in accordance with DEQ guidance on the State Superfund Frequently Asked Questions website (DEQ, 2015), which indicates that Section 37-67-301, et seq., Montana Code Annotated (MCA), and ARM 24.183.101 et seq, requires groundwater monitoring well elevations to be completed by a licensed surveyor or professional engineer registered in the State of Montana (MCA, 2014 and ARM, 2014). Vertical elevations were collected from the top of the polyvinyl chloride (PVC) well, top of the outer casing (if applicable), and the ground surface. The survey adhered to the standards identified in the ARM Subchapter: 24.183.11, Subchapter Title: Uniform Standards for Monumentation, Certificates of Survey, and Final Subdivision Plats. (http://www.mtrules.org/gateway/Subchapterhome.asp?scn=24.183.11). The survey results provide an accuracy of plus or minus 0.1 foot horizontally and plus or minus 0.01 foot vertically. The vertical control datum used to determine the elevation of the well was the North American Vertical Datum of 1988 (NAVD 88), which was referenced to a nearby U.S. Geological Survey (USGS), or equivalent, benchmark.

5.0 SAMPLING PROCEDURES

This section describes the procedures for sample collection, including sampling methods and equipment, sample preservation requirements, decontamination procedures, and management of investigation derived waste. Project personnel collected surface soil, subsurface soil, sediment, surface water, vapor (soil gas), and groundwater samples from the MRA and PRA. Procedures for the collection of soil and water samples were developed in accordance with industry standard practices and utilize current relevant regulatory guidance (EPA-817-R-08-003, OSWER 9285.7-50, and DEQ SRS guidance). These procedures were intended to provide for the collection of consistent, comprehensive, and representative samples.

The sample collection procedures described in this section were used to ensure the quality of the data and support the investigation of COPCs in soils, sediment, vapor, surface water, and groundwater. Due to the variety of different media sampled, the following sections detail the reasoning and procedures for collecting samples for the MRA and PRA RI.

Table 5-1 identifies the type of analyses, method, sample container requirements, and preservation requirements for liquid and solid matrices. Appendix B in the RIWP (Trihydro 2014) provides sampling rationale and sample collection details specific to each location. Figures and Appendix B in the RIWP (Trihydro 2014) were utilized in support of field investigation activities and for tracking purposes.

5.1 FIELD PREPARATION AND ANALYSIS

5.1.1 SIEVING OF SOIL SAMPLES

Surface and subsurface solid matrix samples collected for metals analyses were screened with a 60-mesh screen in the laboratory. The finer-grained fraction passing the sieve was analyzed for metals. Analysis of the finer-grained fraction was necessary at sample points where lead is likely to be a contaminant of concern because previous investigations across the country have demonstrated a tendency for lead contamination to be concentrated in the finer (dust-sized) fraction of soil and it is from this size fraction that most exposure to humans occurs (http://www.deq.mt.gov/StateSuperfund/FrequentlyAskedQuestions.mcpx).

5.1.2 PHOTOIONIZATION SCREENING

As indicated in the following sections for collection of surface and subsurface soil samples, screening of the headspace of soil samples was conducted with a photoionization detector (PID) (10.6 electronvolt lamp). The PID measures ionizable particles and was calibrated to an isobutylene standard to approximate petroleum hydrocarbons. The PID is sensitive to volatile organics, particularly the benzene, toluene, ethylbenzene, xylenes (BTEX) suite of gasoline. Soil samples were screened at collection with the PID; a subset of the soil samples that had measurable PID readings were then analyzed according to the standard operating procedure (SOP) in Appendix C of the RIWP (Trihydro 2014). A head space aliquot of the soil sample was collected directly from the soil sample in a small Ziploc-style bag. The bag was filled half-full with soil and sealed. The soil was then manually broken up within the bag and the soil was allowed to warm for approximately 15-minutes out of direct sunlight in a 60-80 degree Fahrenheit temperature environment (i.e. automobile). The PID was then inserted into the bag without opening the bag significantly to collect vapor measurements. The PID results, in parts per million (ppm), were recorded on the field logs for each sample depth and location. Blank (no soil) tests were performed on the Ziploc-style bags with the PID to document any impact of the bags on the PID readings.

Samples with headspace readings greater than 100 ppm were selected for analyses of VOCs. If there was more than one subsurface depth interval in a borehole with headspace readings greater than 100 ppm, the sample interval corresponding to the highest headspace reading in that borehole was selected for VOC analyses.

5.1.3 FIELD INSTRUMENTS AND CALIBRATION

Prior to use, field instruments were calibrated in accordance with the manufacturer’s specifications and the Field Instrument Calibration SOP in Appendix C of the RIWP (Trihydro 2014). Calibration was repeated at prescribed intervals according to the manufacturer’s requirements. The calibration frequency depends on the type and stability of equipment, the intended use of the equipment, and the recommendation of the manufacturer. Calibration information was recorded in a field logbook or on field forms.

5.2 ANALYTE-SPECIFIC SAMPLE COLLECTION METHODS

This section briefly discusses analyte-specific sample collection methods. Sample collection methods for the different media are described in subsequent sections. Detailed discussion of the sample collection methods is available in the RIWP (Trihydro 2014).

5.2.1 VOCS

Soil samples were collected using PVC liners in a core barrel with a direct push drill rig or by directly filling 4-oz glass jars with sample material. When collecting direct push soil samples, sample portions for VOC analysis were collected by capping the soil-filled PVC liner with Teflon-sealed caps on both ends. When soils were directly placed into 4-oz glass jars, the jars were completely filled to minimize headspace and the jar was capped with a Teflon-lined lid. Solid-phase media to be analyzed for VOCs was collected prior to the collection of other analytes. The procedure for soil sample collection of contaminants is described in the Direct Push Soil Sample SOP in Appendix C of the RIWP (Trihydro 2014).

5.2.2 ASBESTOS-CONTAINING MATERIAL (ACM)

A Trihydro Montana-licensed Asbestos Building Inspector (ABI) was on-site during the performance of field activities. The ABI examined the ground surface in the vicinity of proposed boring and test pitting locations to evaluate for the presence of suspected ACM. Task managers, geologists, field engineers, and sample technicians performing analysis and sample collection were also trained in MT Asbestos Control Program's Asbestos Awareness to aid the ABI in assessing potential for ACM. If field personnel encountered potential ACM, work activities were halted and the ABI was brought in to assess the situation.

The ABI inspected the areas to be investigated at the MRA in advance of soil disturbing sampling activities. The ABI identified and assessed suspect material for friability and collected bulk samples of suspected ACM in accordance with the EPA Asbestos Hazard and Emergency Response Act (AHERA 40 CFR 763, Subpart E) protocols. Collected samples were analyzed by an accredited laboratory using EPA method 600-R-93-116, Method for the Determination of Asbestos in Bulk Materials (1993) as noted in Appendix B.

Results of analysis indicated some building materials scattered on the ground surface of the MRA contained asbestos. Abandoned asbestos-cement pipes were also encountered at the MRA and PRA. Site personnel avoided suspected ACM following the ABI's inspection. Work was able to proceed at planned locations. Asbestos-cement pipes that were removed from excavations were bagged and disposed of as ACM.

5.3 SURFACE SOIL SAMPLES

Surface soil samples were collected from the MRA and PRA. Surface soil is considered to extend from 0 to 2 ft bgs, although subintervals within this depth range were collected. For the majority of the PRA and MRA, collection of surface soil samples typically followed the methods described below for standard collection. However, surface soil samples collected in residential/business yard areas and the BNSF active rail line followed the methods described in their respective subsections.

5.3.1 STANDARD COLLECTION

Surface soil samples were collected from subintervals within a range of 0 to 2 ft bgs at the MRA and PRA. Soil samples collected from 0-0.5 ft bgs were collected as a five-point composite sample from within each proposed

100-foot grid, as discussed below, unless specifically intended as discrete samples for investigation of specific potential sources. Samples collected from 0.5-1 ft and 1-2 ft bgs were collected as discrete samples.

Direct push samples were collected using PVC sleeves inside the direct push sampler. The appropriate interval of the sleeve was cut, labelled, and sealed with Teflon-lined caps. If additional sample volume was needed to complete the suite of analyses, additional samples were collected from co-located borings within approximately 2 feet of the original boring. This sampling procedure minimized the field handling of the samples and allowed for sample compositing in the laboratory. If the proposed sample was located in an area that was either vegetated, or contained duff or surface gravel, the organic material or gravel was first removed and the sample was collected immediately below this layer. Additional co-located samples were collected for sample logging and PID analysis.

Some sample locations including test pits and surface soil sample locations that were inaccessible to the direct push rig were sampled by filling 4-ounce glass jars by hand. Test pit and surface soil samples from 0-0.5 ft bgs were collected using a clean stainless steel hand trowel to fill the sample jars.

Proposed sample locations were uploaded into a mapping-grade GPS, which was used for flagging locations in the field. Final sample locations were determined in the field based on site features or utility locates. During sample collection, locations were recorded using a handheld mapping-grade GPS.

Where soil borings were not being completed as wells, the open borehole was backfilled with bentonite chips or pellets to a depth of approximately 6 inches bgs. Surrounding surface materials were used to backfill the top 6 inches, if possible. Otherwise bentonite was used to backfill to the surface. Boreholes in pavement were resurfaced with asphalt to match the surrounding material. Minimal soil wastes were generated during surface soil sampling. Soil wastes were collected and stored as investigation derived waste (IDW) as described in Section 7.

Composite Samples

Surface soil samples from 0-0.5 ft bgs were collected as a five-point composite surface sample from within each proposed 100-foot grid. Aliquots were spaced throughout the grid to provide a representative sample of each grid. Individual aliquots were collected in PVC liners using a driven sampler, sealed with Teflon-lined caps, and were composited by the laboratory prior to appropriate analysis.

5.3.2 RESIDENTIAL YARDS AND CHURCH PROPERTY

Residential and the church properties were sampled for surface soil contamination in accordance with the Superfund Lead-Contaminated Residential Sites Handbook (EPA 2003). For each property, sampling locations were identified in the field in conjunction with DEQ personnel to confirm that the sample composite locations met requirements. The locations were flagged in the field at that time. Utility locates required the minor adjustment of some locations.

The surface soil sampling methods described in the Sections 4.4.3.1 and 4.4.3.2 of the RIWP were followed. The residential/church yard samples differed from standard surface soil samples as five-point composite samples were collected from each property, rather than each 100-foot grid. For each sample submitted for analysis, the locations of the five aliquots were intended to be roughly equidistant from each other, and provide reasonable coverage of the sampled area. The aliquots were composited and sieved by the laboratory as described in Section 4.4.3.1 of the RIWP.

If there was a building on the property, an additional drip zone sample was collected. A drip zone sample was a four-point composite of surface soil, in which the aliquots are taken from the surface soil at rain gutter downspout discharge locations if present, or alternately at a location between 6 and 30 inches away from each side of the structure. These four drip zone aliquots were then composited at the lab in the same manner as the five-point composite samples. The drip zone samples were analyzed for metals only.

The division of the residential/church lots into sample sections was dependent upon lot size; lots with a surface area less than 5,000 square ft were generally sampled in the front yard, back yard, and drip zone. No residential lots were larger than 5,000 square ft. A children’s play area at the Depot Church was treated as an additional discrete area of the yard, with an additional five-aliquot sample taken from that area.

Surface soil samples from residential/church properties were collected from 0 – 6 inches, 6 – 12 inches, 12 - 18 inches, and 18 – 24 inches bgs. The uppermost horizon were sampled for the standard suite of analyses, and the other horizons were sampled for metals only, as VOC contaminant sources in these areas are anticipated to be surface sources, or subsurface sources below 24 inches bgs. Each depth interval was composited across the sample area.

5.3.3 BNSF RAILWAY COMPANY (BNSF) PROPERTY

Surface and subsurface soil samples were collected from the BNSF property and right-of-way (ROW) to evaluate the extent of the contamination associated with the MRH Facility. These sample locations, along with the approximate extent of the BNSF ROW, are identified on Figures 4-2 through 4-5 for the MRA and PRA respectively. Surface soil samples from 0-0.5 ft bgs were collected as five-point composite samples from just outside the railroad ballast, consistent with the sample collection methods and type of samples collected elsewhere for this RI. Samples from a total of 15 randomly generated 100-ft linear grid sections across the PRA and MRA were collected from 0-0.5 ft bgs and analyzed for metals as identified in Appendix B, Tables B-3 and B-8 of the RIWP (Trihydro 2014). This random grid selection provides a representation of the soil conditions across the active rail line. Similar to the previous general surface soil samples section, 4.4.3.1 of the RIWP, a subset of the surface samples also had samples collected as discrete samples from 1-2 ft bgs. The surface soil sampling was for the collection of soil (not ballast) on the property.

In addition to surface soil samples, railroad ballast samples were collected by hand. These railroad ballast samples were 5-point composite samples with two aliquots collected on the east side of the tracks, two aliquots on the west side, and one in the center along a 100-ft linear section of track (Figures 12-69 for MRA and 13-58 for PRA). Railroad ballast samples were collected in 15 randomly generated 100-ft linear grid sections, 25% of the grid areas from across both the MRA and PRA for analysis. Figures 12-69 and 13-58 indicate the railroad grid sections and the 15 randomly selected sample locations. Railroad ballast samples were collected from the near surface environment (0-0.5 ft bgs) at each aliquot location. Samples of ballast below 0.5 ft bgs were not collected. Ballast samples were analyzed for VOCs and SVOCs (Appendix B, Table B-11 of the RIWP) (Trihydro 2014).

5.4 SUBSURFACE SOIL SAMPLES

Subsurface soil samples were collected from the MRA and PRA. Subsurface samples were collected from below 2 ft bgs to the smear zone/capillary fringe. Subsurface samples were collected as discrete samples. Four methods of subsurface soil sampling were performed during the RI: direct push continuous sampling, hollow-stem auger (HSA) with split-spoon sampling, hand auger sampling, and test pitting.

Subsurface samples were collected as discrete samples. Subsurface samples collected as soil borings were generally collected from the center of each 100-foot grid. The depth of the collection of subsurface soil samples followed the general guidance provided in the RIWP Section 4.4.4.

The presence of potential impacts at the smear zone (visual impact, odor, PID readings) was noted within each subsurface borehole regardless of whether a sample was collected for laboratory analysis. Each boring core was screened at 2-ft intervals using a PID and the results were recorded on the sample logging forms.

5.4.1 SUBSURFACE BORINGS AND DRILLING

Subsurface soil samples were collected from the identified grid locations co-located with surface soil sample locations. Direct-push continuous sampling was used at locations not proposed to be completed as monitoring wells. HSA was used to install groundwater monitoring wells. Continuous soil cores were logged using the Unified Soil Classification System (USCS) in both cases. Observations of odor, LNAPL, visual staining, or evidence of sources were noted in lithology logs. Appendix C includes the RI lithology logs for soil borings, test pits, well installations, and soil gas installations.

Discrete subsurface samples were collected using direct-push continuous sampling. Sample depths were dependent on the sample location and subsurface conditions as described in Section 4.4.4 of the RIWP (Trihydro 2014). Samples were collected following the procedures specified in the RIWP. Reusable sampling devices were decontaminated between sampling locations to avoid cross-contamination as discussed in Section 7. Where sample locations were not being completed as wells, the open sample borehole was backfilled with bentonite chips or pellets to a depth of approximately 6 inches bgs. Surrounding surface materials were used to backfill the top six inches. Boreholes in pavement were resurfaced with asphalt or concrete to match the surroundings. Minimal soil wastes were generated during soil sampling and collected and stored as IDW as described in Section 7.

HSA drilling was used to install monitoring wells. Continuous split-spoon samples were collected, as needed, from surface to the unconfined groundwater table. Direct push drilling was used to install soil vapor monitoring points. Samples were typically not collected during soil gas probe installation and the lithology and samples were collected at co-located well or lithology locations.

5.4.2 SUBSURFACE TEST PIT ACTIVITIES

Test pits were used to investigate the historical subsurface infrastructure and surface and subsurface soil immediately surrounding the infrastructure. The use of test pits and visual observation with documentation allowed the development of a more complete understanding of the potential sources and the nature of the releases from those sources than could be obtained from discrete direct push samples. The nature of the infrastructure, releases/contamination, and soil material were visually observed over a greater distance and area. For example, the ability to see larger, visually impacted soils near pipelines and along a concrete wall foundation was afforded with test pit activities. A greater exposed subsurface area allowed representative samples to be obtained.

General test pit locations are identified in Figures 4-2 and 4-3 for the MRA and PRA respectively. Planned test pit locations were based on past historical data and former facility structures and potential sources. The exact field locations varied slightly from the RIWP based on observations in the field. Test pits were dug with a backhoe (or trackhoe) to expose the lithology, potential relic structures, or piping, and for soil sample collection. The backhoe exposed an area from the surface soil to the unconfined water table. The unconfined water table is located approximately surface to 12 ft bgs depending on the location and season. Soil was logged using the USCS to understand the subsurface lithology. Observations of odor, visual staining, or evidence of sources were noted in field logs. Removal of relic structures or piping was not conducted as part of this RI. The surface was returned to a condition similar to the surroundings.

Test pit soils were segregated accordingly when brought aboveground: 0 to 2 foot soils were placed in one location, 2 to 6 foot soils were placed in a separate location, and 6 to 12 foot placed in another location. Test pits were backfilled with the soil removed from the test pit. When backfilling, the soils were placed in their original depth interval to avoid cross contamination of intervals. The backhoe bucket was decontaminated between test-pit locations.

5.5 POTENTIAL SOURCE AREA INVESTIGATIONS

Several potential source areas were identified prior to the RI. Test pits and soil borings were used to investigate potential source areas across the MRH Facility. Visual signs of impacts or staining were noted and soil samples were collected from the test pits and borings.

At the MRA the potential source area investigations centered around the roundhouse foundation, the former power house foundation, and the area north of the roundhouse foundation where several utilities, drain pits, and other infrastructure were historically located. Historical structures are shown on Figure 2-1. Fuel lines, industrial sewer/drain/stormwater lines, a solvent UST, drip pans, cinder pit, the area of the former Bunker C tank, a landfill, metals-impacted fill, and foundations for other historical infrastructure (the Roundhouse, Oil and Dope House, Power House, Blacksmith Workshop, Maintenance Facility, and Oil House) remain in place and are potential sources of contamination to surrounding soil and groundwater.

At the PRA, fuel lines, oil sumps, refueling stations, fuel pump house, possible remnants of a Standard Oil bulk plant, and other historical infrastructure remain in place and were investigated as potential sources of contamination to surrounding soil and groundwater. Historical structures are shown on Figure 2-2. Concrete pads with cutoff riser pipes were identified as possible refueling areas to the north and south of the depot and correspond with historical fuel lines. Test pitting was performed around these pads. Metals-contaminated fill is also present at the PRA and may be a source of metal impacts to groundwater. Some areas that lie immediately west of the PRA lie within the Clark Fork River floodplain and may have soils contaminated by deposited metals during flooding events. This area is being addressed as part of the CFR OU. A bulk plant to the east of the PRA was identified as a potential source area during the RI by Trihydro and DEQ. A direct-push drill rig was used to perform step-out soil sampling east of the BNSF ROW.

5.6 SEDIMENT AND SURFACE WATER SAMPLES

Sediment and surface water samples were collected from Cottonwood Creek and Tin Cup Joe Creek. Sample locations were selected based on potential migration from groundwater or soil to nearby locations (Trihydro 2014). These selected surface water locations were uploaded to a mapping-grade GPS, which was used to locate each sampling location in the field. Final sample locations were adjusted as needed due to accessibility based on site features and were recorded with the GPS. Sample collection began at the furthest downstream sample point and continued upstream. Samples were analyzed according to analyses indicated in Appendix B of the RIWP (Trihydro 2014).

Surface water samples were collected from Cottonwood Creek and Tin Cup Joe Creek by submerging the sample bottles directly in the water if a preservative was not already introduced into the sample bottle. If preservative was present in the sample bottle, a separate clean, non-preserved sample bottle was used to collect the sample and transfer the sample to the preserved bottles. Parameters for surface water samples were collected by placing the YSI water quality meter directly in the creek. Surface water samples co-located with sediment samples were collected before the sediment samples so as not to affect the turbidity of the surface water samples. Surface water samples were collected in accordance with the surface water sampling SOP included in Appendix C of the RIWP (Trihydro 2014).

Generally, sediment and surface water sample locations were co-located with each other. Sediment samples were collected using a stainless steel trowel to fill 4-ounce glass jars with sediment material from the creek bottom. Sediment samples were collected from about 0-0.5 ft bgs. Sediment was collected and brought to the water surface so as to minimize the loss of fine-grained material. Excess water was drained as necessary and the sample transferred into the soil sample jars. Sediment collection procedures were in accordance with the EPA Region 8 Sediment Sampling SOP (Appendix C of the RIWP).

5.7 GROUNDWATER SAMPLES

Groundwater samples were collected from new and existing monitoring wells within the shallow aquifer of the MRH Facility. This section explains the new monitoring well installation, water level and LNAPL measurements, groundwater sample collection, and groundwater hydraulic testing procedures. Samples from existing wells were collected during April 2014, and samples from new wells were collected during June 2014. Each well sampled during the April and June sampling events was also sampled during August 2014.

5.7.1 MONITORING WELL INSTALLATION

Fifteen new groundwater monitoring wells were installed (seven at the MRA and eight at the PRA). The new groundwater monitoring wells were installed with HSA drilling methods to a maximum depth of approximately

19 ft bgs, which is within the unconfined groundwater unit at the Facility. As discussed in Section 5.4.1, split-spoon soil samples were collected during advancement of the boreholes. Boring logs were maintained and continuous soil cores were logged using USCS. A PID was used to collect routine headspace samples as described in previous sections. Groundwater wells were constructed according to specifications of the RIWP (Trihydro 2014). Boring logs and well completion logs are provided in Appendix C.

The groundwater monitoring wells were constructed in accordance with State of Montana monitoring well standards, including the following:

- Sections 37-43-101 to 402, MCA (provides regulations and licensing for drillers and well installers)
- ARM 36.21.701to 36.21.810 (requirements for licensing and construction standards for drilling and installation of wells)
- Section 85-2-516, MCA (requirement for driller to file a well log with the Montana Bureau of Mines and Geology [MBMG])

Monitoring wells were drilled by Ed Boland Construction and Drilling, Inc., a Montana licensed installer. Trihydro confirmed that the well driller filed the appropriate well logs with the MBMG.

5.7.2 WATER LEVEL AND LNAPL MEASUREMENTS

Prior to groundwater sampling, water levels and LNAPL levels and thickness were measured for each monitoring well location in accordance with FS003-Fluid Level Measurement SOP included in Appendix C of the RIWP (Trihydro 2014). An interface probe was used to determine the depth to LNAPL (if applicable), depth to water, and total depth for each groundwater monitoring well to be sampled. No monitoring wells to be sampled had LNAPL present. The fluid level measurements were recorded to within 0.01 foot. These measurements were used to examine the unconfined aquifer potentiometric surface and gradients at the MRA and PRA.

Existing and new wells to be sampled were developed prior to sampling. A surge block was lowered and raised in each well for approximately 10 minutes. Following surging, 10 well volumes were purged from the well using a portable submersible pump. Sampling was not initiated within 24 hours after development to allow for each well to reach equilibrium conditions.

5.7.3 GROUNDWATER SAMPLE COLLECTION

Groundwater samples were collected from existing and newly installed monitoring wells at the MRA and PRA. Groundwater samples were collected from monitoring wells without observed LNAPL using low-flow sampling methods in accordance with FS001-Low Flow Sampling SOP included in Appendix C of the RIWP. Using a low-flow pump and dedicated tubing for each well, each well was purged prior to sampling. Purging was conducted at a rate of approximately 0.1 to 0.5 liters per minute (L/min). Water levels were measured during purging to confirm that minimal (less than approximately 0.3 foot) drawdown occurred. Following completion of purging, the flow-through multi-meter cell was removed and groundwater samples collected for the location. Samples collected for dissolved metals analysis in water were field filtered using a 0.45 micron filter. Samples collected for analytical parameters other than dissolved metals were not filtered.

During the April and June sampling events Trihydro collected groundwater samples using a peristaltic pump. DEQ guidance (DEQ 2005) suggests that VOC and dissolved metals samples should not be collected using a peristaltic pump (particularly in wells deeper than 10-15 feet), so samples were collected during the August sampling event using a bladder pump. In order to assess site-specific concerns between peristaltic low-flow sampling and bladder-pump low-flow sampling, in August additional samples were collected from two wells using both pumps, and the results were compared to evaluate if the peristaltic pump may have affected the groundwater sampling results. The comparison is included in Appendix D. Based on the results of this testing, the sampling by the two methods appears to be comparable at this Facility.

5.7.4 GROUNDWATER HYDRAULIC TESTING

Following installation of new wells and development, field testing of hydraulic conductivity was conducted at selected groundwater well locations at the MRA and PRA. Five monitoring wells at the MRA and four monitoring wells at the PRA were selected for groundwater hydraulic testing based on the diversity of geographic locations, the drill logs, and the proximity to source zones. Single well, slug-out Bouwer and Rice hydraulic conductivity tests were used to evaluate the hydraulic parameters for the site conceptual model (Appendix E). Slug tests have the advantage that they can be performed quickly and accurately in a single well location that does not have nearby piezometers or monitoring wells.

The depth to water was recorded in each well prior to performing the slug test. A pressure transducer was installed below the water level in each well to record the depth to water during the test, utilizing the initial water level as the reference. A 1.5 inch by 36 inch polyethylene bailer was used to remove a slug of about 3 ft of water. At the start of the test, the slug of water was rapidly removed from the well and the transducer was used to measure the depth to water for approximately 2-3 minutes, which was the time it took for the water level to reach at least 90% of its original level. The hydraulic conductivity was calculated for each monitoring well tested and the average of the tests used for the area.

5.8 SOIL GAS SAMPLES

Soil gas samples were collected from newly installed soil vapor gas points. Figures 4-6 and 4-7 show the locations of the new soil gas points for MRA and PRA. Soil gas points were installed near potential receptors as outlined in the RIWP, Section 4.3.5 (Trihydro 2014).

The soil gas probes are immediately adjacent to groundwater monitoring wells to help correlate groundwater and soil gas contaminant concentrations. The soil gas probes are nested at discrete depths to assess potential migration to surface as well as vadose zone attenuation. The soil gas probes were installed at two depths, if possible: just below 5-ft bgs to assess the upper area of soil gas contaminant concentrations and just above the smear zone to assess the worst case of soil gas contaminant concentrations just above the high water level. The high water level and smear zone were determined by analysis of past historical data for each area, if available, and by field assessment of the saturation of soil cuttings/samples along with evidence of contamination (elevated PID readings, LNAPL presence, staining, etc.).

5.8.1 SOIL GAS PROBE/WELL INSTALLATION

Soil gas probes were installed with a direct push drill rig. Two soil gas probes were installed in one borehole, but were separated by bentonite seals to allow for sampling from discrete intervals. The soil gas probes are constructed of a stainless steel screen, approximately 6-inches in length, and connected to the ground surface using ¼-inch Teflon tubing. A ¼-inch, stainless steel, compression-fit ball valve is attached to the top of each probe so that the probes remain closed except during testing and sampling activities. Each probe is labeled with its associated probe name and depth.

Probes were installed at a shallow depth of about 5-ft bgs and a greater depth at/near the potential smear zone at 8-10 bgs. Depending on the water level only the upper probe was installed in several cases.

Leak testing of soil gas probes tests the integrity of the surface seal and verifies the connection between the sample container and subsurface probe. Soil gas probes were installed with a direct push rig and those that were completed with screens above the water table were leak tested between 30 minutes to 2 hours after completion of the installation. Leak testing included the introduction of helium at the surface while pumping 3 or more volumes of subsurface gas and comparing the surface and subsurface helium concentrations. Per DEQ request, each soil gas sample location was leak tested after installation, but also leak tested with helium prior to each sampling event. Section 4.7 in the Montana

Vapor Intrusion Guide (DEQ 2011) provided guidance on leak testing procedure and leak testing was documented on the field forms.

During sample collection these locations were recorded in the sampling log and located via a handheld mapping-grade GPS. Soil gas probes were surveyed at the same time as the monitoring wells.

5.8.2 SOIL GAS SAMPLE COLLECTION

As discussed in Section 5.8, soil gas sample locations were selected and installed based on their locations near potential receptors and/or potential volatile impacts in soil or groundwater. Rationales for each location are outlined in Appendix B-1 of the RIWP (Trihydro 2014). Samples from these locations provide the results to evaluate potential migration of volatile contaminants through the vadose zone at the Facility. Samples were collected during the initial investigation in May 2014 and during the August 2014 groundwater sampling event.

The soil gas samples were collected as grab samples using gauges and 6 Liter summa canisters which were certified as "clean." Each soil gas point was purged prior to being connected to a dedicated summa canister. Sampling was performed at less than 200 milliliters (mL)/min to ensure appropriate capture of VOCs from the subsurface. Once the canister was filled, the summa canister was closed, labeled, and stored/shipped according to lab instructions. Soil gas was sampled for VOCs and Air Phase Petroleum Hydrocarbons with EPA Method TO-15 low-level as described in Section 5.

Eight soil gas probes were installed at the MRA and PRA, four at each area. However, two locations at each area were not sampled for soil gas due to high groundwater that impeded the most shallow soil gas depth probe. On the PRA, SG-208 and SG-209, which are within the city of Deer Lodge ROW near the southern end of the city shop and within the southeast corner of the city shop fenced area were not sampled. Additionally, the deeper soil gas probe at SG-206, SG-206D, was also not sampled due to groundwater present at that depth. On the MRA, SG-104 and SG-105 were not sampled due to groundwater more shallow than the soil gas probe depths in that area (<5 ft bgs). The soil gas probes below the water table (SG-104, SG-205, SG-206D, SG-208, and SG-209) have not been leak-tested.

6.0 SAMPLE DOCUMENTATION, HANDLING, AND MANAGEMENT

Sampling activities were documented in the field logbook and field forms to verify that they were conducted in accordance with this RIWP, or to record deviations. (Note: Deviations from the RIWP required for sample collection were discussed with the Trihydro Project Manager and the DEQ Project Officer for approval prior to implementing the deviation). Procedures for completing the sample documentation and procedures for control of custody and sample shipment are described in the following subsections.

6.1 SAMPLE IDENTIFICATION

A unique sample identification number was assigned to each sample collected at the MRH Facility. The sample identification numbering system is designed to be compatible with Trihydro's Project Direct system that includes results from previous investigations conducted at the MRH Facility. The sample numbering system allows each sample to be uniquely identified, and provides a means of tracking the sample from collection through analysis.

Each sample was assigned an alpha-numeric identification number, where the first alpha characters (QQ) indicate the sample type, the second three alphabetic characters identify the sample as either from the MRA or PRA, the next four numeric characters (XXXX) identify the location number (either a monitoring point for groundwater, surface water, and soil gas probe or the grid number for a soil sample), and the interval code (CCC) indicates the interval that the sample is intended to delineate such as the vadose zone, the smear zone, etc. The final numeric characters (ZZ-ZZ) designate a sample depth in ft for a soil sample or soil gas sample.

Sample Type	**Location**	**Number**	**Interval Number (Soil Sample Only)**	**Sample Depth (Soil/Sed/Soil Gas)**
QQ	MRA	XXXX	CCC	(ZZ-ZZ)

Possible sample types (QQ) include:

- OT – Other
- SB – Soil Boring
- SD – Sediment
- SG – Soil Gas
- SL – Sludge

- SS – Surface Soil
- SW – Surface Water
- TP – Test Pit
- W – Waste

Unique location numbers were assigned for proposed sample locations, as follows.

- MRA – Use MRA as the initial 3 letters for the location number followed by:
    - Surface water: SW101-SW199
    - Sediment: SD101-110
    - Soil Gas: SG101-SG199
    - Soil: Grid location from Figure 4-2
- PRA – Use PRA as the initial 3 letters for the location number followed by:
    - Surface water: SW201-299
    - Sediment: SD111-120
    - Soil Gas: SG201-299
    - Soil: Grid location from Figure 4-3

Existing groundwater monitoring wells, industrial wells and residential wells sampled as part of this investigation maintained their original monitoring well designation as presented in the figures in this RI and the DSR.

The sample number (ZZ-ZZ) for soil samples pertains to a specified depth interval sampled to facilitate interpretation, as defined in Appendix B of the RIWP. Sample collection depths were recorded on sample logs, in addition to the sample name.

The field QC samples for this investigation include field analytical duplicates, equipment rinsate blanks, and trip blanks. Each QC sample was delineated by the station type, followed by the date and the numerical number of QC samples. For QC samples, the station types include:

- QW – Quality water sample as duplicate or rinsate blank
- QS – Quality soil sample as duplicate

- QG – Quality soil gas sample as duplicate
- QT – Trip blank

An example of a QC sample for a duplicate of a groundwater analysis on January 1, 2014 would be QW-20140101-001. A log of QC samples was maintained for each day, and was kept separate from the sampling chain of custody (COC) so that the lab received the QC samples as a blind sample.

6.2 FIELD SAMPLING DOCUMENTATION

Field forms were used to augment the field log book to document the above-described data collection activities. Documentation includes the date of sampling, sample location, sample identification, and borehole, test pit, and sample observations. Deviations from the procedures described in the RIWP were noted on the field forms. Entries made in forms and logbooks were made in indelible ink. A single line was used to cross out incorrect information and the change initialed and dated by the sampler. Photographs were used to substantiate and augment the field notes. Photographs contained a date/time stamp and were also noted in the field logbook.

Field documentation was checked for completeness. Field sampling logs, forms, and COC were reviewed; identification of field duplicates were verified; and signatures and dates of field personnel and the laboratory sample custodian were checked. If inconsistencies or issues were identified during the review, the records were verified by field personnel and corrected. Inconsistencies or issues noted during the field documentation and procedures review required implementation of corrective measures and 100% validation of field records. Corrective measures were implemented based on the determination of the QA manager and the Trihydro Project Manager.

6.3 SAMPLE CUSTODY AND SHIPPING PROCEDURES

The following procedures were used to document sample custody, provide accurate analytical parameter request information, and provide that samples arrive at the laboratory intact and within prescribed holding times:

- Members of the sampling team were responsible for the care and custody of the samples collected until the samples were relinquished to the laboratory. A sample was under custody if it was in the possession of a sampling team member or in his/her view, or if the sample was in the possession of the sampling team, and then placed in a secure holding or storage area.
- COC forms were completed in the field and accompanied each cooler to the laboratory. The forms included the name and address of the laboratory, sample ID names, dates and times of sample collections, sample type or matrix, number of containers, analyses to be performed, applicable analytical methods, special preservation, or

handling information and the name of the sampler. The COC forms were legibly completed using ink, and were signed by the sampler.

- Samples were packed to remain cool and intact during transit to the laboratory. Sample containers were packed securely in coolers to minimize the potential for breakage during transport. Packing materials, such as polyfoam and bubble wrap, were used to protect sample containers in the cooler. The coolers and containers were sealed with a custody seal for transport to the laboratory, as described below.
- Sample deliveries were accompanied by a completed COC form. When transferring samples, the individuals relinquishing and receiving them signed, indicated the date, and noted the time on the COC. The COC documents the sample custody transferred from the sampler to the laboratory; the original custody record accompanied the sample delivery and a copy was retained by the field sampling team for reference. Upon arrival at the laboratory, internal custody procedures were followed in accordance with the laboratory QA manual.
- To provide a means of detecting potential tampering during transport, signed custody seals were attached to the cooler or shipping container in a manner which would indicate tampering.

7.0 DECONTAMINATION & INVESTIGATION DERIVED WASTE

7.1 DECONTAMINATION

Sampling equipment that was not expendable was thoroughly decontaminated prior to use. The sampling devices were decontaminated in the field prior to sampling. Non-disposable field equipment was decontaminated as follows. Equipment was first wiped with paper towels to remove as much material as possible. It was then washed in tap water with Alconox (or similar detergent) and then tap water. The equipment was then rinsed with deionized or distilled water. The equipment was either air- or towel-dried and placed in a plastic bag until it was used. Equipment was decontaminated between sampling locations to avoid cross-contamination. Appropriate equipment blank samples were collected from the decontaminated sampling equipment used during collection. A daily equipment blank was performed for any day of the investigation in which equipment was decontaminated and reused in the field.

The tooling for the direct push and drill rig was clean and free of contamination prior to arrival onsite. Downhole equipment was decontaminated between borings. Split spoons, macrocore, or other types of reusable samplers were decontaminated after each sample was collected. Decontamination was completed by dry scrubbing soil from equipment and wet scrubbing with detergent and/or pressure washing remaining soil or contamination. Additional use of a biodegradable solvent, such as Simple Green™, was used before an Alconox cleaning if the tooling contained NAPL residual resistant to decontamination. Sampling equipment was rinsed with deionized or distilled water. Other drilling equipment was rinsed with clean tap water or deionized/distilled water.

7.2 INVESTIGATION DERIVED WASTE

Soil wastes from the installation of subsurface borings and groundwater monitoring wells were collected and drummed. IDW for each area of the Facility was stored inside the locked security fence at the MRA.

Drums were stored with a layer of plastic for secondary containment between the drums and the ground surface within a timber-bermed area until disposal. A total of twenty 55-gallon drums were filled with soil sample waste material from soil boring, test pitting, and well/soil gas installation activities. Since IDW was composited into drums (given the small soil volume generated by direct push drilling), one sample was composited from all 20 of the drums and analyzed for the parameters required by the disposal company, Emerald Services (Emerald). The drums remained closed to prevent off-gassing and were routinely checked for any physical change. The analytical results and waste manifests are included in Appendix F.

One drum of asbestos containing material samples was disposed of as ACM waste on December 2, 2014. This waste included approximately 9, 1-foot long sections of transite pipe samples that were collected during test pit activities for the RI. The manifest for this waste is included in Appendix F.

Non-soil solid waste (e.g., gloves and disposable sampling equipment) was bagged and placed in a dumpster for off-site disposal at the Deer Lodge Solid Waste Landfill in Deer Lodge, MT.

Purge water and decontamination water was containerized in drums and tanks within secondary containment within the locked security fence at the MRA until disposal. Approximately 1,300-gallons of waste water from well development, well sampling and decontamination activities were collected during the RI. A composite sample was collected from the containers and analyzed for the parameters required by Emerald. Tanks remained closed to prevent off-gassing and were routinely checked for physical change. The analytical results and waste manifests are included in Appendix F.

8.0 FIELD OBSERVATIONS, DEVIATIONS FROM WORK PLAN

Field observations and activities were documented in the field logbook and Field Direct forms. Deviations from the work plan were discussed with the DEQ Project Officer and Trihydro Project Manager prior to continuing the investigation work in the field.

8.1 FIELD OBSERVATIONS

As described in Section 5, field observations were documented with field notes, field forms, and photographs. Field notes and forms are included in Appendix G, and photographs are included in Appendix H.

8.2 DEVIATIONS FROM WORK PLAN

Some deviations from the Work Plan were required to complete the RI. Deviations from the RIWP were discussed with the Trihydro Project Manager and DEQ Project Officer. Deviations included additional sampling in areas not previously identified and limited soil gas sampling due to groundwater near or above the soil gas probe screen.

8.2.1 TRESTLE AREA ADDENDUM

The Trestle Area includes the area along the CMSPP railway between the MRA and PRA. The area lies between W. Milwaukee Ave. and the historical Milwaukee railroad trestle that crosses the Clark Fork River just north of College Street. This area was identified by Trihydro and DEQ as a potential spatial data gap during initial RI field work.

The Trestle Area was not originally identified as an area of significant railroad operations in previous investigations. However, verbal communications during the RI with the current owner, Terry White, and a former railroad employee indicated that the area south of W. Milwaukee Ave and north of the historic trestle may have included aboveground tanks during the operational timeframe and that the railroad used the property for administrative offices at a minimum through the early 1980’s. In addition, underground piping exposed at the PRA with evidence of petroleum hydrocarbons and staining appeared to travel south under W. Milwaukee Ave. possibly toward the Trestle Area (Trihydro, 2014).

Trihydro performed five soil borings using a direct-push drill rig within the Trestle Area following the approved protocols from the RIWP (Trihydro 2014). Surface and subsurface soil samples were collected from three of the borings within the CMSPP railway area. Surface samples were five-point composite samples and subsurface samples were discrete samples. The other two borings were used to characterize subsurface lithology to the east and west of the

CMSPP railway area. The Trestle Area Addendum, included as Appendix I, includes a figure with the sample locations and Table B-13 lists sample suites and rationale for the sampling locations.

8.2.2 ADDITIONAL SOURCE SAMPLING – FORMER BULK PLANT

As discussed in Section 5.5, Trihydro and DEQ identified a potential source area during the RI, a former bulk plant located to the east of BNSF's active railroad tracks/ROW, east of the PRA. Contamination from the bulk plant could possibly contribute to impacts at the PRA. Trihydro used a direct-push drill rig to collect surface and subsurface soil samples from two locations (grids GG17 and GG19) east of the PRA. Samples were collected following the procedures specified in the RIWP (Trihydro 2014). The borings were located on BNSF ROW. Trihydro coordinated with BNSF and its consultant (Olympus) to perform the sampling east of the railroad.

8.2.3 LIMITED SOIL GAS SAMPLING

As discussed in Section 5.8.1, not all of the soil gas monitoring points were installed as planned during the RI. In some cases, the depth to water prevented the deeper probe from being installed. In cases where the deeper probe was installed, sampling has been limited by groundwater levels.

Four soil gas monitoring points were installed at the MRA using a direct-push drill rig. Points SG-101 and SG-102 are located on the northern MRA and installed in February 2014 as part of the northern MRA investigation. A single vapor probe was installed at point SG-102 due to groundwater appearing at about 7 ft bgs. Points SG-104 and SG-105 are located on the south portion of the MRA on the Sun Mountain Lumber property. However due to shallow groundwater, the deeper probes were not installed at these locations. Groundwater levels have prevented sampling of points SG-104 and SG-105.

Four soil gas monitoring points were installed at the PRA. A nested soil gas monitoring probe was installed at SG-206. Points SG-208, SG-209, and SG-210 were installed as single probes. Soil gas probe SG-202 was not installed as groundwater at that location was about 1 ft bgs. The shallow points at SG-206 and SG-210 were sampled during the June and August 2014 groundwater sampling events. Points SG-208, SG-209 and the deep point at SG-206 were not sampled during either event due to high groundwater levels.

8.2.4 MODIFIED SOIL SAMPLING LOCATIONS

As discussed in Section 4.1.2, some soil sampling locations needed to be revised based on utility locations. The southern area of the MRA was the primary location where the soil samples, surface and subsurface, were moved with approval from the DEQ Project Officer. Revised sample locations were evaluated as to whether they met the original objectives of the soil boring. Most locations were installed within 20 feet of the proposed location, but some sample locations were moved to adjacent grids. Only one boring location (MRA-J25) was not installed during this RI, as field observations indicated limited contamination in the area, and it was not possible to relocate the boring nearby due to rail lines and uncertainty regarding the locations of utilities in the area.

9.0 ANALYTICAL PROGRAM

9.1 METHODOLOGY

9.1.1 STANDARD SUITE OF ANALYTES

Table 5-1 presents the analytical methods that were used to analyze samples collected during the field activities at the MRH Facility.

Both the MRA and PRA are known to contain petroleum hydrocarbon-related contamination. Bunker C fuel oil was used at the MRA and free-phase diesel has been reported at both the MRA and PRA. Therefore, EPH/VPH methods were run for both soil and groundwater at both the MRA and PRA in accordance with DEQ guidance (DEQ 2009). VOCs have been reported at both the MRA and PRA as well. Chlorinated solvents have been reported at low concentrations at the MRA and BTEX compounds have been reported at the PRA.

Historical VOC and SVOC results are limited for soil and groundwater at the MRH Facility. The Montana-modified Massachusetts methods for VPH and EPH typically include reporting of specific compounds (BTEX, methyl tert-butyl ether (MTBE), and naphthalene for VPH, PAHs for EPH). However, analysis of VOCs by method 8260B and SVOCs by method 8270C were used to characterize the potential impacts at the Facility, regardless of VPH/EPH screen results, as some of these contaminants may have originated from non-petroleum sources. These methods include reporting of BTEX, MTBE, naphthalene, and PAHs, along with confirmation of these compounds. Therefore, Trihydro requested that the lab not include these compounds as part of the VPH/EPH analytical reports.

As directed by DEQ, pesticides and herbicides were analyzed in samples collected from the MRH Facility. Because these compounds typically sorb strongly onto soil, they were not proposed for analysis in surface water or groundwater as part of the RIWP. If soil data indicate a potential for pesticides or herbicides to leach to groundwater, then additional evaluation will be needed as part of a data gaps assessment.

Therefore, the “standard suite” of analytes in the RIWP, is as defined below. Specific considerations regarding the analytical methods for various matrices are described subsequently.

<u>Liquid matrix analyses</u>:

EPH/VPH: By Montana-modified Massachusetts Method (DEQ 2009).

> VPH was performed separately from EPH. An EPH screen was performed initially. If EPH > 1,000 ug/L, then EPH fractionation was conducted. EPH fractionation typically includes reporting of PAH compounds; however,

PAHs were reported as part of the full 8270C analysis as part of the standard suite and were not reported as part of the EPH analysis.

Metals (Dissolved): EPA Method 200.7/200.9. For surface water and residential well sampling, total metals were analyzed in lieu of dissolved metals. The sample from the background monitoring well was analyzed for both total and dissolved metals.

SVOC: By EPA Method 8270C, RLs generally 10 µg/L. The SVOC by 8270C were analyzed in conjunction with the EPH analyses regardless of the EPH concentration.

PAH Low Level: EPA Method 8270C Selective Ion Monitoring (SIM), RLs generally 0.1 µg/L.

The low level PAH method provided RLs (0.1 µg/L) less than DEQ-7 SLs for PAH compounds except for benzo(a)pyrene and dibenzo(a,h)anthracene. 8270C SIM was only performed if PAH compounds are not detected during the standard 8270C analysis with RLs exceeding the DEQ-7 SLs. The laboratory included 8270C SIM for PAHs at no additional cost.

VOC: By Method 8260B, RLs generally at 1.0 µg/L.

Solid matrix analyses:
EPH/VPH: By Montana-modified Massachusetts Method (DEQ 2009)

VPH was performed separately from EPH. EPH screen was performed initially. Samples greater than 200 mg/kg total EPH were subjected to EPH fractionation. The EPH analysis typically includes reporting of PAH compounds; however PAHs were reported as part of the full 8270C analysis as part of the standard suite and were not reported as part of the EPH analysis.

Metals: EPA Method 6010/6020B. Reporting limits are generally 0.05 to 0.2 mg/kg, depending on the analyte with some minor exceptions. Tetraethyl lead was not proposed for analysis.

SVOC: By EPA Method 8270C, RL generally 0.33 mg/kg.

PAH (SIM): By EPA Method 8270C SIM. Reporting limits are generally 0.0033 mg/kg. The RL for PAHs from the EPH analysis is generally 0.1667 mg/kg. The regular SVOC analysis provides RLs for PAHs of only 0.33 mg/kg. However, there are a number of PAHs for which both the soil and sediment SLs are not only below the RLs for 8720C and EPH analyses, but also below the DL. Therefore, PAHs by 8270C SIM were analyzed only if PAHs are not detected by 8270C with RLs exceeding the SLs. The laboratory included 8270C SIM for PAHs at no additional cost.

VOC: By Method 8260B LVP, RL generally 0.005 mg/kg.

> VOCs in solid matrices were generally analyzed by a modification of the EPA Method 8260B which provides RLs of 0.005 mg/kg for Energy Laboratories' "short-list" of analytes. This alternate method utilizes a large volume purge (LVP) approach in order to reduce the Method Reporting Limits (MRLs)/Method Detection Limits (MDLs). The LVP method with the lower RL allows a significantly greater number of VOC analytes to have RLs less than the soil SLs (as compared to the regular method), and a modest additional number of VOC analytes to have RLs less than the sediment SLs. The lowest SLs for soil are typically based on the migration to groundwater values. The regular 8260B method only provides RLs of 0.2 mg/kg, which is greater than the majority of the VOC analyte SLs for migration to groundwater. However, the LVP modification to EPA Method 8260 B is only offered for the "short list" of VOC analytes and therefore a limited number of VOC analyses by the non-modified EPA Method 8260B were planned to provide data on the "long-list" of compounds that aren't on the "short-list."

Trihydro instructed the laboratory to retain adequate extract from each 8270C analysis to perform 8270C SIM, and also had the laboratory perform the 8270C SIM on each sample with 8270C analysis. The holding time from sampling to extraction for Method 8270 and 8270-SIM is 7 days for water and 14 days for soil samples and 40 days from extraction to analysis, so the SIM analyses were performed, as needed, using the same sample extract.

Soil samples that were analyzed for metals were first air dried and screened with a 60-mesh screen in the laboratory and only the finer grained fraction passing the screen was analyzed. Possible use of the data in a risk assessment dictates that the solid matrix samples were initially analyzed by 6010/6020B for the complete suite of metals identified in Appendix B of the RIWP.

9.1.2 ADDITIONAL LIQUID/WATER ANALYSES

9.1.2.1 PESTICIDES/HERBICIDES AND POLYCHLORINATED BIPHENYLS

Pesticides and herbicides were not initially scheduled for analysis in surface water or groundwater. If the results of analyses of soil samples for these compounds were greater than SLs, then analysis of the pesticides/herbicides in surface water and/or groundwater was discussed with DEQ. Due to the historical detections of PCBs in sludge and petroleum-contaminated soil, a few groundwater samples were also proposed for analyses of PCB by EPA Method 8082.

9.1.2.2 MONITORED NATURAL ATTENUATION PARAMETERS

Free-phase product (diesel, Bunker C fuel oil) has been observed in groundwater at the MRH Facility. Petroleum hydrocarbons have also been detected in groundwater, and at the PRA, these concentrations have exceeded SLs in some cases (DEQ 2013). The frequency of groundwater monitoring in the past has not been sufficient to evaluate groundwater contaminant trends, nor is groundwater quality data for natural attenuation parameters available. One of the objectives of the RI is to evaluate fate and transport of contaminants. In order to help evaluate fate and transport of petroleum hydrocarbon contamination in groundwater, a limited number of groundwater samples were analyzed for natural attenuation parameters. These parameters include: dissolved iron, total iron, nitrate, sulfate, total manganese, pH, and dissolved oxygen (field-measured with an in situ downhole probe).

9.1.3 ADDITIONAL SOLID MATRIX ANALYSES

The RIWP (Trihydro 2014) outlines the locations and depths that required additional soil analyses. The following section discusses the analytical methods for those additional analyses.

9.1.3.1 PESTICIDES/HERBICIDES

Selected soil samples were analyzed for common pesticides by EPA Method 8081A and common herbicides by EPA Method 8151. Nitrogen and phosphorous containing pesticides analyzed by EPA Method 507 were not targeted as part of this RI.

9.1.3.2 POLYCHLORINATED BIPHENYLS

Selected soil and sediment samples were analyzed for PCBs by EPA Method 8082.

9.1.3.3 ASBESTOS-CONTAINING MATERIAL

Materials suspected to potentially contain asbestos were analyzed by Polarized Light Microscopy (PLM) by OSHA Method ID-191. If asbestos was not detected, the samples were analyzed by the full quantitative bulk transmission electron microscopy (TEM) method.

9.1.3.4 TOXICITY CHARACTERISTIC LEACHING PROCEDURE

Gross (heavy) petroleum-contaminated soil were collected and analyzed by toxicity characteristic leaching procedure (TCLP). These samples were typically analyzed for total analyte concentrations by the routine methods identified above and were also analyzed for assessment of hazardous waste by TCLP. Leachate resulting from application of the TCLP was analyzed by the appropriate liquid matrix method for metals, VOCs, and SVOCs.

9.1.3.5 SYNTHETIC PRECIPITATION LEACHING PROCEDURE ANALYSES

Selected paired (split) soil samples were collected to use in the leaching evaluation of metals and organic constituents. One split was analyzed for total metals, VOCs, and SVOCs. The compounds of concern were confirmed to be present prior to proceeding with the synthetic precipitation leaching procedure (SPLP) and analysis. Following confirmation, one split was subjected to the SPLP (SW 1312) and the resulting leachate analyzed for metals, VOCs, and SVOCs by the methods identified for the standard suite of analytes for liquid/water analyses.

9.1.3.6 SOIL PHYSICAL PARAMETERS

In order to assist in the evaluation of fate and transport of contaminants, selected soil samples were collected for the analysis of TOC, soil bulk density, soil moisture, particle size analysis, and pH. These parameters were analyzed by the methods identified on Table 5-1. Soil sample locations identified in Appendix B of the RIWP (Trihydro 2014) were selected to obtain data to characterize the vertical distribution of these parameters in uncontaminated surface soils, subsurface soils and aquifer materials (TOC only), consistent with DEQ guidance (DEQ 2008).

9.1.4 RAILROAD BALLAST ANALYSES

Samples of railroad ballast were analyzed for VOCs and SVOCs per the direction of DEQ. These analyses involved modified extraction procedures utilizing a methanol extraction and subsequent analysis. A 25-gram sample aliquot was extracted with 25 mL of methanol. Analyses of the extracted fluid were conducted by EPA Method 8260B for VOCs and EPA Method 8270C for SVOCs.

9.1.5 ANALYTICAL LABORATORY

The soil, groundwater, sediment, ballast, and surface water samples were submitted for analysis to Energy Labs in Helena, MT. Samples were analyzed at both the Helena and Billings, MT, Energy Lab locations. Asbestos samples from the surface at the PRA and MRA were also submitted to Energy Labs. The soil gas samples were submitted through Energy to ALS Environmental Labs, formerly Columbia Analytical Services Laboratory, in Simi Valley, California.

9.2 ANALYTICAL REQUIREMENTS

Trihydro evaluated the ability of analytical methods and laboratory performance to achieve the project DQOs. Appendix J presents the project’s human health and ecological risk screening values for individual analytes (updated based on January 2015 EPA Regional SLs) in comparison to the anticipated laboratory MRLs and MDLs. This table shows that in most cases the analytical MRL/MDLs are less than the most stringent (lowest) SL. However, there are some instances in which the laboratory/method performance is unable to achieve MRLs/MDL below SLs. Additional considerations regarding the tables in Appendix J include:

- As discussed for the standard analyses, Energy Laboratories' low-level VOC method was used on the tables in Appendix J for the soil VOC MRLs/MDLs, which gave a MRL of 0.005 mg/kg.
- As shown in Appendix J, the lower DLs achieved with Method 8270C SIM result in a greater number of PAHs with DLs less than SLs, but there are still PAH compounds for which DLs less than the SL cannot be achieved, including 1-methylnaphthalene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene.
- MRLs/MDLs for a number of the soil gas compounds are greater than the residential and industrial standards. These standards are for indoor air, but samples collected at the MRH Facility were being collected for soil gas analysis. EPA Method TO-15 typically uses a 1-liter Summa, but a 6-liter Summa canister was used to help obtain lower detection limits. Ambient air samples and leak testing of the soil gas sample locations confirmed that the sample is representative of soil gas and not affected by ambient air.

Actual method performance varied from the values presented in Appendix J due to sample matrix issues and/or contaminant concentrations. Energy Laboratories attempted to achieve the SLs for the investigative samples collected. Results below the RLs, but above the DLs, are reported with appropriate flags to indicate the greater uncertainty associated with these values.

9.3 ANALYTICAL AND LABORATORY COORDINATION

Analytical and laboratory coordination was performed by Trihydro throughout the project. Email and phone communication with field staff was on-going throughout the field effort. Additional coordination occurred between the lead QA chemist at Trihydro, including review of COCs submitted to the laboratory for compliance with the RIWP.

9.4 DATA QUALITY AND USABILITY

Including field sample duplicates, a total of 82 groundwater samples, 20 sediment samples, 12 soil gas samples, 10 surface water samples, 554 soil samples, and 139 QA samples (equipment blanks, trip blanks, and ambient air samples) were collected during the months of February, April, May, June, and August 2014. The samples were submitted to and analyzed by Energy Laboratories, Inc., located in Helena, with some analyses subcontracted to the Energy Laboratories facility located in Billings, Montana and to ALS Environmental located in Simi Valley, California.

Tier II data validations were performed on the analytical data to evaluate and assess the analytical accuracy, precision, completeness, method compliance, and instrument performance. Data validations were performed in accordance with DEQ's Data Validation Guidelines for Evaluating Analytical Data (DEQ 2010), Trihydro's Data Validation Guidelines, and the RIWP. However, EPA updated National Functional Guidelines during execution of the RI. Therefore, with DEQ's approval, Trihydro validated the data according to the updated guidelines as follows:

- EPA National Functional Guidelines for Superfund Organic Methods Data Review, OSWER 9200-2.134, EPA 540-R-014-002, October 2013 (replaced EPA Contract Laboratory Program National Functional Guidelines for Superfund Organic Methods Data Review, EPA-540-R-08-01, June 2008)
- EPA National Functional Guidelines for Inorganic Superfund Data Review, OSWER 9200.2-133, EPA 540-R-013-001, October 2013 (replaced EPA Contract Laboratory Program National Functional Guidelines for Inorganic Superfund Data Review, OSWER 9240.1-51, EPA 540-R-10-011, January 2010)
- EPA Hazardous Waste Support Branch Validating Air Samples Volatile Organic Analysis of Ambient Air in Canister by Method TO-15

Tier II data validations were performed for each laboratory analytical report for samples collected during the RI. Data validation summaries are included as Appendix K, while data validation reports are included as Appendix L. Laboratory analytical reports are included as Appendix M.

Of the 48,145 environmental and field duplicate sample results reported for the groundwater and surface water, soil, sediment, and air samples collected during the RI, a total of 87 water and soil sample results were rejected as a result of the data validation review. The completeness measure for the generated data is 99.82%, which is acceptable based upon the project data completeness goal of 90%. Data were rejected due to significant data quality non-compliances related to matrix spike/matrix spike duplicate samples, laboratory control samples, and surrogate recoveries in organic analyses. A total of 9,228 data qualifiers, excluding the rejections, were assigned to the data due to non-compliance with data validation criteria as detailed in the validation summaries in Appendix K. Data not rejected is useable for the purposes of the RI.

10.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

The following subsections describe the general Facility setting including surface features, geology, hydrogeology, climatic conditions, and ecological environment.

10.1 SURFACE FEATURES AND HYDROLOGY

The MRH Facility lies within the Deer Lodge Valley, a north-south trending basin within Powell, Deer Lodge, and Silver Bow Counties in west-central Montana. The principal topographic features include a broad lowland, the Clark Fork floodplain, bordered by low fringing terraces that are in turn bordered by broad, high terraces, which slope gently upward to the mountains. The MRH Facility's two areas, MRA and PRA, are located in the City of Deer Lodge and both abut the Clark Fork River. The primary surface feature at both the MRA and PRA is the relatively flat elevated area where the railroad tracks, roundhouse, fueling facility, and other railroad structures were located (Figures 2-1 and 2-2). Many of the structures have been demolished, but some foundations remain. Former railroad buildings including the maintenance building at the MRA and the depot at the PRA remain standing. The current BNSF railway line runs along the eastern side of both areas, but is not specifically a boundary. The PRA has three primary land features; a low-lying floodplain area near the Clark Fork River to the west, a creek feature running through the area, and wetland areas in low lying sections. The MRA also includes a creek and wetland area.

The Clark Fork River and associated floodplain are dominant features near both the MRA and PRA. The following is a summary of the hydrology at the MRH Facility as observed during RI field work and as described in the DSR (DEQ 2013):

The Clark Fork River is the main hydrologic feature of the valley and flows roughly south to north through Deer Lodge. The Clark Fork abuts the MRA on the east and north and the PRA on the west. The mean annual flow of the Clark Fork at Deer Lodge has been estimated at about 250±75 cubic feet per second (cfs) based on a USGS water stage gauge. The average monthly flow of the Clark Fork River at Deer Lodge in July is 205 cfs and 94 cfs in August based on the period of record for the gauge station (1978 - 2013). The lowest recorded daily average flow at this site was 22 cfs on August 18, 1988. The highest daily average was 2,390 cfs on May 23, 1981.

<u>MRA</u>

- The MRA is located on a low terrace alongside the Clark Fork River.
- Tin Cup Joe Creek runs along the west of the MRA to its confluence with the Clark Fork River in the northern part of the MRA. Tin Cup Joe Creek originates near Mt. Powell in the Flint Creek Range and drains from the west into

Deer Lodge Valley. The confluence of Tin Cup Joe Creek and the Clark Fork River occurs at the northern end of the MRA near the former MRH railroad trestle bridge (Figure 1-2). Surface water likely interacts with groundwater in the northern area of the MRA.

- Tin Cup Joe Creek is an intermittent creek that is dependent on upstream agricultural usages and storage. During the summer months, there is complete dewatering of Tin Cup Joe Creek in the last mile before it flows into the Clark Fork River in the MRA (Figure 1-2). The Montana Clean Water Act Information Center (CWAIC) indicates that Tin Cup Joe Creek fully supports agriculture and drinking water uses but does not support aquatic life and primary contact recreation. In October 2011, KirK Engineering and Natural Resources, Inc. (KirK) completed a memorandum detailing flow volume testing of Tin Cup Joe Creek. Flow in Tin Cup Joe Creek averaged 3.6 cfs according to measurements conducted in October 2011 (KirK 2011). However, as observed from March to October 2014, flow in Tin Cup Joe Creek near the MRA is highly dependent on the upstream uses and is not always consistent even in the spring and fall.

- As indicated in the DSR, Tin Cup Joe Creek from the Deer Lodge water supply intake to the confluence with the Clark Fork River is classified as B-1 (Administrative Rules of Montana [ARM] 17.30.607). ARM 17.30.623 requires that waters classified as B-1 are to be maintained suitable for drinking, culinary, and food processing purposes, after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Concentrations of carcinogenic, bioconcentrating, toxic, radioactive, nutrient, or harmful parameters may not exceed Montana water quality standards (DEQ-7) and other standards provided for in the rule must be maintained.

- Between the elevated former operations area of the MRA and the elevated active BNSF railway bed to the east is a slough, which has wetland characteristics. Surface water was observed and sediment samples were taken in this area during the RI. Section 10.6.1 discusses the wetlands and their evaluation further.

PRA

- The PRA is also located on a low terrace along a bow in the Clark Fork River (Figure 1-3) downstream, generally north, from the MRA. The majority of the western fields and low-lying areas of the PRA are included in the Clark Fork River's 100-year flood plain.

- Cottonwood Creek cuts east to west through the northern section of the PRA. It runs from the Boulder Mountains in the east, through Deer Lodge, and into the Clark Fork River. Its confluence with the Clark Fork River occurs just west of the PRA on the Grant-Kohrs Ranch.

- Cottonwood Creek has not yet been assessed by DEQ's Water Quality Planning Bureau and flow measurements are not available, but field observations during the RI season indicate that Cottonwood Creek is a perennial stream.

As it crosses the PRA, there are two railroad trestles, CMSPP's historical trestle and the active BNSF railway trestle.

- Between the two elevated railway lines, former CSMPP and active BNSF, there is a low-lying wetlands swale area that extends approximately 500 to 600 ft south of Cottonwood Creek and is approximately 50 to 100 ft wide. Section 10.6.1 discusses the wetlands and their evaluation further.

10.2 GEOLOGY

The Deer Lodge Valley is filled with a great mass of material (valley fill) eroded from the surrounding mountains and with smaller amounts of volcanic ejecta. A series of gravimetric profiles indicate a maximum thickness of more than 5,500 ft of valley fill on a basement profile of moderate relief. The valley fill consists mostly of unconsolidated to semi-consolidated Tertiary sedimentary deposits. An average of about 25 feet of this material is believed to be Quaternary alluvium (Konizeski, et al., 1968).

The geology of the MRH Facility is characterized by a localized fill material overlying the quaternary alluvium, which is primarily dominated by medium to coarse grained sands and gravels from the alluvial valley. Appendix C contains the boring logs and test pit logs for the RI investigation work. Figures 10-1 through 10-6 show cross sections of the facility areas. To understand the localized geology of the MRH Facility, a description of the geology from surface to depth follows.

Both areas of the Facility have fill material present in the historical operations areas. Fill material was used to elevate and support the historical railroad features. The fill material is primarily a sandy silt or silty sand with some gravel and cobbles. There are only a few areas of silt, but they seem to coincide with areas of deeper fill at the MRA. The depth of fill material is not consistent throughout the Facility or across each area and there could have been additions or changes during the MRH Facility operations. The fill material can be detailed further. There is typically 0.5 ft that has organic silty sand on top of operations areas and usually 0.5 ft layer of organic silt in the undeveloped field or low-lying areas of the facility. This organic layer is on top of the silty sand, sandy silt, or gravelly sand fill material. The elevated operations and rail line areas appear to have more fill material to support historical site features. Figures 10-2 and 10-5 show the north to south cross-sections of the MRA and PRA, respectively. These figures use lithology and field descriptors to delineate between the fill and native materials. In general, the central operations areas for the MRA and PRA have approximately 5 to 10 feet of fill material over the native soil. At the east and west edges of both the MRA and PRA, the fill material lessens. Figures 10-3 and 10-6 illustrate this east-west trend. The only exception is at the eastern side of the MRA where the fill may have increased in this area which is just on the edge of the historical track sidings. This area was likely historically a low area and may have needed additional fill to accommodate track sidings.

Historical data has indicated that the fill at the Facility was easily identifiable and associated with metals contamination. A 2010 Tetra Tech investigation at the MRA identified a dark brown fill at 1-foot or less throughout the MRA (DEQ 2013). This 2010 report indicated the fill material as being distinct in appearance from other underlying tan to yellow-red lithology, as well as containing high metals, primarily lead and arsenic, concentrations (DEQ 2013). The RI expanded the lithologic and analytical results for both surface and subsurface soil to aid in evaluating the extent of contamination and to investigate if the dark brown fill was present at the MRA or PRA.

General field observations from the RI indicate that the top one-half foot to one foot of material was often a medium to dark brown color and the deeper native sands and gravels were yellow or lighter colored. A distinct definition between a darker fill and lighter native material underneath was not universally recognizable during soil and test pit logging. The transition from darker silty sands/sandy silts to the lighter sands beneath was most often gradual. However, in three test pit locations a dark brown upper material was distinguishable from other types of soil. Two of the locations were at the PRA (TP-PRA-DD15A and TP-PRA-DD22A) and one location at the MRA (TP-MRA-K11A). Table 10-1 compares the metals concentrations for the upper darker fill to the underlying lighter fill. Table 10-1 shows that at the MRA the metals concentration of arsenic, barium, chromium, and lead in the surficial darker brown fill was 2.36 to 6.00 times higher than the metals concentrations in deeper, lighter soil beneath. This is consistent with historical observations as discussed in the Tetra Tech report (DEQ, 2013a); however, the presence of a distinct darker fill was only discernible at this one location for the entire MRA during the RI. Conversely, the results at the PRA show that the metals concentrations in the deeper, lighter soil are 9.75 times lower to 8.25 times higher (lead at TP-PRA-DD22A) than the upper, darker fill material for arsenic, barium, chromium, and lead (Table 10-1). Based on laboratory field observations of results described in Sections 12 and 13, the relative difficulty in discerning a distinct horizon between darker fill and lighter native materials across the MRA and PRA, and Table 10-1 results for the PRA and MRA being conflicting, a direct correlation between metals concentrations and observable field indicators such as color was not confirmed. However, from similarities observed in lithology of the fill as compared to the underlying native sands and gravels, as well as the presence of apparent cuts in hillsides south of the MRA, it is possible that at least some of the fill may have come from a relatively local source, which would likely have similar metals concentrations. None of the detected metals concentrations in the three test pits used for fill comparisons in Table 10-1 had SL exceedances in the comparable samples. The only SL exceedance for these locations for metals was one deeper sample in at TP-PRA-DD22A from 10 to 11 ft bgs. This deepest sample at TP-PRA-DD22A is from a petroleum impacted area within the smear zone/saturated zone, which likely also impacted the metals concentrations.

At the PRA, there was a central area where a peat-layer was observed between the fill material and the sand alluvial material. This area was isolated, but is expected in alluvial depositional environments where plant material decays in anaerobic conditions.

Below the fill material soils consist primarily of unconsolidated sand and gravel that is associated with the floodplain of the Clark Fork River. The alluvial sediments are made up of numerous inter-layered lenses of channel, overbank, and bar deposits from a high energy stream similar to the modern Clark Fork River. These gravelly sands were primarily yellow or light brown in color and consist of medium to coarse-grained sands with gravels and cobbles. During drilling activities, it appeared that the saturated sands in these layers could flow easily. Also, cobble areas proved to be difficult for drilling activities. The sands were primarily underlying the PRA, the low lying areas of the MRA, and the more northern areas of the MRA. The EPA also described the general geology in the vicinity of a recovery trench that was excavated at the PRA (DEQ 2013). EPA found that below the fill material, the top 3 to 4 ft of soils were very loose and caved easily, the next 10 ft were very clayey and fine-grained and did not cave, and the last 1 to 1.5 ft were cobbles (approximately 14 to 15 ft below fill material). The groundwater monitoring wells installed as part of this RI are in this upper 16 ft of fill material and quaternary alluvium.

The fill is less thick and the underlying alluvial material changes further south on the MRA in the Sun Mountain Lumber operations area (south of MRA-K27 on Figure 10-1). The elevated bench that the Sun Mountain Lumber operation occupies has more gravels and cobbles. This is in line with the terminal moraines of the Wisconsin age that would extend from the Tin Cup Joe Creek Canyon into low terraces near the Clark Fork River (Konizeski 1968). The glacial deposited cobbles are found south of the former MRH blacksmith and tank shop and also west of that on a terrace that holds a rerouted Tin Cup Joe Creek flowing to the north rather than its historical flow pattern to the east and northeast through this area.

Below the quaternary alluvium, which is typically 20 feet thick near the Clark Fork River flood plain, is a tertiary (specifically, Pliocene) interbedded sand and gravel material. This usually has gravel-bedded former alluvial channels near the center of the Deer Lodge Valley and will contain more silts and clays over the flood-plain area. These tertiary-aged alluvial deposits are typically 300 ft of interbedded sands and gravels, but can be as thick as 5,000 ft in some areas of the Deer Lodge valley (Konizeski 1968). The City of Deer Lodge drinking water source wells are screened in these tertiary alluvial sands and gravels.

10.3 HYDROGEOLOGY

The hydrogeology underlying the MRH Facility consists of at least two alluvial aquifers. Both the upper quaternary and lower tertiary alluvial lithology, primarily sands and gravels, are natural groundwater aquifers. The interbedded quaternary alluvium typically has the uppermost unconfined aquifer and extends to approximately 20 to 40 ft bgs depending on proximity to the Clark Fork River flood plain (Konizeski 1968). The deeper tertiary alluvial aquifer is typically confined and extends to approximately 300 ft bgs before typically running into a thick bentonite clay layer below (Konizeski 1968).

The quaternary alluvial aquifer has the most interaction with infiltration from precipitation and surface activities. Furthermore, the upper aquifer has the most interaction with the creeks and rivers, especially the Clark Fork River valley. This aquifer is typically 20 feet deep and includes the groundwater beneath both areas of the MRH Facility. During the RI, groundwater was observed in the MRH Facility area from ground surface at a seep behind the former MRH Wood Working shop in the MRA to almost 14 ft bgs in the elevated area of the PRA. The average depth to groundwater was just over 7 ft bgs. Groundwater flow responds to variations in seasonal precipitation and is drawn from upland areas around the baseline of the Clark Fork River. Groundwater flow generally follows the topographic surface, typically flowing towards the nearest stream or river. The Clark Fork River, in the vicinity of the MRA and PRA appears to be a receiving stream (DEQ 2013). The rate of groundwater inflow is approximately 88 cfs (Nimick 1993). Irrigation return flow is thought to be responsible for this rate of inflow. Groundwater levels are highest during spring runoff and are highly influenced by local irrigation practices. The Clark Fork River loses to groundwater during high flow events. At lower flows, it is unclear whether the Clark Fork River is gaining from or losing to groundwater (Pioneer 2000).

Beneath the quaternary alluvium are discontinuous beds of silt and minor amounts of fresh water lime that were deposited during the Pliocene on the bordering flood plain of the ancestral Clark Fork River (Konizeski 1968). Additionally intermittent ash layers are present from eroded debris that accumulated in the valley areas through erosion washes. These Pliocene-aged silt, lime, and ash layers may act as aquicludes between the quaternary alluvial aquifer and the deeper tertiary alluvial aquifer.

The deeper tertiary alluvial aquifer is approximately 300 ft thick near the Facility, but may be greater than 700 ft in some southern areas of the Deer Lodge valley near Warm Springs, MT. This tertiary aquifer is comprised of coarser grained beds and lenses composed of sands and gravels and is typically confined (Konizeski 1968). Depending on hydraulic gradient, groundwater is thought to move laterally through adjacent aquifers at depth. The City of Deer Lodge public water supply wells are completed in this tertiary alluvial aquifer. Regionally, the Quaternary alluvium and Tertiary deposits are presumably connected hydraulically; thus some groundwater flows vertically downward from the alluvium into the older deposits (Nimick 1993); however, a 2012 localized investigation by Morrison and Maierle for the City of Deer Lodge found a small amount of connectivity at the PRA near the public water supply Park Street well and surrounding shallow monitoring wells finished in the upper aquifer. The City chose to take the Park Street well offline in 2013 after findings from the same report indicated that there were increases in detected petroleum hydrocarbons in MW-11 at the PRA, which is in the shallow aquifer near the Park Street well, despite no evidence of contamination in the public water supply well (DEQ 2013).

Groundwater at the MRA

Although the quaternary alluvial aquifer underlies both the MRA and PRA, both areas have localized groundwater trends that are specific to each area and determined by the relationship to the up gradient drainage network and the Clark Fork River. The following is a summary of the hydrogeology for the MRA, both historical data provided in the DSR (DEQ 2013) and RI results are included in this discussion. As of September 2014, there are 33 monitoring wells at the MRA north of the Powell County southern property line and 5 monitoring wells south of this line (Figure 4-6). Table 10-2 shows the status and completion information (if available) of existing Facility wells. Eight historical wells appear to have been previously removed by pre-RI removal actions conducted at the MRA since 2010. Twenty-two of the existing wells are shallow wells (less than 20 ft bgs) installed by the EPA Superfund Technical Assistance and Response Team (START) in the summer of 2011. The wells were generally screened from approximately 4 to 14 ft bgs and were designed to bridge the water table, although there were exceptions as noted in the well logs included in the DSR (DEQ 2013). The measured depth to groundwater at the MRA in the monitoring well network ranged from approximately 2 ft bgs to 14 ft bgs (Table 10-3). The shallowest depths to groundwater are observed in MW-104 and MW-105, which are on the southern area of the MRA near the former blacksmith shop. The hydraulic gradient in the area ranges from 0.004 ft per foot to 0.0009 ft per foot based on the measurements between five well pairs. In both April and August 2014, groundwater flow direction was generally in a north northeast direction (Figures 10-7 and 10-8, respectively) across the MRA. The groundwater flow direction appears to be consistent with flow to areas with lower ground surface elevations.

In addition to the fluid level monitoring, the RI field work included slug testing at the five wells on the MRA: MW-101, MW-102, MW-103, MW-106, and MW-107. These wells were selected to represent the spatial variation across the site. A slug-out test was performed to measure the recovery of the groundwater and calculate aquifer properties from the recovery data. A Level Troll 700 water level transducer was placed in each well approximately 2 feet from the bottom of the well. The transducer was set to record the water level every 2 seconds. The water level was allowed to equilibrate to pre-installation levels and then a 1-inch polypropylene bailer was lowered and left in place until the water level equilibrated again. Once the water level was within 90%, most often the exact same, as initially measured, the test was started and the bailer removed quickly from the well while the transducer recorded the water level drop and recovery. Due to the high hydraulic conductivity, each aquifer test took approximately 2 minutes to equilibrate to the original depth to water. To confirm results, each well was tested between two and four times. The data was then uploaded into the hydraulic testing software program Aqtesolv, and the results were fit to an unconfined Bouwer-Rice solution to find the hydraulic conductivity. The results for the hydraulic conductivity for the MRH Facility are presented in Table 10-4 and Appendix E shows the results of the analytical solutions for each test. As Table 10-4 shows, the average hydraulic conductivity for the MRA ranges from 10.7 ft/day to 55.9 ft/day with an average of 33.2 ft/day. These ranges of hydraulic conductivity are consistent with well-sorted sands, gravels, and glacial outwash, which is consistent with the lithology for the Facility (Fetter 1994).

The Clark Fork River is thought to significantly influence groundwater elevations at the MRA. High flow events in the Clark Fork River correspond to higher groundwater elevations. The DSR references that the Clark Fork River loses to groundwater during high flow events, but at lower flows, it is unclear whether the Clark Fork River is gaining from or losing to groundwater (DEQ 2013a). The DSR also references a 2000 Pioneer report that inferred that there may be groundwater mounding underneath the historical Milwaukee railroad bed at the northern end of the MRA. However, data collected by EPA in 2011 did not confirm the presence of a groundwater mound in this area (DEQ 2013), nor did data collected during the RI. Mounding, if it occurs in this area, appears to be limited in extent and/or hydrologic conditions or may have been alleviated by the removal of LNAPL (Bunker C) in 2011.

A City of Deer Lodge public water supply well, the Second Street Well, is within ¼ mile of the MRA, east of both the MRA and the Clark Fork River (Figure 4-6). This well was not found in the Ground Water Information Center (GWIC) database. However, Well MW 13B installed by Morrison and Maierle Inc. (MMI) in 2012 next to the Second Street Well (Figure 4-6) was completed between 135 and 145 ft bgs in gravels and silts, similar to the Second Street Well (MMI 2012). This would indicate that both are finished in the tertiary alluvial aquifer. The log for Well 13B included in the DSR (DEQ 2013) indicates that there is a shallow clay zone (10 to 16 ft bgs) and two deeper clay layers (one 8-foot thick layer and one 2-foot thick layer) between the shallow aquifer and the supply well completion zone. Depending on the composition of these clay intervals, this thickness of clay may or may not provide an effective barrier for hydraulic connection between the shallow and deeper aquifers.

Groundwater at the PRA

The groundwater in the alluvial quaternary beneath the PRA is influenced locally by the topography, the interactions with Cottonwood Creek, and the Clark Fork River. In addition to the interspersed coarser-grained or finer-grained or alluvial deposits within the PRA, historical geophysical data supports the idea of a potential paleo channel below the PRA (DEQ 2013a). Furthermore, a localized peat layer in the central area of the PRA is also present and could affect vertical groundwater flow. The following is a summary of the hydrogeology for the PRA, including information from both the DSR (DEQ 2013) and the RI.

As of September 2014 there were 32 monitoring wells at the PRA south of Cottonwood Creek and no monitoring wells north of Cottonwood Creek (Figure 4-7). Table 10-2 shows the status (active or removed) and completion details (if available) of existing facility wells. These wells do not include the six piezometers and two recovery wells that are present in the free-phase recovery trench installed by EPA in 2011. In addition, five historical wells were removed by EPA in the summer of 2013. The PRA wells are generally completed to less than 20 ft bgs, with groundwater observed between 2 and 14 ft bgs.

The depth to groundwater is greater along the elevated railroad grade (comprised of fill) along the PRA as compared to the western area of the PRA. The depth to groundwater across the elevated portion in August 2014 was approximately 10 ft bgs. The depth to groundwater in the low-lying area on the western portion to the PRA in August 2014 was approximately 5 ft bgs. Available seasonal groundwater elevation data is limited and routine static water level measurements have not been performed for the PRA prior to 2014. Trihydro measured groundwater elevations in spring 2014 and again in August 2014, and there appears to be limited seasonal variation in groundwater elevations (Table 10-5). In general, groundwater elevations were about the same or less than 0.5 ft shallower during the August event. In April and August 2014, groundwater flow direction was generally to the west (Figures 10-9 and 10-10) across the PRA towards the Clark Fork River. The hydraulic gradient is higher near the elevated railway area of the site at an average of 0.015 ft per ft and is shallower in the western lower lying area at an average of 0.006 ft per ft based on the measurements between five well pairs. The groundwater flow direction appears to be consistent with flow to areas with lower water table elevations and corresponds to the surface topography.

In addition to the fluid level monitoring, the RI field work included slug testing at the four wells on the PRA: MW-201, MW-202, MW-205, and MW-207. These wells were selected to represent the spatial variation across the site. Slug-out tests were performed to measure the recovery of the groundwater and calculate aquifer properties from the recovery data. A Level Troll 700 water level transducer was placed in each well approximately 2 feet from the bottom of the well. The transducer was set to record the water level every 2 seconds. The water level was allowed to equilibrate to pre-installation levels and then a 1-inch polypropylene bailer was lowered and left in place until the water level equilibrated again. Once the water level was within 90%, most often the exact same, as initially measured, the test was started and the bailer removed quickly out of the well while the transducer recorded the water level drop and recovery. Due to the high hydraulic conductivity, each aquifer test took approximately 2 minutes to equilibrate to the original depth to water. To confirm results, each well was tested between two and four times. The data was then uploaded into the hydraulic testing software program Aqtesolv, and the results were fit to an unconfined Bouwer-Rice solution to find the hydraulic conductivity. The results for the hydraulic conductivity for the MRH facility are presented in Table 10-4 and Appendix E shows the results of the analytical solutions for each test. As Table 10-4 shows, the average hydraulic conductivity for the PRA ranges from 12.33 ft/day to 40.07 ft/day with an average of 29.06 ft/day. These ranges of hydraulic conductivity are also consistent with well-sorted sands, gravels, and glacial outwash, which is consistent with the lithology for the site (Fetter 1994).

The water-table slope will be more shallow, gentler, if the transmitting material is coarse and permeable, such as a clean sand and gravel, and the gradient will increase if the aquifer has more fine grained, less permeable materials, such as a fine sand or silty sand and gravel (Konizeski 1968). The presence of the underlying peat or silty-sands at the PRA compared to the MRA may account for the higher observed gradient at the PRA, especially in the elevated former operations area at the PRA that had more peat and silty sands. Hydraulic conductivity data across a screened interval that included both the finer material and the clean sand/gravel material would likely be skewed more toward the groundwater flow in the clean sand/gravel lithology. This could account for some of the similar hydraulic conductivities at the PRA and MRA.

LNAPL is present in the central area of the PRA in wells MRMW08, MRMW09, and the wells and piezometers within the recovery trench (Figure 10-10). While LNAPL is able to affect the groundwater flow parameters, the DSR reports that EPA found that the finer-grained material in the vicinity of its recovery trench at the PRA likely minimizes the down gradient movement of free-phase product (DEQ 2013a). In this same central area of the PRA, RI field observations and lithologic logs indicate a peat layer between the upper sands and gravels and lower sands and gravels, which might be responsible for maintaining the LNAPL thickness. Section 13.5 discusses the LNAPL presence and location further.

There are two public water supply wells in the vicinity of the PRA. Park Street public supply water well (GWIC ID 181290) is located within the PRA (Figure 4-7). The total depth of the well is 236 ft; the production interval in the Park Street Well is from 148 to 236 ft bgs. This would indicate that both are finished in the tertiary alluvial aquifer. This well was flow tested at 700 gallons per minute (gpm). The Milwaukee Avenue public water supply well (GWIC ID 57428) is located immediately south of the PRA, and based on GWIC, it appears that this well was completed to a total depth of approximately 200 ft, but the completion interval wasn’t provided. The hydraulic relationship between the shallow and deeper production aquifers is discussed further in the 2012 MMI report as well as the DSR.

10.4 SOIL CHARACTERISTICS

During the RI, the soils for the MRH Facility were examined for physical parameters and SPLP. These parameters are used for developing site-specific SLs and performing remediation design calculations.

In order to assist in the evaluation of fate and transport of contaminants, selected soil samples were collected for the analysis of TOC, soil bulk density, soil moisture, particle size analysis, and pH. Soil sample locations were selected to obtain data to characterize the vertical and horizontal spatial distribution of these parameters in uncontaminated surface soils, subsurface soils, and aquifer materials (TOC only).

Select soil samples collected from PRA and MRA soil borings were submitted for physical parameter analysis. Samples were submitted for the analysis of particulate size (percent clay, sand, and silt), density, texture, moisture, and pH. Samples were submitted from locations PRA-CC17, PRA-FF06, PRA-FF17, MRA-G20, MRA-J11, MRA-J20, MRA-K17, MRA-L09, MRA-M10, MRA-M16, and MRA-N18. Laboratory results are summarized in Table 10-6, with the laboratory reports located in Appendix M. Laboratory results for particulate size were compared to observations and soil descriptions made by the field crews to confirm that field observations were consistent with laboratory analysis. Overall, both the field crews and the laboratory results identified that sand and silt were the primary components of the Facility soils, clay being a minor component.

The field observations and laboratory results were generally comparable in description with the following exceptions. PRA-FF17 (1-2 ft-bgs) was identified as silt with trace amounts of sand and clay; however, the laboratory analysis results indicate that the material was 50% sand, with 25% silt and 25% clay. MRA-G20 (2-3 ft-bgs) was identified as sandy silt by the field crew; however, the laboratory analysis indicated that the sample was comprised of 80% sand, with 14% silt and 6% clay. Location MRA-L09 (18-19 ft-bgs) was not logged by the field crew, so there is no field description to compare against. MRA-L09 (18-19 ft-bgs) laboratory results indicated the sample was composed of 88% sand, 8% silt, and 4% clay.

In addition to the physical parameters of soil at the MRH Facility, selected paired (split) soil samples were collected to use in the leaching evaluation of metals and organic constituents. One split was analyzed for total metals, VOCs, and SVOCs and a split was subjected to the SPLP (SW 1312) and the resulting leachate analyzed for metals, VOCs, and SVOCs by the methods identified for the standard suite of analytes for liquid/water analyses.

One subsurface soil sample was collected from location TP-PRA-FF11B at a depth of 4-5 ft-bgs. This sample was submitted for SPLP analysis. Results of the SPLP analysis as well as total for this sample are shown in Table 10-7 and the laboratory report is included in Appendix M. Eight analytes were detected after SPLP extraction:

1-methylnaphthalene (7.6 mg/L), arsenic (0.032 mg/L), barium (0.07 mg/L), chromium (0.007 mg/L), fluorene (2.8 mg/L), lead (0.017 mg/L), selenium (0.001 mg/L), and silver (0.002 mg/L). Of the detected analytes, arsenic was detected above the DEQ human health groundwater standard of 0.01 mg/L. Fluorene exceeded the DEQ-7 human health groundwater standard of 1.1 mg/L. Lead exceeded the DEQ-7 human health groundwater standard of 0.015 mg/L. In comparison, the analytes arsenic, fluorene, and lead which were detected during the SPLP extraction were also detected in the soil analysis and also exceeded applicable soil SLs. In addition, barium and chromium also exceeded their respective applicable soil SLs; however, the SPLP extraction results for these two analytes did not exceed the DEQ-7 groundwater standards. A number of other SVOCs were detected in the soil sample that were not detected in the SPLP extraction.

These soil physical parameters and SPLP results may be used during future evaluations for determining site-specific cleanup levels, for localized fate and transport calculations, or during remedial design phases.

10.5 CLIMATE

The climate of the Deer Lodge Valley is discussed in the DSR (DEQ 2013) and is summarized as follows:

- The climate is semiarid and is characterized by long cold winters and short cool summers.
- Annual precipitation at the town of Deer Lodge is 10.72 inches.
- The growing season is generally very short, usually falling between June and August, and generally only about 30 percent of annual precipitation falls during this period at lower elevations.
- The prevailing wind is highly dependent on terrain, but generally follows the valleys, with south winds for much of the year in the main valley, but also from the north at times. Average wind speed is highest, around 9 miles per hour, in April and May.

10.6 ECOLOGY

10.6.1 WETLAND EVALUATION

A wetlands and stream assessment was conducted at the MRH Facility on October 22, 2013. The assessment was intended to identify and delineate potential jurisdictional waters of the United States that could be affected by future remediation activities and to evaluate which areas should be classified as sediment, soil, or aquatic for potential risk assessment evaluation. Evaluation of the MRH Facility for potential wetlands included assessment of those portions of the site with hydric soils, hydrophytic vegetation, and wetland hydrology. These three criteria are used by the U.S.

Army Corps of Engineers (Corps) to define a wetland. Disturbance activities within wetland areas are governed by the Corps.

The MRH Facility includes land that abuts the Clark Fork River, other surface water bodies including Tin Cup Joe Creek and Cottonwood Creek, man-made ditches, and low-lying areas that appear to have surface or near-surface expression of groundwater with associated wetland vegetation, such as cattails, reeds, and willows. Data from the Montana Natural Heritage Program (MTNHP) (MTNHP 2014) and National Wetlands Inventory (NWI) (FWS 2014) show that portions of the MRH Facility include four wetland types: riparian scrub-shrub, riparian forested, freshwater emergent, and riverine. Maps showing available MTNHP/NWI data for the project area along with wetland polygons delineated during a field survey conducted on October 22, 2013, are provided as Figures 10-11 and 10-12. Wetland habitat extends laterally along the Clark Fork River in the vicinity of the PRA and MRA. Additional information on these wetland types is available from the MTNHP website: http://mtnhp.org/wetlands/. MTNHP/NWI wetlands are not always synonymous with jurisdictional wetlands. MTNHP/NWI mapping units provide a starting point for identifying potential jurisdictional wetland sites regulated by the Corps under Section 404 of the Clean Water Act (CWA).

The MRH Facility is covered by the Corps' Nationwide Permit 6 for Surveying, which includes "core sampling, seismic exploratory operations, plugging of seismic shot holes and other exploratory-type bore holes, exploratory trenching, soil surveys, sampling, sample plots or transects for wetland delineations, and historic resources surveys" (Corps 2012). This permit indicates that if there will be less than 1/10 of an acre impact from site activities (for example, from soil bore drilling or test pit excavations), then pre-construction notification is not required. The area of impact for the soil borings placed in wetland or wetland-like areas for this RI was less than 1/10 acre (4356 sq ft).

10.6.2 HABITAT SURVEY AND ECOLOGICAL RECEPTOR ASSESSMENT

Habitats at the MRH Facility include aquatic and wetland habitats and terrestrial upland areas. Understanding the extent of the various types of wildlife habitat in and around the MRH Facility in order to understand the types of ecological receptors that may be exposed and to identify the locations where exposures would be most likely is a component of the RI. Numerous types of ecological receptors could potentially be exposed to Facility-related contaminants in surface water, soil, sediment, the food web, and/or air, depending upon their use of habitats in and around the MRH Facility.

An on-site survey to identify the types and extent of habitat and the types of ecological receptors that may use each type of habitat was conducted at the MRH Facility on October 22-23, 2013. The central portion of the MRH Facility consists primarily of commercial / industrial operations, small businesses, a church, and a small residential area that do not provide notable habitat. There are, however areas of habitat on the periphery of the facility consisting primarily of riparian floodplain forest and open riparian meadow. Disturbed habitat and areas that lack vegetation entirely are located along roadways, adjacent to the BNSF ROW corridor, and in areas surrounding the Sun Mountain Lumber property. Dominant plant species in riparian areas include perennial grasses and forbs, shrubs, and trees that are characteristic of the Clark Fork River valley and vicinity. Primary plant species include: smooth brome (*Bromus inermis*), Baltic rush (*Juncus balticus*), redtop bentgrass (*Agrostis stonlonifera*), beaked sedge (*Carex utriculata*), geyer willow (*Salix geyeriana*), water birch (*Betula occidentalis*), sandbar willow (*Salix exigua*), western snowberry (*Symphoricarpos occidentalis*), Bebb willow (*Salix bebbiana*), woods rose (*Rosa woodsii*); black cottonwood (*Populus trichocarpa*), and Rocky Mountain juniper (*Juniperus scopulorum*) (NPS 2004).

The native mixed-grass prairie ecosystem surrounding the MRH Facility and the City of Deer Lodge consists of intermountain grasslands dominated by western wheatgrass (*Pascopyrum smithii*), needle and threadgrass (*Hesperostipa comata*), and bluebunch wheatgrass (*Pseudoroegneria spicata*). Other species include crested wheatgrass (*Agropyron cristatum*), Kentucky bluegrass (*Poa pratense*), thistle (*Cirsium* spp.), Indian ricegrass (*Achnatherum hymenoides*), alkali sacaton (*Sporobolus airoides*) and alkali cordgrass (*Spartina gracilis*). The area immediately surrounding the MRH Facility contains a diverse mix of plant species. Percent ground cover varies between 0 and approximately 90%, with shrub and tree species interspersed throughout the habitats. The mosaic of cover and plant community types at the MRH Facility provides diversity for a variety of ecological receptors.

There are a number of bird species that utilize the areas adjacent to the MRH Facility. The type of species varies with the specific habitat and vegetation community (i.e. riparian and/or upland). Some of the species that use the upland areas and open meadows are the western meadowlark (*Sturnella neglecta*), red-tailed hawk (*Buteo jamaicensis*), sparrow (Passer spp.), mourning dove (*Zenaida macroura*), American robin (*Turdus migratorius*), loggerhead shrike (*Lanius ludovicianus*), killdeer (*Charadrius vociferus*), brown-headed cowbird (*Molothrus ater*), Brewer’s blackbird (*Euphagus cyanocephalus*), Swainson’s hawk (*Buteo swainsoni*), horned lark (*Eremophilia alpestris*), red-winged blackbird (*Agelaius phoeniceus*), and ferruginous hawk (*Buteo regalis*).

The areas surrounding the Clark Fork River corridor and associated riparian areas provide habitat for other species, including: the American avocet (*Recurvirostra americana*), California gull (*Larus californicus*), yellowheaded blackbird (*Xanthocephalus xanthocephalus*), Canada goose (*Branta Canadensis*), and Mallard duck (*Anas platyrhynchos*). Ground birds in the area include the pheasant (*Phasianus colchicus*) and Hungarian partridge (*Perdix perdix*).

Several bald eagles (*Haliaeetus leucocephalus*) were observed in large cottonwood trees along the Clark Fork River during the field survey conducted on October 22, 2013. In addition, white-tailed deer appear to reside on a year-round basis in the meadows adjacent to the MRA and PRA areas. Additional species observed during the field survey conducted on October 22, 2013, include great blue heron (*Ardea Herodias*), beaver (*Castor Canadensis*), magpies (*Pica hudsonia*), and crows (*Corvus brachyrhynchos*).

Large mammals in the area include mule deer (*Odocoileus hemionus*) and whitetail deer (*Odocoileus virginianus*). Smaller mammals include ground squirrels (*Spermophilus* spp.), long-tailed weasels (*Mustela frenata*), blacktailed jack rabbits (*Lepus californicus*), red foxes (*Vulpes vulpes*), coyotes (*Canis latrans*), and kangaroo rats (*Dipodomys deserti*). Additional information about the ecology of the MRH Facility, including a list of animal and plant species of concern is provided in the DSR (MNHP 2012).

Primary potential transport mechanisms to ecological receptors that occupy the MRH Facility include wind erosion, plant uptake, invertebrate prey uptake, vertebrate prey uptake, volatilization, leaching, and stormwater runoff. Secondary potential transport media include plant tissue and residue, invertebrate prey tissue, vertebrate prey tissue, burrow vapor, and groundwater.

Potential exposure pathways for each medium are summarized below:

- Direct contact with surface and subsurface soil by plants.
- Direct contact/ingestion of surface and subsurface soil by invertebrates.
- Ingestion of surface soil by birds and mammals.
- Ingestion of dietary items contaminated by uptake from surface soil by birds and mammals.
- Ingestion of subsurface soil by burrowing mammals.
- Ingestion of dietary items (i.e., plants, invertebrates, and burrowing mammals) contaminated by uptake from subsurface soil by birds and mammals.
- Ingestion of dietary items contaminated by uptake from surface water and sediment in the river by birds and mammals.
- Ingestion of surface water from the river by riparian/aquatic birds and mammals or fish and amphibians.
- Ingestion of sediments by riparian/aquatic birds and mammals.
- Direct contact with surface water and sediment by aquatic life, including invertebrates.

According to the DEQ Site Response Section’s Ecological Risk Assessment Guidance, the habitat survey and ecological receptor assessment in this Section along with the RI data presented in this report provide the majority of the information needed to evaluate the need for an ecological risk assessment for the Facility (DEQ, 2013b). However, it has not been determined if the Facility or parts of the facility are designated as a wildlife refuge or management area or if they contain threatened or endangered species. This ecological risk evaluation data gap is noted in Section 15.2. Depending on the results of screening evaluations using Facility data collected as part of this RI, additional evaluation of these pathways may be warranted in subsequent ecological risk assessment (ERA) analyses or during risk management implementation.

11.0 CONTAMINANTS OF POTENTIAL CONCERN

As part of the initial step to determine the contaminants of potential concern (COPC) for the MRH Facility, historical use and analytical results were evaluated. The DSR provides a synopsis of historical use and buildings associated with the roundhouse and refueling areas in addition to a summary of the analytical results from previous investigations (DEQ 2013). The DSR determined that the historical data available for the Facility was of "variable quality," but could still be used confidently to "make decisions as to the potential presence of COPCs" at the facility (DEQ 2013). This determination and a review of the spatial variation in the historical data were guidance for determining that the RI needed to expand both the analytes examined across a wider spatial area and the analyte list itself. Since the MRA and PRA have had different historical uses and therefore different potential analytes introduced to the environment, this RI report focuses on the current conditions at the Facility and the COPCs associated with each type of media at both the MRA and PRA. Additionally, both historical analytical results and the current RI analytical results are examined in this section of the RI report with respect to COPCs. All analytical results, historical and current RI, are compared to the appropriate SLs for current conditions at the Facility.

The following section details the steps taken to evaluate which analytes are COPCs specific to each of the areas.

11.1 SCREENING LEVEL SELECTION

The screening levels appropriate for the Facility are based on DEQ guidance and regulations, EPA SLs, and background levels for inorganic constituents. The SLs are based on the analyte, the media sampled, and, if applicable, the depth of the sample and depth to groundwater. SLs for residential and commercial/industrial direct contact are included as well as migration to groundwater. The following SLs were used in data evaluation and specific SLs for each analyte and media are detailed in Appendix J:

- Montana DEQ-7 Water Quality Standards (October 2012)
- Montana Tier 1 Risk-Based Screening Levels (RBSLs) (September 2009)
- EPA Regional Screening Levels (RSLs) for Chemical Contaminants at Superfund Sites (January 2015)
    - RSLs for soil results were modified based on DEQ's State Superfund Attachment C – Soil Screening Process (October 2013)
- EPA Region 3 Biological Technical Assistance Group (BTAG) Freshwater Sediment Screening Benchmarks (July 2006)

- Background Concentrations of Inorganic Constituents in Montana Surface Soils (Hydrometrics 2013)
- Site-specific Background Concentrations for Inorganics (Section 11.1.1)

The inclusion of these SLs is conservative to account for the potential end use of the property within the Facility. Depending on DEQ's determination regarding the reasonably anticipated future use of the Facility, these SLs may be adjusted to account for the number of COPCs present at the Facility or site-specific cleanup levels may be developed.

11.1.1 BACKGROUND SOIL SAMPLE RESULTS

Background surface soil samples were collected at four locations (two each at the MRA and PRA) in areas not expected to be impacted by historical releases or activities at the MRH Facility (Figures 4-2 and 4-3). Results from the background samples are shown in Table 11-1. The highest concentration for each metal was compared to the SLs for that metal, and if the background sample concentration was greater than the SL(s), the background sample concentration was used as the SL, as remediation to standards less than background conditions is generally not required by DEQ. Site-specific background sample concentrations for arsenic, cadmium, chromium, lead, and silver exceeded the Montana Surface Soil Background Threshold Values, but only arsenic background values were greater than direct contact, leaching to groundwater, or risk-based SLs. Therefore, arsenic is the only metal for which site-specific background values are used.

Only one PAH analyte (benzo(a)pyrene) was detected at one background sample location at a level greater than the SLs. There were 18 other PAH analytes that were not detected, but RLs could not meet SLs. Based on these results, there is very limited background PAH contamination. Therefore site-specific background levels for PAHs were not used for screening.

11.2 COPC SELECTION CRITERIA

The COPCs for the Facility are applied with the criteria that any detection of an analyte over any of the applicable SLs for that media and depth/depth to groundwater are considered to be a COPC for that area of the Facility (MRA or PRA) and that particular media (surface soil, subsurface soil, groundwater, surface water, sediment, or soil gas). Additionally, if there are laboratory reporting limits above an applicable SL, those particular analytes are only COPCs if there is also a detection of that analyte above the laboratory reporting limit in the same area of the Facility and media. If there are only reporting limit exceedances of applicable SLs in that area of the Facility and media, but no detections of that analyte exceed applicable SLs, then those analytes are noted, but not deemed COPCs. Also, if an analyte was detected in fewer than 5% of the RI samples for a particular medium and area, the analyte is noted but not considered to be a COPC.

Sections 12 and 13 include the COPC list for each area and media and discuss the spatial (vertical and horizontal) variation in the analytical results. Historical COPCs are identified and noted but if the RI results indicate that the analyte is no longer present above SLs, that analyte has been eliminated from further consideration.

12.0 NATURE & EXTENT OF CONTAMINATION – MRA

Based on historical use and current activities, the analyte groups of concern for the RI included petroleum hydrocarbons, PAHs, metals, PCBs, pesticides, herbicides, VOCs, and asbestos. The fate and transport of COPCs across the Facility and between media had also not been addressed, and there were no previous soil vapor investigations.

The RI focused on filling the data gaps as outlined previously and providing a more comprehensive analytical suite to refine the COPCs and the vertical and horizontal extent of contamination. The following subsections discuss the analytical results of the specific media, specify historical and current COPCs, and reference figures which illustrate the current analytical results.

12.1 TEST PITS

Twenty-five MRA test pits were excavated around historical infrastructure features associated with the CMSPP operations. These test pits were focused on locations that were suspected to have former fuel lines, drain lines, and sewer lines; as well as near the former drip pans, blacksmith workshop, oil and dope house, the roundhouse, and other support buildings and infrastructure. Test pits were used to evaluate both qualitatively and quantitatively the potential for these features to be contaminant source areas. Not every test pit was sampled for laboratory analysis. Sampling tended to focus on test pits that did appear to be source areas. Test pit logs are included in Appendix C.

Thirteen test pits excavated would not be considered to be a source area for gross contamination, although they may be contributing more localized contamination that would still need to be addressed as part of an overall cleanup strategy. These test pits were determined to not have significant subsurface impacts since they did not appear to have visual evidence of petroleum contamination or odor and PID evidence during sample collection. The test pits without obvious source area contamination include the following:

- TP-MRA-I14A (Drip Pan): No piping was exposed during the excavation. Debris, brick, and railroad ties were observed 0.5-1.7 ft bgs. Trace sheen was observed on the groundwater, but no odor was noted. Groundwater was encountered at approximately 5 ft bgs. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 4-5 ft bgs (smear zone), but contaminants were not detected exceeding the SLs.
- TP-MRA-I14B (Roundhouse & Drain Lines): No piping or structures were encountered in the excavation, nor was there any staining or odor noted. Brick debris was observed 0.5-1.5 ft bgs. Groundwater was approximately 5.5 ft bgs. Metals, SVOCs, VOCs, and VPH samples were collected from 3-3.5 ft bgs, but contaminants were not detected exceeding the SLs.

- TP-MRA-I14C (Drip Pan): The excavation was conducted near a small wooden box situated near the northwest corner of the roundhouse. A 2-inch metal pipe was observed exiting the box in east-west direction. The wooden box is 5 feet in depth. Analytical samples were not collected.
- TP-MRA-J13A (Cinder Pit): The excavation exposed a concrete lined pit approximately 11 ft wide with centered iron rail supports that were set approximately 5 feet apart. The floor of the pit was lined with brick. One wall was followed to the end where soil was excavated to the base of the pit footer. No contamination was observed within the pit or at the end with the footer. Analytical samples were not collected.
- TP-MRA-J14A (Drip Pan): No piping or structures were encountered in the excavation. The only potential hydrocarbon-like odor was detected at 7.5-9 ft bgs with a brief odor being noted, but not repeated. There was a slight sheen noted on the groundwater which was located approximately 8 ft bgs. A sample from 1-2 ft bgs was analyzed for metals, a sample collected from 3-4 ft bgs was analyzed for metals, a sample collected from 5-6 ft bgs was analyzed for metals and VOCs, and a sample collected from 8-9 ft bgs was analyzed for metals. Analytes were not detected at levels exceeding the SLs, except the barium concentration exceeded the Montana background threshold value in the 1-2 ft bgs interval.
- TP-MRA-J15A (Roundhouse & Drain Lines): The excavation was located near the center of the turntable near a foundation. No visual impacts were observed in the test pit. Groundwater was encountered approximately 5 ft bgs. Analytical samples were not collected.
- TP-MRA-K11A (Unidentified Structure): Excavation was completed on east and west side of a concrete tank structure. No visual impacts were noted. Groundwater was approximately 11 ft bgs. Metals samples were collected from 1-2 ft bgs and 2-3 ft bgs; reported concentrations did not exceed SLs.
- TP-MRA-K14A (Roundhouse & Lines): A 6-inch transite pipe was exposed about 4 ft bgs on south side of the test pit. The pipe was oriented generally N-S and had water in it. Groundwater was approximately 9.5 ft bgs. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 1-2 ft bgs and 4-5 ft bgs. Lead, C11-C22 aromatics, and five PAHs exceeded SLs from 1-2 ft bgs.
- TP-MRA-K19A (Fuel Line & Power House): A circular fill feature was exposed from 2-3.5 ft bgs and a 2-inch steel pipe was encountered approximately 2.5 ft bgs. Groundwater was approximately 7 ft bgs. Analytical samples were not collected.
- TP-MRA-L09A (UST/Wheel House): This excavation was located on the north side of the UST/Wheel House area and exposed what appeared to be the edge of an old excavation with a visual distinction between the excavated area and surrounding soil. The old excavation was a lighter brown soil while there was stained, dark soil towards the southeast corner of the excavation (towards the UST area). Groundwater was encountered approximately 7.5 ft bgs and rose quickly in the excavation once the layer was exposed. The top of an old pipe was apparently

punctured; which drained the nearby underground tank (in the UST area). Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 1-2 ft bgs and 2-3 ft bgs. SVOCs exceeded SLs from both the 1-2 ft bgs and 2-3 ft bgs intervals.

- TP-MRA-L14A (Oil & Dope House): The excavation was located near a foundation and located two 1.5-inch pipes running N-S right next to the foundation. In addition, what appeared to be a trench feature was located half way across the test pit (dark brown soil bounded by light brown soil). Groundwater was approximately 9 ft bgs. Analytical samples were not collected.
- TP-MRA-L15A (Blacksmith Workshop): Excavation was located between two concrete paths (boxcar maintenance). No staining or odors were noted. Groundwater was approximately 9.5 ft bgs. Metals, SVOCs, VOCs, and VPH samples were collected from 1-2 ft bgs. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 4.5-5 ft bgs. Metals and SVOCs exceeded SLs from the 1-2 ft bgs interval and one SVOC analyte exceeded SLs in the 4.5-5 ft bgs interval.
- TP-MRA-L15B (Roundhouse & Lines): The excavation was located near the former solvent storage area. No staining or odors were observed. Groundwater was encountered at approximately 7.5 ft bgs. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 8-8.5 ft bgs. Analytes were not detected at levels exceeding the SLs, except one SVOC and one EPH fraction.

Twelve test pits which may be in potential source areas or within petroleum contaminated areas include TP-MRA-I16A, TP-MRA-J13B, TP-MRA-J15B, TP-MRA-K09A, TP-MRA-K12A, TP-MRA-K12B, TP-MRA-K13A, TP-MRA-K13B, TP-MRA-K13C, TP-MRA-K14B, TP-MRA-L09B, and TP-MRA-L13A. The potential sources and evidence of contamination excavations are summarized below.

- TP-MRA-I16A (Roundhouse & Drain Lines): The excavation was located near the center of the roundtable. No piping or other structures were observed in the excavation. There was light grey staining 3-8.5 ft bgs. A slight odor was noted in the groundwater; however, it was more septic/decay-like than hydrocarbon. Groundwater was approximately 5 ft bgs. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 3-4 ft bgs and from 5-6 ft bgs. Metals and PAHs exceeded SLs, including a lead concentration of 4,030 mg/kg in the 5-6 ft bgs interval, one of the highest lead concentrations detected in subsurface soil at the MRA.
- TP-MRA-J13B (Drip Pan): Excavation had two legs. One was an E-W oriented leg and one was an N-S oriented leg. The E-W leg encountered timbers at the surface on east end of the trench with heavy staining underneath. The western end of the excavation was observed to have less staining and general contamination than the east end. The N-S leg of the excavation followed the timbers. On the north end of the timbers a shallow pit (5 ft deep) was excavated and it was noted that there was not as much staining. The excavation was then moved to a location to

the east side of the timbers where a vertical 30-inch helix galvanized culvert was exposed. The culvert was 5 ft bgs, packed with coarse gravel and had two 8-inch lateral pipes extruding from the north and east sides. The vertical culvert was considered to be a potential sump. Gray staining was observed starting at the base of the culvert to total depth with a slight to moderate hydrocarbon odor noted. Hydrocarbon product was noted in a layer approximately 8.5 ft bgs. Groundwater was approximately 9 ft bgs. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 6-7 ft bgs. Metals, SVOCs, EPHs and VPHs exceeded SLs.

- TP-MRA-J15B (Roundhouse drain lines): Encountered hydrocarbon impacts. Staining was noted at 6 ft bgs with a slight odor. A pipe was identified at 7 ft bgs; with no odor or staining around the pipe. No odor or sheen was identified in the groundwater at 7.5 ft bgs. A PID reading of 60 ppm was measured right above the groundwater contact on the west edge of the pit near the pipe. Railroad ties and debris were identified from the surface to approximately 2.75 ft bgs. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 1-2 ft bgs and SVOCs and EPH samples were collected from 5-6 ft bgs. Metals and SVOCs exceeded SLs in the 1-2 ft bgs interval and SVOC and EPH analytes exceeded SLs in the 5-6 ft bgs interval.

- TP-MRA-K09A (Fuel Lines): Located railroad ties and former rail bed with 2-inch steel line running under ties. In the pipeline there was a grease-like product (possibly Bunker C). The north end of the trench showed heavier staining under ties, with heavy oils/product. When excavating from 4.5-6.5 ft bgs free product, both heavier and lighter, seeped out of the formation, generally above the tight silt lenses. When groundwater was encountered there was free product on the groundwater surface. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 3-4 ft bgs. Metal, SVOC, EPH, and VPH analytes exceeded SLs.

- TP-MRA-K12A (Drip Pan): Located a drip pan with clay tile pipe extruding from it and a large 14 inch vertical hole out of the bottom of the steel container. The clay tile pipe was located approximately 2 ft bgs under concrete and the top of the drip pan was located approximately 1 ft bgs with a steel grate covering the opening. Staining and hydrocarbon odor were exposed to the total depth of 12 ft. Groundwater was encountered approximately 11.5 ft bgs and a sheen was observed. Samples for metals, SVOCs, VOCs, EPH/VPH were collected from 1-2 ft bgs and 4-5 ft bgs. Metals, SVOCs and VOCs exceeded SLs in the 1-2 ft bgs interval and SVOC and EPH analytes exceeded SLs in the 4-5 ft bgs interval.

- TP-MRA-K12B (Drip Pan): The excavation exposed a potential pit. In the east half of the trench, cinder debris (0-3.5 ft bgs) pinched out near the surface. In the west half of the trench, the black cinder, brick, and debris layer thickened. Staining and odor was observed underlying the cinder from 3.5-9 ft bgs in the east half of the pit. The staining and odor were not present under the west half. Groundwater was approximately 8.5 ft bgs. Metals were sampled from 1-2 ft bgs and 4-5 ft bgs. Barium and lead were the only analytes that exceeded SLs from the 1-2 ft bgs interval. There were no exceedances from the 4-5 ft bgs interval.

- TP-MRA-K13A (Drip Pan): A circular concrete tank feature with timbers as part of the wall on the west side was excavated. The infrastructure is in line with one of the rail lines. The interior of the feature was excavated first, with large amounts of brick and other debris being uncovered. The debris looked like it was used as backfill material. Water was encountered at 5 ft bgs with hydrocarbon sheen. The exterior of the tank with the west side timbers being the focal point was excavated around as well. No visible contamination was evident on the outside of the tank. Two N-S stacks of timbers set about 4 ft apart were exposed. Concrete was encountered between the timbers at approximately 3 ft bgs with stained coarse sands and silts as fill material. The timbers apparently formed a drain/trench along the tracks. Analytical samples were not collected.

- TP-MRA-K13B (Oil/Water Separator): oose timbers and debris were unearthed in the 0-5 ft bgs interval. Organized timbers were located approximately 5 ft bgs with stained soil noted from 6 ft bgs to the bottom of the excavation at 10 ft. Free product was noted on the groundwater which was approximately 9 ft bgs. Samples for metals, SVOCs, VOCs, and VPH were collected from 9-10 ft bgs. SVOCs exceeded SLs.

- TP-MRA-K13C (Drip pan): This location was installed as an intermediate location between TP-MRA-J14A and the concrete tank excavated under TP-MRA-K13A. Minor amounts of debris and cinder were identified from 0-4 ft bgs. Groundwater was located approximately 9.5 ft bgs with sheen. Analytical samples were not collected.

- TP-MRA-K14B (Roundhouse & Lines): Excavated near a concrete foundation and exposed a 6-inch transite line approximately 1 ft bgs next to the foundation, and 6-inch transite line approximately 5.5 ft bgs. Staining was noted near the foundation. Groundwater was not encountered. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 1-2 ft bgs and 2-3 ft bgs. Metals and SVOCs exceeded SLs from both intervals including a lead concentration of 5,960 mg/kg from the 2-3 ft bgs sample, the highest subsurface lead concentration reported at the MRA. SVOCs exceeded SLs from 2-3 ft bgs.

- TP-MRA-L09B (UST/Wheel House): The excavation was located on the south side of the former UST/Wheel House. An 8-inch cast iron pipe and a 1 ½-inch steel pipe were uncovered approximately 0.75 ft bgs. Underneath the pipe was dark heavy oil, “tar-like,” and stained soil to depth. Groundwater was encountered approximately 8.5 ft bgs and had a hydrocarbon-like sheen on the surface. Samples for SVOCs, VOCs, and EPH were collected from 2.5-3.5 ft bgs. There were four SVOCs and one VOC that exceeded SLs.

- TP-MRA-L13A (Oil and dope house): Excavation was on the north side of the structure. Staining was prevalent from ground surface to the total depth of the excavation. Groundwater was encountered approximately 10 ft bgs and had a noticeable sheen on the surface. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 1-2 ft bgs and 2-3 ft bgs. SVOCs and EPH samples were collected from 10-11 ft bgs. Metals, SVOCs and EPH exceeded SLs.

12.2 SURFACE SOIL

Prior to the RI, 269 surface soil and solid samples were collected from the MRA and analyzed for 37 different analytes. Of the 37 analytes, 18 are considered to be COPCs since they had detected values above the current SLs for surface soil. The following 18 analytes are the historical COPCs for the MRA:

- Metals
    - Arsenic, Total
    - Barium, Total
    - Cadmium, Total
    - Lead, Total
    - Mercury, Total
    - Selenium, Total
    - Silver, Total
    - Antimony, Total
    - Copper, Total
    - Iron, Total
    - Manganese, Total
    - Zinc, Total
- SVOCs
    - Benzo(a)anthracene
    - Benzo(a)pyrene
    - Benzo(b)fluoranthene
    - Indeno(1,2,3-cd)pyrene
    - PCB-1260-Aroclor
- VOCs
    - 1,2- Dichloroethane

The historical SL exceedances for metals span the entire area of the MRA (Figure 12-1). The historical SVOC SL exceedances also span 12 of the 15 locations across the MRA (Figure 12-2). Historical VOC exceedances are isolated to three samples located in the northern MRA near the historical trestle, just east of the former drip pans and north of the former roundhouse footprint, and between the county road and the lumber mill operations southwest of the historical MRA property (Figure 12-3). Surface soils were not historically sampled for EPH or VPH fractions.

To assess the current conditions at the MRA, 184 surface soil samples, including 11 duplicates, were collected across 101 locations at the area during the RI. The results of this RI sampling effort illustrate the current conditions and current COPCs for the MRA. Approximately 88 of the surface soil samples were collected as 5-point composites in order to get a broader assessment of surface soil contamination across the MRA. COPCs are listed in Table 12-1. The analytical results are presented in Tables 12-2 through 12-6 and Appendix M. Figures 12-1 through 12-23 visually illustrate the analytical results as exceedances of the surface soil SLs or non-exceedances. From the comparison of the analytical results to the surface soil SLs, there are 18 current COPCs identified for surface soil for the MRA. The following analytes represent COPCs for MRA surface soil:

- Metals
    - Arsenic, Total
    - Barium, Total
    - Cadmium, Total
    - Lead, Total
    - Mercury, Total
- SVOCs
    - Benzo(a)anthracene
    - Benzo(a)pyrene
    - Benzo(b)fluoranthene
    - Benzo(k)fluoranthene
    - Dibenzo(a,h)anthracene
    - Indeno(1,2,3-cd)pyrene
    - 1-Methylnaphthalene

  - PCB-1260-Aroclor
  - Dieldrin
- VOCs
  - Methylene Chloride
  - Trichloroethene
- EPH Fractions/VPH
  - C9-C18, Aliphatic, Adjusted
  - C11-C22, Aromatic, Adjusted

There are an additional 56 analytes that were not detected above the analytical detection limit, but had a reporting limit above the current surface soil SLs. The only analytes in this group that are COPCs in other media at the MRA are vinyl chloride in groundwater and benzene in soil gas. Based on the spatial distance between the limited detections in other media and the surface soil non-detect exceedances, the 56 analytes that had non-detect exceedances only (including vinyl chloride and benzene) were not retained as COPCs in surface soil.

COPCs are listed on Table 12-1, and Tables 12-2 through 12-6 show the analytical results with detections or reporting limits exceeding the SLs in bold. Figures 12-1 through 12-4 show the sample locations exceeding SLs for each analyte group for both RI and historical samples.

MRA Surface Soil - Metals

The metals surface soil exceedances for the MRA are located throughout the former process and maintenance area of the MRA from the trestle to south of the former maintenance shop and into the historical lumber spur along the east side of the Sun Mountain Lumber property. The SL exceedances also stretch from the west side of Sun Mountain Lumber along Greenhouse Road (the southern extension of Kentucky Avenue) to the elevated bank just west of the Clark Fork. Despite having six identified metals COPCs for the MRA, there does not appear to be a correlation between the spatial location of the exceedances and other contamination or fill materials. The exceedances are located in historical process/maintenance areas as well as historically non-railroad areas such as the fields to the west and east of the MRA and are presented in Figures 12-5 through 12-10. Each metal COPC is discussed with respect to the concentration and location of SL exceedances in the MRA surface soil, as follows:

Arsenic - Out of 184 samples, arsenic exceeds the site-specific background level of 65 mg/kg-dry at eight surface soil locations (Figure 12-5). The locations are located in the following grids: MRA-P07, MRA-J09, MRA-J10, MRA-I11, MRA-O11, MRA-M12, MRA-O15, and MRA-N18. Three of the exceedances are east of Tin Cup Joe Creek, but still west of the main maintenance process area of the MRA: MRA-J09, MRA-J10, and MRA-I11. These are in areas that were not historically part of the MRH activities, but may have been impacted by both Tin Cup Joe Creek and former site activities topographically upgradient from these locations. Additionally, four of the MRA arsenic surface soil exceedances are located in grids near the former CSMPP and current BNSF ROW: MRA-P07, MRA-011, MRA-015, and MRA-N18.

Barium - Barium exceeds the surface soil SLs in 33 of the 184 samples (Figure 12-6). Samples primarily exceeded the MT Inorganic Threshold SL values and only exceeded the RSL for residential soil in one sample (MRA-L08 [1-2 ft]), just at the eastern edge of the Bunker C excavation area in MRA-L08. Barium samples exceeding the barium SLs were found across the MRA. Composite samples (0-0.5 ft bgs) tended to be located near the BNSF ROW, the Clark Fork, or Tin Cup Joe Creek. However, discrete samples (generally from 1-2 ft bgs) exceeded the barium SLs near Tin Cup Joe Creek, surrounding the roundhouse operations area, and near the former rail line.

Cadmium - Cadmium was detected above the surface soil SLs in 22 of the 184 samples for the MRA (Figure 12-7), primarily exceeding the SLs for leaching to groundwater. Nine samples also exceeded the residential RSL. The highest concentration was recorded for a surface soil sample at MRA-G13 (1-2 ft bgs) at 24 mg/kg-dry, which is west of Tin Cup Joe Creek within a horse pasture.

Lead - Out of 184 metals surface soil samples on the MRA, 83 results exceeded the leaching to groundwater SL (140 mg/kg-dry). The concentrations of lead measured at the MRA during the RI range from 4 mg/kg-dry to 6,040 mg/kg-dry. The SL exceedances in surface soil range from the northern MRA grid MRA-N03 to the southern area along the active railway spur for Sun Mountain Lumber in MRA-M31 (Figure 12-8). They also span from the west to the east of the area across both the historical MRH railroad area and into adjoining fields. There does not appear to be a correlation between the elevated lead data and the spatial distribution across the MRA; however, the lead exceedances appear to be most concentrated north of the Sun Mountain Lumber shop and throughout the historical MRA maintenance area.

Mercury - Out of 184 surface soil samples, mercury concentrations exceeded SLs for surface soil in 3 samples. These three samples exceeded the residential RSL (0.94 mg/kg-dry), but only two exceedances were above the SL for leaching to groundwater (1.04 mg/kg-dry). The highest reported mercury concentration, 1.7 mg/kg-dry, in surface soil was at MRA-K18A from 1-2 feet bgs just west of the historical power station and current vehicle wash pad, but it was also detected in the same grid at 0-0.5 feet bgs at 1 mg/kg-dry (Figure 12-9). Mercury was at detected at 1.3 mg/kg-dry at MRA-M05A on the northern MRA just north of the road culvert of Tin Cup Joe Creek.

MRA Surface Soil - SVOCs

The SVOC COPCs for the MRA range from PCB constituents, to petroleum hydrocarbon constituents, to one insecticide. The suite of SVOCs sampled at the MRA varies based on location and depth of the soil samples. A total of 55 surface soil samples at the MRA were sampled for at least a subset of SVOCs.

Several SVOC COPCs are PAHs and are constituents associated with petroleum fuel products: benzo(a)anthracene (Figure 12-10), benzo(a)pyrene (Figure 12-11), benzo(b)fluoranthene (Figure 12-12), benzo(k)fluoranthene (Figure 12-13), dibenzo(a,h)anthracene (Figure 12-14), indeno(1,2,3-cd)pyrene (Figure 12-15), and 1-methylnaphthalene (Figure 12-16). These seven PAH COPCs for the MRA surface soil are detected above the SLs typically for both residential RSLs and for RBCA RBSL for direct contact for residential. However, each of these PAHs except benzo(k)fluoranthene has at least one location exceedance for the RBCA RBSL direct contact for commercial SL. Figures 12-10 through 12-16 illustrate the spatial locations of surface soil samples and exceedances for these COPCs. In general, the exceedances for these PAH COPCs range from the northern grid of MRA-N04 to the southern grids of MRA-A28 and MRA-H25. The exceedances are also found as far east as the grids that abut the BNSF ROW and as far west as the horse pasture to the west of Tin Cup Joe Creek. This distribution indicates that PAHs are a potential concern for almost the entire area of the MRA depending on the use and activities currently at, or projected for, the area.

One PCB congener, PCB-1260-Aroclor, exceeded the residential RSL in grid MRA-I17 for surface soil at the MRA and is a COPC (Figure 12-17). PCB-1260-Aroclor was detected in 19 of 34 samples at the MRA. The area where the SL was exceeded is not directly near the historical power house or oil house, but is a grid that includes a portion of the roundhouse foundation in a sample result from 0-0.5 ft bgs.

A smaller subset of surface soil samples were analyzed for pesticides and herbicides at the MRA. In one of the three samples for pesticides and herbicides, the insecticide dieldrin was detected above the residential RSL and leaching to groundwater SL and determined to be a COPC. Dieldrin was detected above the SLs at 0.12 mg/kg-dry at MRA-J10 from 0-0.5 ft bgs. This is just west of the operations area between the former storage/tracks and east of Tin Cup Joe Creek, but south of the Bunker C excavation area (Figure 12-18). The dieldrin results are below the detection limit at MRA-M10 and MRA-N16, but the reporting limit was above the leaching to groundwater SL. Since dieldrin is a COPC based on the results at MRA-J10, it is considered an exceedance and Figure 12-18 shows those locations with results below the reporting limit as exceedances for dieldrin.

MRA Surface Soil - VOCs

During the RI, 50 surface soil samples were analyzed for 72 VOC analytes to evaluate current conditions across the MRA. Of these 50 samples, only 2 VOC COPCs were identified: methylene chloride and trichloroethene.

Methylene chloride - Three surface soil analytical results detected methylene chloride above the leaching to groundwater surface soil SLs for the MRA (Figure 12-19). The leaching to groundwater SL for methylene chloride is 0.0128 mg/kg-dry, which is over 2,000 times less than the next lowest SL, the residential RSL of 35 mg/kg-dry. The highest concentration of methylene chloride in surface soil at the MRA was 0.0198 mg/kg-dry at MRA-I19. This grid is south of the roundhouse footprint in an area that typically houses Sun Mountain Lumber's timber cutting equipment for maintenance. However, there were two other surface soil exceedances of methylene chloride north of the roundhouse footprint at TP-MRA-K12A and MRA-L10. The sample from the test pit TP-MRA-K12A has a result of 0.0155 mg/kg-dry and is located within the historical drain pan area. That test pit also exhibited additional evidence of contamination as discussed in Section 12.2. The sample from MRA-L10 was a composite sample with a concentration of 0.0142 mg/kg-dry and is north of the main historical maintenance and operations area.

Trichloroethene (TCE) - TCE was detected above the leaching to groundwater SL (0.0176 mg/kg-dry) for nine surface soil samples on the MRA, but the concentrations did not exceed the residential or industrial RSLs. Figure 12-20 illustrates the surface soil sample locations where TCE concentrations exceeded the SL during the RI sampling in 2014. TCE concentrations exceeded the SL in the northern MRA both north and south of where Tin Cup Joe Creek crosses the MRA access road at Railroad Ave. in grids MRA-M05A and MRA-L06B. In this northern area, the highest concentration is 0.238 mg/kg-dry at 1-2 ft bgs at MRA-L06B, but still exceeds the leaching to groundwater SL at 0-0.5 ft bgs in the same grid at almost an order of magnitude smaller at 0.0279 mg/kg-dry. Across Tin Cup Joe Creek and the access road in grid MRA-M05A, the concentration is 0.0225 mg/kg-dry at 1-2 ft bgs, and no VOC sample was taken from 0-0.5 ft bgs in this grid. This area is not associated with historical structures, but is downgradient of the former excavation area for Bunker C (EPA, 2011) and former ASTs and is located along Tin Cup Joe Creek. Soil vapor monitoring point SG-101S is installed in grid MRA-M06 and has evidence of TCE above soil vapor SLs as discussed in Section 12.8.

TCE is also greater than the leaching to groundwater SL in the middle of the MRA just south of the roundhouse footprint and near the former oil house area, former power plant, and continuing south past the former MRH railroad blacksmith and tank maintenance building, which is currently the Sun Mountain Lumber timber operations offices and maintenance shop (Figure 12-20). Sample results from grids MRA-K17, MRA-K18, MRA-I19, MRA-J20, and MRA-J22 have TCE concentrations in surface soil samples above the leaching to groundwater SLs. The surface soil TCE is generally bounded by sample results below the SLs to the north, east, and west of these grids, but no VOC soil samples were taken directly south of grid MRA-J22. The highest concentration of 0.407 mg/kg-dry was at 0-0.5 ft bgs at MRA-I19, which is between the roundhouse and the maintenance shop and within an area where timber machinery is stored during the off-season for maintenance. Soil sample results are similarly elevated for TCE in MRA-K17A from 1-2 ft bgs (0.118 mg/kg-dry) and MRA-J20 from 0-0.5 ft bgs (0.116 mg/kg-dry). Lower TCE results were reported at MRA-K18A from 0-0.5 ft bgs and 1-2 ft bgs and MRA-J22 from 0-0.5 ft bgs. Soil gas probe SG-105 and monitoring well MW-105 are both located near this area of TCE exceedances in surface soil.

MRA Surface Soil - EPH/VPH

Two EPH fractions exceeded the SLs for the surface soil at the MRA. Both C9-C18 aliphatic and C11-C22 aromatic fractions exceeded the RBCA RBSL direct contact residential SL for a small subset of the samples. The C9-C18 aliphatic fraction exceeded the SL in two samples at one test pit location, while the C11-C22 aromatic fraction exceeded the SL in 5 samples out of 35 MRA surface soil samples. Specifically, the C9-C18 aliphatic fraction only exceeded the SL at 1-2 ft bgs for the test pit at MRA-L13A (341 mg/kg dry). This appears to be a localized exceedance and was observed in both the sample and a duplicate taken at that location and depth (Figure 12-21). The C11-C22 aromatic fraction exceeded the RBCA RBSL direct contact residential SL in five surface soil locations: MRA-I11, MRA-L10, MRA-M05A, and test pits for MRA-K14A and MRA-L13A (in a duplicate sample) (Figure 12-22). These locations are north of the roundhouse and extend to the northern MRA near Tin Cup Joe Creek (Figure 12-4).

12.3 SUBSURFACE SOIL

The MRA had historical subsurface samples for 32 analytes. Of the 32 analytes, 6 were determined to be COPCs since they had detected values above the SLs for subsurface soil. The following 6 analytes are the historical COPCs for the subsurface soil at the MRA:

- Metals
  - Arsenic, Total
  - Lead, Total
- SVOCs
  - Benzo(a)anthracene
  - PCB-1260-Aroclor
- EPH/VPH
  - C11-C22, Aromatic
  - C9-C18, Aliphatic

The SL exceedances for metal historical sampling results for subsurface soil are primarily located in the northern MRA where the majority of the 37 historical samples were collected (Figure 12-23). Arsenic and lead are historical MRA subsurface COPCs for exceedance of the site-specific background SL (arsenic, seven result exceedances) and the leaching to groundwater SL (lead, ten result exceedances). Coordinates are not available for samples from Trench 6 and Trench 7.

Benzo(a)anthracene and PCB-1260-Aroclor exceeded the SLs at just one historical subsurface sampling location each, MHCF13F60 (in the center of the bunker C excavation area) and SMRH-PCBT5 (within the former power plant area, which appears behind MRA-K18A on Figure 12-24), respectively. These locations are shown on Figure 12-24. The EPH fractions exceeding SLs were limited to two sample locations, both part of the EPA START work in 2011 in the Bunker C excavation area.

To assess the current conditions at the MRA, 133 subsurface soil samples, including 9 duplicates, were collected across 76 locations for 196 different analytes during the RI field work. The results of this RI sampling effort illustrate the current conditions and current COPCs for the MRA. The COPCs are listed in Table 12-7. The analytical results are presented in Tables 12-8 through 12-12 and Appendix M. Figures 12-23 through 12-26 visually illustrate the analytical results as exceedances of the subsurface soil SLs or non-exceedances for each analyte group. From the comparison of the analytical results to the subsurface soil SLs, there are 19 current COPCs identified for subsurface soil for the MRA:

- Metals
    - Arsenic, Total
    - Barium, Total
    - Cadmium, Total
    - Lead, Total
    - Mercury, Total
- SVOCs
    - Benzo(a)anthracene
    - Benzo(a)pyrene
    - Benzo(b)fluoranthene
    - Dibenzo(a,h)anthracene
    - Indeno(1,2,3-cd)pyrene

  - 1-Methylnaphthalene
  - 2-Methylnaphthalene
- VOCs
  - Trichloroethene
- EPH/VPH Fractions
  - C5-C8, Aliphatic, Adjusted
  - C9-C12, Aliphatic, Adjusted
  - C9-C18, Aliphatic, Adjusted
  - C11-C22, Aromatic, Adjusted
  - C19-C36, Aliphatic Adjusted
  - Naphthalene (also sampled during SVOC analysis)

There are an additional 60 analytes that were not detected above the analytical detection limit, but had a reporting limit above the current surface soil SLs. Benzene, 1,2,4-trimethylbenzene, and vinyl chloride were COPCs for soil gas or groundwater at the MRA. The other analytes were not detected above SLs in other media at the MRA. Due to spatial distances between the detections in other media and the locations of the non-detect exceedances in MRA subsurface soil, none of the 60 analytes (including benzene, 1,2,4-trimethylbenzene, and vinyl chloride) were retained as COPCs. COPCs are listed on Table 12-7, and Tables 12-8 through 12-12 detail those analytical results.

MRA Subsurface Soil Metals

The SL exceedances for the RI sampling results for subsurface soil are primarily located in the northern MRA near Tin Cup Joe Creek. Four additional exceedances are found at MRA-G18, MRA-L14, TP-MRA-I16A, and MRA-O15. Figure 12-23 illustrates the locations of these subsurface metals results exceedances. Despite having five identified metals COPCs for the MRA, there does not appear to be a direct correlation between the spatial location of the exceedances and other contamination or fill materials. There were six instances at the MRA where both surface soil and subsurface soil had metals exceedances at the same location: MRA-G18, MRA-LO6B, MRA-M05A, MRA-N03, MRA-015, and TP-MRA-K14B. Lead was the primary COPC found in both the surface and subsurface, but barium was also present at both depth profiles for MRA-L06. In general the lead concentrations cannot be correlated with depth since three of the samples exhibited the highest lead concentrations in the surface soil and the other three at depth in the subsurface soil. The higher results do not follow either a type of material or a depth profile pattern for the metals in the subsurface at the MRA. However, the exceedances in the northern MRA at MRA-N03, MRA-M05A, and

MRA-L06B are adjacent to Tin Cup Joe Creek and may have been along a traditional groundwater and surface runoff pathway from the MRH operations near the former Bunker C tank. TP-MRA-K14B is near the former sewer line that ran south to north from the roundhouse. MRA-G18 is just southwest of the former roundhouse area and MRA-O15 is near the BNSF right of way on the eastern side of the MRA.

<u>Arsenic</u> - Out of 84 samples, arsenic exceeds the site-specific background level of 65 mg/kg-dry at only 2 subsurface soil locations at the MRA – MRA-N03 (3.5-4 ft) and MRA-N04B (14.5 to 15 ft) (Figure 12-27). MRA-N03 is a sample adjacent to the former railroad bridge, while MRA-N04B is directly south of the former railroad trestle bridge and is at the northern edge of the past remedial excavations and the corresponding surface soil sample at this location does not have an arsenic exceedance. At the depth of MRA-N04B, the sample is likely from native medium-grained sand with a trace of gravel and just above the saturated zone.

<u>Barium</u> - Barium was above the Montana background threshold SL in 6 of the 84 samples (Figure 12-28). The six samples are from five locations: MRA-L06B, MRA-L07B, MRA-N03, TP-MRA-I16A, and TP-MRA-K14B. The highest MRA subsurface soil barium concentration was found in the area just north of the roundhouse footprint between the footprint and the historical drain pan area, near the historical storm and process lines. The result for TP-MRA-K14B was 1,590 mg/kg-dry and also exceeds the EPA residential RSL.

<u>Cadmium</u> - Cadmium was above the soil SLs in 2 of the 84 sample results at locations MRA-L07B and TP-MRA-I16A (Figure 12-29). The highest concentration was 17 mg/kg-dry at TP-MRA-I16A from 5-6 ft bgs and exceeds both the leaching to groundwater SL of 3.8 mg/kg and the residential RSL of 7 mg/kg. Similar to barium, there were no other exceedances in surrounding subsurface soil samples in this location. One additional isolated exceedance was found at MRA-L07B from 4.5 to 5.5 ft bgs. This result was 4 mg/kg-dry which exceeds the leaching to groundwater SL of 3.8 mg/kg, but a deeper sample at the same location (5.5 to 6.5 ft bgs) had a result below the 1 mg/kg detection limit.

<u>Lead</u> - Out of 84 subsurface soil samples, the MRA has 13 SL exceedances for the leaching to groundwater SL (140 mg/kg-dry). The lead concentrations in the subsurface sample results at the MRA range from 3 mg/kg-dry to 5,960 mg/kg-dry. Figure 12-30 shows the sample locations and exceedances for lead in the subsurface soil. There does not appear to be a correlation between the elevated lead data and the spatial distribution across the MRA; however, the northern MRA exceedances are primarily in areas near Tin Cup Joe Creek at the smear zone. The exceedances are not found south of grid MRA-G18 on the remainder of Sun Mountain Lumber property. The highest concentration is found at TP-MRA-K14B at 2-3 ft bgs, which is just east of the roundhouse near the foundation. The lithology at this depth is gravelly sand with some silt and cobble and no odor was noted; however, there was staining near the roundhouse foundation. The next two highest concentrations are not near TP-MRA-K14B, but are to the southwest at

TP-MRA-I16A (4,030 mg/kg-dry) and further southwest at MRA-G18 (1,030 mg/kg-dry) near the ditch to Tin Cup Joe Creek.

Mercury - Out of 84 subsurface soil samples, mercury was above SLs for soil in only 2 subsurface MRA soil samples. These two samples exceeded the residential RSL (0.94 mg/kg-dry), but only one concentration was above the SL for leaching to groundwater (1.04 mg/kg-dry). The highest reported mercury concentration, 1.1 mg/kg-dry, in subsurface soil is at MRA-N04B at 14.5 to 15 ft bgs. This location is near the trestle area in the northern MRA. Mercury was also detected above the soil SLs at 1.0 mg/kg-dry at TP-MRA-I16A within the footprint of the roundhouse turntable area (Figure 12-23).

MRA Subsurface Soil SVOCs

Of the 86 SVOC analytes sampled in up to 83 samples, there were 8 identified SVOC COPCs for the subsurface soil at the MRA. Figure 12-24 indicates the locations with exceedances in the subsurface soil SVOCs at the MRA. Some of these exceedances align with some of the historical areas of concern where petroleum products were stored, transferred, or used, but not all of them align with known areas of historical use. There are SVOC exceedances around the roundhouse footprint, near the historical drip pans and product piping runs and in the area of the former Bunker C tank and excavation. However, three samples south of the former MRH operations areas just north and south of the Sun Mountain Lumber access road (MRA-G24, MRA-G25, and MRA-G27) also have SVOC exceedances, but these were only based on detection limits above SLs for 1-methylnaphthalene.

PAHs - The eight identified SVOC COPCs are PAH constituents: benzo(a)anthracene (Figure 12-31), benzo(a)pyrene (Figure 12-32), benzo(b)fluoranthene (Figure 12-33), dibenzo(a,h)anthracene (Figure 12-34), indeno(1,2,3-cd)pyrene (Figure 12-35), 1-methylnaphthalene (Figure 12-36), and 2-methylnapthalene (Figure 12-37). These PAH COPCs for the MRA subsurface soil are detected above the SLs typically for both residential RSLs and for RBCA RBSL for direct contact for residential. Benzo(a)pyrene and both methylnaphthalene constituents also exceed additional SLs. In general the exceedances for these PAH COPCs range from the northern grid of MRA-N04A near the confluence of Tin Cup Joe Creek and the Clark Fork River to the southern grid of MRA-G18, which is southwest of the roundhouse foundation. This would indicate that PAHs are a concern for the majority of the former engine maintenance process areas, engine storage areas, and refueling areas.

PCBs - PCBs were not detected in ten subsurface soil samples from the MRA at concentrations exceeding SLs. These samples were collected from areas with potential historical PCB contamination including near the transformer storage area and along Tin Cup Joe Creek.

MRA Subsurface Soil VOCs

During the RI 31 subsurface soil samples from the MRA were analyzed for VOCs to establish current conditions across the area. Trichloroethene was the only current VOC COPC identified. Figure 12-25 shows the two locations with exceedances for TCE at the MRA: one is a detected TCE exceedance and the other has a reporting limit exceedance. The only detected concentration of TCE is at 0.169 mg/kg-dry at MRA-L06B from 6 to 7 ft bgs, which is approximately one order of magnitude above the leaching to groundwater SL (0.0179 mg/kg). This soil boring location is on the northern MRA and adjacent to Tin Cup Joe Creek and within a horse pasture area. This area is not associated with historical structures, but is down gradient of the former excavation area for Bunker C (EPA, 2011), former ASTs and along Tin Cup Joe Creek, which had some historical releases within or nearby. Soil vapor monitoring point SG-101 is installed in grid MRA-M06 and has evidence of TCE above soil vapor SLs as discussed in Section 12.3. There is also one location, TP-MRA-L09A at 2 to 3 ft bgs, where the laboratory reporting limit was above the leaching to groundwater SL, but the result was reported to be below the detection limit.

MRA Subsurface Soil EPH/VPH

During the RI, 31 subsurface soil samples from locations on the MRA were analyzed for EPH and/or VPH (Figure 12-26). Five EPH/VPH fractions and naphthalene were found to have exceeded the SLs for the subsurface soil at the MRA. The five EPH fractions (C5-C8 aliphatic, C9-C12 aliphatic, C9-C18 aliphatic, C11-C22 aromatic, C19-C36 aliphatic) and naphthalene exceeded the RBCA RBSL direct contact residential SL for 1 to 15 sample results. Two results for naphthalene also exceeded the EPA RSL for residential soil. Both C9-C18 aliphatics and C19-C36 aliphatics also had exceedances of the RBCA RBSL for both direct contact during excavation and direct contact for commercial use. Figures 12-38 through 12-42 illustrate the locations of the exceedances.

Some of the highest exceedances for EPH/VPH are found at TP-MRA-J15B from 5 to 6 ft bgs. This test pit is located within the former roundhouse footprint just west of the foundation near the turntable. TP-MRA-J15B resulted in exceedances for three of the EPH fraction COPCs. This is consistent with the depth of the smear zone. Several test pits and soil borings to the north and west of this test pit did not have samples with concentrations exceeding SLs.

Several other test pits near the roundhouse foundation area also exhibited EPH fraction exceedances: TP-MRA-J13B, TP-MRA-K12A, and TP-MRA-L13A. Additionally, one test pit and two soil borings have EPH fraction exceedances to the east of the roundhouse foundation and along the potential pipe corridor in the central area of the PRA: MRA-M16, MRA-K17, and TP-MRA-K17A. This is consistent with potential petroleum spills in the area and the direction of groundwater flow. While there is no sample directly east of MRA-M16, three samples to the northeast and northwest from that grid did not have any EPH exceedances (MRA-N14, MRA-O15, and MRA-N18).

Similarly, TP-MRA-J13B from 2-3 ft bgs also had three exceedances of EPH fractions, but also had a naphthalene exceedance. This test pit is located within the drip pan area and was the location of the potential timber sump. A deeper sample at this test pit location from 5 to 6 ft bgs had results below the detection limit for EPH fractions and naphthalene.

Several other test pits and soil borings that follow the piping corridor from historical storm water, fire suppression, and chemical transport pipes to the historical storage area near the Bunker C excavation also show EPH/VPH exceedances. Samples from TP-MRA-L13A, TP-MRA-K12A, TP-MRA-K09A, MRA-L09, MRA-K08 and MRA-L07B had EPH exceedances and follow the piping system to the Bunker C excavation area. Specifically, TP-MRA-K09A has some of the highest EPH concentrations and has exceedances at two sample depths from 3 to 10.5 ft bgs. This test pit has exceedances for C9-C18 aliphatics, C11-C22 aromatics, and naphthalene. North of the Bunker C area and through the northern MRA, the results for EPH/VPH are below the SLs and often below detection limits.

There is one sample in the southern area of the MRA in MRA-K23 (4.5-5.5 ft) that also has two EPH fraction exceedances, C19-C18 aliphatics and C11-C22 aromatics. MRA-K23 is just north of the pad for Sun Mountain Lumber's AST and fueling area. Nearby soil borings do not show exceedances.

12.4 GROUNDWATER

Prior to the RI groundwater sampling events, groundwater at the MRA was historically analyzed for 30 different analytes. Of the 30 analytes, 4 were determined to be COPCs since they had detected values above the current SLs for groundwater. The following analytes are the historical COPCs for the MRA:

- Metals
    - Cadmium, Total
    - Barium, Total
- VOCs
    - Trichloroethene
    - Vinyl Chloride

Barium exceeded the SL at DDH-8, which is located in the northern MRA near the historical trestle. The samples with cadmium exceedances were collected from wells DDH-1, DDH-3, DDH-7, and DDH-8, each located north of the former roundhouse (Figure 4-6). Historical results were reported as total metals concentrations; however, DEQ-7 groundwater standards are based on dissolved metals. The total metals concentrations were conservatively compared to dissolved metals screening levels. The VOC exceedances are isolated to just one historical sample location for each analyte. The trichloroethene exceedance occurred at well DDH-4 which is located northeast of the drip pans (Figure 4-6). The vinyl chloride exceedance occurred at well DDH-8.

An additional ten historical analytes had reporting limits above the current SLs for surface soil, but had no detections and are therefore not historical COPCs. These include 1,1-dichloroethane, 1,2-dichloroethane, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, total lead, and total mercury.

To assess the current conditions at the MRA, groundwater samples from 18 wells were collected and analyzed for 169 constituents during the RI field work. The results of this RI sampling effort illustrate the current conditions and current COPCs for the MRA (Table 12-13). Groundwater samples were collected using low-flow sampling techniques. The analytical results are presented in Tables 12-14 through 12-18 and Appendix M. Figures 12-44 through 12-47 visually illustrate the analytical results as exceedances of the groundwater SLs or non-exceedances. From the comparison of the analytical results to the groundwater SLs, there are seven current COPCs identified for groundwater for the MRA. The following analytes are the COPCs for the MRA groundwater:

- Metals
    - Arsenic, Dissolved
    - Cadmium, Dissolved
    - Iron, Dissolved
    - Iron, Total
    - Manganese, Dissolved
    - Manganese, Total
- VOCs
    - Vinyl Chloride

There are an additional 10 analytes that were not detected above the analytical detection limit, but had a reporting limit above the groundwater SLs (Table 12-13). Only benzo(a)pyrene and dibenzo(a,h)anthracene were detected as COPCs in surface and subsurface soil; however, they were not detected at concentrations exceeding the leaching to groundwater SLs and therefore were not retained as COPCs for groundwater.

MRA Groundwater Metals

The metals groundwater exceedances for the MRA are located throughout the MRA (Figure 12-43). Metals exceedances span from the southern-most well located north of the Sun Mountain Lumber operations area to the northern MRA; however, metals concentrations exceeded SLs at only 6 of 20 wells sampled at the MRA. Dissolved manganese was the only metal exceeding SLs at three of these wells. In the following section each metal COPC is discussed with respect to the concentration and location of SL exceedances in the MRA surface and subsurface soil.

Arsenic - Out of 38 samples, arsenic exceeds the DEQ-7 standard of 0.01 mg/L at 2 well locations (DDH-6 and MW-107). Both wells had exceedances for dissolved arsenic during both the spring and fall sampling events. DDH-6 is located on the north end of the MRA, west of Tin Cup Joe Creek (Figure 12-47). MW-107 is located on the south end of the MRA, north of the Sun Mountain Lumber operations area. These wells are in areas that were not historically part of the MRH activities, but DDH-6 is downgradient of the Bunker C area and MW-107 is near a possible historical dump area which may be affecting groundwater in the area.

Cadmium - The dissolved cadmium concentration exceeded the DEQ-7 standard of 0.005 mg/L in 1 of 38 samples (Figure 12-48). Cadmium was detected at a concentration of 0.0056 mg/L in the August 2014 sample from well RHMW02S, which is the shallow well at the northwestern edge of Bunker C excavation area. The cadmium result from the April sampling event at the well was less than the standard. Although RHMW02S was an existing well, it had not been previously sampled for cadmium.

Iron - Iron was detected above the RSL for Tapwater of 14 mg/L (for both dissolved and total iron) in one well at the MRA. Sample results from monitoring well MW-107 exceeded the SL for both dissolved and total iron (23 mg/L and 29.6 mg/L, respectively) during the August 2014 sampling event. Both concentrations were 12.9 mg/L for samples collected in June 2014.

Manganese - Dissolved and total manganese were detected at concentrations exceeding the RSL for Tapwater of 0.43 mg/L in four wells at the MRA (Figure 12-49): MW-101, RHMW06, MW-105, and MW-107. Both dissolved and total manganese exceeded the SL in samples from the four wells during the spring and summer sampling events, except the manganese concentrations were less than the RSL in the August 2014 samples from MW-101. The highest concentrations were detected at MW-105 and MW-107 which are both located on the southern portion of the MRA on Sun Mountain Lumber property. MW-107 is the only well at the MRA with exceedances for more than one metal. This may be a result of the former dump area to the northwest of the well.

MRA Groundwater SVOCs

The only SVOC at the MRA that exceeded SLs was the PAH dibenzo(a,h)anthracene, which is a constituent of petroleum fuel products. The August 2014 sample from monitoring well RHMW06 was the only sample with a detected concentration of dibenzo(a,h)anthracene (0.12 ug/L) which exceeded the DEQ-7 standard of 0.05 ug/L. However, as the frequency of detection of dibenzo(a,h)anthracene was less than 5%, it is not considered a COPC for groundwater (Figure 12-46).

MRA Groundwater VOCs

During the RI, 38 groundwater samples were analyzed for 72 VOCs to evaluate conditions across the area (Figure 12-45). Only one current VOC COPC was identified: vinyl chloride. Vinyl chloride is an industrial chemical that is primarily used today for the production of PVC pipe, but has also been used as a solvent and aerosol spray propellant. However, it is also a product of biodegradation of trichloroethene and tetrachloroethene.

Vinyl chloride was detected above the DEQ-7 standard of 0.2 ug/L in groundwater collected from monitoring well DDH-8 during both the April and August 2014 sampling events (Figure 12-50). DDH-8 is located in the northern MRA. The reporting limit for vinyl chloride at all the wells at the MRA exceeded the standard. Trichloroethene was a historical COPC and was identified as a COPC for surface and subsurface soil at the MRA, but was not detected at concentrations exceeding the DEQ-7 standard in RI groundwater samples.

However, groundwater sample results from MW-105 have had detections of TCE and degradation products cis-1,2-dichloroethene and trans-1,2-dichloroethene, but these compounds were not detected above the groundwater standards. MW-105 has also had several other chlorinated solvent degradation products without detections, but with reporting limits above the standards for those analytes. SG-105 has not been monitored for VOC soil gas concentrations since the groundwater has been shallower than 5-ft bgs in the central MRA area (Section 12.8).

MRA Groundwater EPH Fractions/VPH

TEH exceeded the 1 mg/L screen for groundwater at two locations; RHMW-02S in August 2014 (2.47 mg/L) and RHMW06 in April 2014 (1.5 mg/L); however, the EPH and VPH fractions did not exceed screening levels.

Field Parameters

Parameters were collected in the field for each well sampled. Parameters collected included pH, temperature, dissolved oxygen (DO), conductivity, and oxidation-reduction potential (ORP). Groundwater at the MRA is consistently around neutral with pH measurements ranging from 6.24 standard units (SU) at well DDH-3 in August 2014 to 7.41 SU at well DDH-6 in April 2014. Temperatures varied with seasons and ambient temperatures, ranging from 0.9 degrees Celsius at well DDH-5 in April 2014 to 17.36 degrees Celsius at well RHMW-02S in August 2014. ORP ranged from a low of -128.5 millivolts (mV) at well MW-107 in August to a high of 220.5 mV at well DDH-5 in April. DO ranged from 0.26 mg/L at well MW-101 in August 2014 to 7.53 mg/L at well DDH-2 in August. Conductivity in the field ranged from 292 microSiemens per centimeter (uS/cm) at well MW-102 to 1310 uS/cm at well RHMW-02S. The groundwater across the MRA generally is considered Class I under ARM 17.30.1006 with natural specific conductance less than 1,000 uS/cm. Wells with specific conductance greater than 1,000 uS/cm (DDH-4 and RHMW-02S) are in impacted areas at the MRA.

12.5 LNAPL

Bunker C is a generic term for residual fuel oil that is approximately the equivalent of No. 6 fuel oil. Bunker C is dense, viscous oil produced by blending heavy residual oils with a lighter oil (often No. 2 fuel oil) to meet specifications for viscosity. It was used as fuel for steam engines and stored in above ground and underground storage tanks at the MRA from 1908 until 1935. In June 2011, EPA, operating under the Oil Pollution Act, began excavation of the Bunker C fuel tank and adjacent petroleum-contaminated soils. During groundwater monitoring activities in 2014, dark globules were observed on the oil/water interface probe at wells near the former Bunker C tanks. Wells RHMW-02S and RHMW04 had dark brown, sticky globules of Bunker C. Globules were not seen at well RHMW-02D, which is the deeper well paired with RHMW-02S and monitors the deeper confined aquifer. The recovery wells on the upgradient side of the sheetpile wall were opened and a sheen was visible, but LNAPL measurements were not conducted. The recovery wells were not sampled as part of the RI. No product was observed in or along Tin Cup Joe Creek or in down gradient wells DDH-5 and DDH-6. It appears the residual product is isolated to the upper aquifer in the area of the former Bunker C tanks and the sheetpile wall is preventing movement downgradient. LNAPL thickness measurements, along with groundwater elevations, are included in Table 12-19.

During the April groundwater sampling event, Bunker C was observed at well RHMW05. The product could not be accurately measured because it was sticking to the interface probe. However, in August 2014, no product was present in the well. In October 2014, the depth of Bunker C in RHMW05 was evaluated using a bailer, but there were only small oil globules in clear groundwater.

12.6 SEDIMENT

Sediment sampling at the MRH Facility began in April 1990 (MSE, 1990). The historical sediment sample set from the MRA consists of eight samples. Of those eight samples, six were analyzed for SVOCs, four were analyzed for VOCs, seven were analyzed for metals, and four were analyzed for the EPH/VPH carbon fractions. The following nine constituents are the historical COPCs for the MRA:

- Metals
    - Arsenic, Total
    - Barium, Total
    - Cadmium, Total
    - Lead, Total
    - Mercury, Total
- SVOCs
    - Benzo(a)pyrene
    - Benzo(b)fluoranthene
    - Indeno(1,2,3-cd)pyrene
    - Pyrene

Of the eight historical sediment samples collected across the MRA (locations depicted on Figure 4-8), six had detection exceedances for at least one metals constituent. Lead, arsenic, and cadmium were the primary metals constituents detected above SLs. These 3 constituents resulted in 12 of the 16 historical metals concentrations exceeding SLs at the MRA.

The only MRA sediment sampling location with detected SVOC concentrations exceeding SLs was SD-01. Location SD-01 is located in the wetland area just west of the railroad tracks (grid cell O7 on Figure 4-8). Locations SD-01, SD-02, and SD-04 were sampled for PCB-1260-Aroclor, a PCB, which was only detected in the sample from SD-01 (0.29 mg/kg). The Region III BTAG freshwater sediment SLs do not include PCBs, but this concentration does exceed the RSL for residential soil of 0.24 mg/kg. For the sake of comparison, the value does exceed the most conservative value listed in the NOAA Squirts table for the PCB (sum) value (http://response.restoration.noaa.gov/sites/default/files/SQuiRTs.pdf).

To assess the current sediment conditions, additional sediment samples were collected for the RI. During February and May of 2014, 11 sediment samples were taken from 10 locations (11 samples including the one duplicate) at the MRA. The samples were analyzed for 8 metals constituents, 74 SVOC constituents, 50 VOC constituents, and 17 EPH/VPH constituents; a total of 149 constituents. The 11 samples taken at the MRA resulted in the following 19 COPCs:

- Metals
    - Arsenic, Total
    - Cadmium, Total
    - Chromium, Total
    - Lead, Total
    - Silver, Total
    - Mercury, Total
- SVOCs
    - Acenaphthene
    - Anthracene
    - Benzo(a)anthracene
    - Benzo(a)pyrene
    - Benzo(b)fluoranthene
    - Benzo(k)fluoranthene
    - Chrysene
    - Dibenzo(a,h)anthracene
    - Fluoranthene
    - Indeno(1,2,3-cd)pyrene
    - Naphthalene
    - Pyrene
- VOCs
    - m,p-Xylene

COPCs are listed in Table 12-20. While the RI did not include a sediment sample upstream of the Facility for Tin Cup Joe Creek, the upstream samples were evaluated with respect to the downstream samples. MRA-SD107 is the most upstream sample within Tin Cup Joe Creek and is within Facility boundaries directly west of the former roundhouse building foundation, but elevated approximately 15-20 feet above former roundhouse operations areas. MRA-SD108 and MRA-SD109 are located in a drainage ditch that is not part of the Tin Cup Joe Creek channel, but does connect surfacing groundwater or spring water along with site runoff with Tin Cup Joe near MRA-SD107. An additional five analytes had reporting limits above the SLs and are detailed in Table 12-20. The detection limit for mercury exceeded the SL, and mercury is a COPC for surface water, therefore mercury is considered a COPC for sediment. Analytical results are included in Tables 12-21 through 12-24 and Appendix M. Analyte groups are shown on Figures 12-51 through 12-54.

MRA Sediment Metals

The RI sampling indicates that metals concentrations exceed sediment SLs for 9 of the 10 MRA locations sampled in 2014: each location except MRA-SD106. Note that location MRA-SD106 is depicted as having metals exceedances on Figure 12-51; this is due to the reporting limits for cadmium and mercury not meeting the applicable SLs. Since these metals are COPCs based on detections exceeding SLs at other locations, they are considered exceedances at MRA-SD106 as the reporting limits exceed the SL criteria. Similar to historical results, lead, arsenic, and cadmium still account for the majority of the metals exceedances on the MRA (over 80%). Results for metals COPCs are shown on Figures 12-55 through 12-59.

MRA Sediment SVOCs

Eight of the ten sediment samples taken in 2014 from the MRA had SVOC detection exceedances. Samples from locations MRA-SD107, MRA-SD108, and MRA-SD109, the three southernmost (upstream) sediment locations, contained a larger number of exceedances compared to those taken downstream. The downstream locations may have had lower SVOC concentrations as a result of the removal actions along and near Tin Cup Joe Creek. The locations sampled at the MRA in 2014 resulting in SVOC detection exceedances are depicted on Figure 12-52. Note that location MRA-SD102 is depicted as having SVOC exceedances due to reporting limits exceeding SLs for COPCs. Figures showing the locations of each PAH COPC are included as Figures 12-60 through 12-66.

PCB samples were collected from each MRA sediment sampling location. PCB-1260-Aroclor was the only PCB congener detected, at three locations (MRA-SD107, MRA-SD108, and MRA-SD110). The PCB-1260-Aroclor concentration exceeded the RSL for residential soil (0.24 mg/kg) in the sample from MRA-SD110 (0.98 mg/kg), which is near the location of SD-01 where PCB-1260-Aroclor previously exceeded the residential soil RSL.

MRA Sediment VOCs

The only VOC concentration detected that exceeded SLs was m,p-xylene from MRA-SD104, located just southwest of the former waste water sump. The reported detection limit for MRA-SD110 also exceeded the SL form, p-xylene.

Therefore, both MRA-SD104 and MRA-SD110 are depicted as having VOC exceedances on Figure 12-53. A figure of the m,p-xylene results is included as Figure 12-67.

EPH/VPH

EPH/VPH fractions were not detected in the sediment samples collected from the MRA during 2014 (Figure 12-54).

12.7 SURFACE WATER

Surface water sampling at the MRH Facility began in April 1990 (MSE, 1990). There were five historical surface water samples collected at the MRA (SW-01 through SW-05), shown on Figure 4-8. SW-01 and SW-02 were located in wetlands/low-lying areas between the former CSMPP elevated tracks and the active BNSF railway tracks in the northern area of the MRA. SW-03 through SW-05 were collected from Tin Cup Joe Creek with SW-03 being in the northern MRA, SW-04 being in the central area of the MRA, and SW-05 being upgradient of the former CSMPP facility on the bench southwest of the former process and maintenance areas. Each of the five samples was analyzed for 24 constituents, including metals, PAHs, and PCBs. Arsenic was the only constituent detected above the applicable SL, and therefore the only historical COPC identified for surface water. The two surface water samples with arsenic exceedances were collected at SW-01 and SW-02, located between the former rail line and the current railroad tracks.

During the RI, an additional five surface water samples were taken at the MRA. Surface water samples taken during 2014 were analyzed for 10 metals constituents, 73 SVOC constituents (including PCBs), 72 VOC constituents, and 13 EPH/VPH constituents; a total of 168 constituents.

Detection exceedances at the MRA resulted in the identification of five COPCs. The following five analytes are the RI surface water COPCs for the MRA:

- Metals
  - Arsenic, Total
  - Iron, Total
  - Lead, Total
  - Manganese, Total
  - Mercury, Total

Surface water COPCs are listed in Table 12-25. Table 12-25 also includes the 35 analytes with reporting limit above the SLs. Analytes benzo(a)anthracene, benzo(b)fluoranthene, benzo(a)pyrene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, PCB congener PCB-1260-Aroclor, and vinyl chloride are detected COPCs in other media. Analytical results are shown in Tables 12-26 through 12-29. Analyte group maps are shown on Figures 12-51 through 12-54.

The detection exceedances at the MRA occurred at 3 locations: MRA-SW101, MRA-SW102, and MRA-SW110. MRA-SW101 and MRA-SW102 are in the lower portion of Tin Cup Joe Creek near the Clark Fork, while MRA-SW110 is located in the wetlands between the former rail line and the current rail line, near the historical SW-01 and SW-02 sample locations, where arsenic also exceeded the SLs. Arsenic and lead maps (including sediment data) are included as Figures 12-55 and 12-58.

There were no surface water detection exceedances for SVOCs (including PCBs), VOCs, or EPH/VPH constituents at the PRA. However, there were 30 SVOC constituents (out of 73) and 5 VOC constituents (out of 72) with reporting limits that exceeded the SL. Based on the COPC selection criteria, these constituents are not considered COPCs because they were not detected above SLs in any of the samples.

12.8 SOIL GAS

As detailed in Section 5.8, soil gas probes were installed near potential receptors to evaluate the vapor contamination pathway. Locations of the soil gas points are depicted on Figure 4-6. As described in Section 8.2.3, up to eight soil gas probes were proposed for installation at four locations at the MRA, but only five soil gas probes were installed due to high groundwater at some locations. Only three soil gas probes were sampled during the two sampling events, each located in the northern MRA, as groundwater was too high to sample the locations in the southern MRA. Sample locations on the MRA include SG-101D (8.5-9 ft), SG-101S (5-5.5 ft), SG-102S (6-6.5 ft). The three MRA soil gas probes were sampled for the first time in February 2014, and a second time in August 2014.

Each of the soil gas sample locations was analyzed for 78 VOCs and VPH fractions. Of the 78 constituents, 11 have been identified as COPCs for the MRA. There were also 42 constituents that had at least one instance when the method reporting limit was unable to meet the SL. Of those 42 constituents, 15 of them were unable to meet the SL for any of the samples. Soil gas COPCs are listed on Table 12-31. Analytical results are shown on Table 12-32.

The following analytes were identified as soil gas COPCs for the MRA:

- VOCs
  - 1,2,4-Trimethylbenzene
  - Benzene

- C5-C8, Aliphatic, Adjusted
- C9-C10, Aromatic, Adjusted
- C9-C12, Aliphatic, Adjusted
- Chloroform
- Ethylbenzene
- Naphthalene
- Nonane
- o-Xylene
- Trichloroethene

In total, there were 37 detection exceedances reported for the six samples taken from the MRA, with 26 from the February 2014 sampling event and 11 from the August 2014 sampling event. In general, vapor concentrations were lower during the August sampling event than the February sampling event. The shallow and deep vapor points at SG-101 provide one location to compare the soil gas levels approximately 5 ft bgs to a deeper level at approximately 8 ft bgs. During each sampling event the detected concentrations exceeding the SLs were generally greater in the shallow point than the deeper point, occurring 8 out of 12 times at SG-101. TCE soil gas results are shown on Figure 12-68.

C5-C8 Aliphatic, C9-C12 Aliphatic, naphthalene, and TCE are COPCs in surface and/or subsurface soil at the MRA, which may be the source of soil gas concentrations. The remaining soil gas COPCs were detected in at least one groundwater, surface soil, or subsurface soil sample at the MRA except for 1,2,4-trimethylbenzene, chloroform, and nonane. 1,2,4-trimethylbenzene was not detected in each of the RI groundwater samples collected, but was only analyzed in one surface and one subsurface soil sample from the MRA. Chloroform was not detected in other environmental matrices, but could be present in soil gas as a result of past anthropogenic uses (such as an extraction solvent or in fire extinguishers), through natural biotic processes, or potentially due to the presence of chlorinated municipal water in the area (ASTDR, 1997). Nonane was not analyzed in matrices besides soil gas.

12.9 RAILROAD BALLAST

On BNSF property, railroad ballast samples were collected from the active railway lines and ROW at the MRA. Railroad ballast samples were collected by hand. The samples were 5-point composite samples with two aliquots collected on the east side of the tracks, two on the west side of the tracks, and one in the center along a 100-ft linear grid section of track. Samples were collected from randomly generated 100-ft linear grid sections (Figure 12-69). Ten samples of railroad ballast were collected from the MRA. The railroad ballast samples were collected from the surface environment (0-6 inches bgs) at each aliquot location. Ballast samples below 6 inches bgs were not collected. Ballast samples were analyzed for VOCs and SVOCs.

Trihydro coordinated with BNSF to collect the railroad ballast samples. BNSF provided a flagger during the sample collection and a representative from Olympus (BNSF's consulting firm) was onsite during collection of the ballast samples.

Detected concentrations from samples collected at the MRA did not exceed SLs. Reporting limits for several analytes were higher than some SLs, most often leaching to groundwater SLs (Table 12-33). No COPCs were identified for the ballast on the active railroad line on the MRA.

12.10 ASBESTOS-CONTAINING MATERIAL

Fourteen samples of material suspected to potentially contain asbestos were collected from within the fenced area owned by Powell County on the MRA (Appendix B). Samples were collected from random surface debris and a six-inch transite pipe that was discovered during test pitting activities at the MRA. The analysis was performed in accordance with EPA Method 600/R-93/116, which employs polarized light microscopic (PLM) techniques. The quantification of asbestos in the sample method is intended to be an estimate only and limit of detection for this method is approximately 1% by volume. Samples with non-detect results by PLM method were analyzed using TEM, which can detect concentrations less than 1% by volume.

The following five samples were reported by laboratory analysis (PLM) as containing asbestos greater than 1% by volume and are considered ACM:

- MRA-20140501-006, cement board, 50-60% Chrysotile asbestos
- MRA-20140501-007, grey transite board, 40-50% Chrysotile asbestos
- MRA-20140501-008, brick mortar, 20-30% Chrysotile asbestos
- MRA-20140501-009, pipe gasket, 10-20% Chrysotile asbestos
- MRA-20140506-001, six inch transite pipe, 70-80% Chrysotile asbestos, 5-10% Crocidolite asbestos

The following samples were reported by laboratory analysis (TEM) as containing asbestos less than 1% by volume:

- MRA-20150501-003, fiberglass board, trace Chrysotile (one structure)
- MRA-20140501-005, black plastic pieces, less than 1% Chrysotile

The other six materials sampled during the limited inspection are reported by laboratory analysis as “non-detect” for asbestos by both methods. The actual amount of ACM left onsite is difficult to estimate. The transite pipes are still in place below the ground surface and other ACM debris is likely scattered across the MRA, especially within the fenced area where there has apparently been limited surface disturbance since demolition of the roundhouse.

13.0 NATURE & EXTENT OF CONTAMINATION – PRA

Based on historical analytical results and uses at the PRA, the primary initial data gaps centered around a concern that sources of contamination were not identified across the area, especially those associated with former structures, and that the fill material used throughout the area may have been sourced from areas of elevated metals as indicated from x-ray fluorescence samples across the surface soil. The historical analyte groups of concern included petroleum hydrocarbons, PAHs, metals, PCBs, VOCs, and asbestos (DEQ 2013). The PRA was investigated several times to assess soil and groundwater conditions at the area and the potential impacts to the city drinking water well within the area. However, like the MRA, the fate and transport of COPCs had not been addressed for most of the area and hydraulic data was limited despite the numerous wells at the area.

The RI focused on filling the data gaps and providing a more comprehensive analytical suite to refine the COPCs and the vertical and horizontal extent of contamination. The following subsections discuss the analytical results of the specific media, specific historical and current COPCs, and reference figures which illustrate the current analytical results.

13.1 TEST PITS

Eighteen PRA test pits were excavated around infrastructure features that include former AST locations, fuel lines, refueling areas, oil sump, oil house, Standard Oil area, diesel unloading area and unknown lines (Figure 4-3). Of the 18 test pits, 7 test pits were not observed to be potential source areas for gross contamination, although they may be contributing to more localized contamination that would still need to be addressed as part of an overall cleanup strategy. The remaining 11 test pits had observations consistent with significant impacts, indicating a potential to affect a larger area with contamination.

The seven test pits that did not appear to be source areas did not appear to have visual evidence of petroleum contamination or odor and PID evidence during sample collection. The following test pits were observed to not have significant impacts:

- TP-PRA-EE13A (Standard Oil-near structure): The excavation exposed concrete debris, asphaltic material, a post, pitcher pump, and wood material. Also, what appeared to be a concrete foundation was exposed on the east side of the excavation. Groundwater was encountered approximately 8.5 ft bgs. Samples for metals, SVOCs, VOCs, and VPH were collected from 0-0.5 ft bgs and 7-8 ft bgs. SVOCs exceeded SLs.
- TP-PRA-EE17A (Fuel Line): Excavation exposed one transite pipe approximately 2 ft bgs, and three cast iron pipes (4-inch, 3-inch, 2-inch diameters). The cast iron pipes were stacked with the 4-inch pipe on top. None of the

pipe was wrapped. The piping was generally oriented N-S. No staining or odors were noted during the excavation. There was a water saturated layer from 6.5-7.25 ft bgs. Analytical samples were not collected.

- TP-PRA-FF09A (Fuel Line and Refueling Area): The excavation did not expose any structures, staining or hydrocarbon related odors. There was a wedge of dark brown soil on the east edge of the excavation that was noted from 4.16-5.16 ft bgs. Groundwater was encountered approximately 8.75 ft bgs. Analytical samples were not collected.
- TP-PRA-FF11A (Unknown Line with Manhole): Excavated on the west side of a circular concrete vault. Groundwater was encountered at 0.25 ft bgs impeding positive feature identification. Approximately 5 ft bgs a pipe was encountered and, by feel, was assumed to be clay tile. Investigation with a rod was conducted on the interior of the vault. The pipe entered the vault on both the west and east sides. No staining or hydrocarbon odor was observed. Analytical samples were not collected.
- TP-PRA-FF11B (Fuel Line and Refueling Area): Clay tile pipe encased in wood was exposed in the excavation. A heavy immobile hydrocarbon product was observed around the joints. Metals, SVOCs, VOCs, and VPH samples were collected from 0-0.5 ft bgs. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 4-5 ft bgs and SVOCs, and EPH/VPH samples were collected from 8.5-9.5 ft bgs. SVOCs, EPHs, and VPHs exceeded SLs.
- TP-PRA-FF11C (Fuel Line and Refueling Area): Excavated around a concrete vault. Cast iron piping and valve assemblies were exposed on the east side. The line appeared to be a water line. Groundwater was not encountered. Analytical samples were not collected.
- TP-PRA-FF16A (ASTs): Encountered a large amount of concrete debris, rebar, wood, etc. in the excavation. Stopped excavation at 6 ft bgs due to excessive debris. Groundwater was not encountered. Analytical samples were not collected.

Eleven locations in the PRA were observed to have the greatest potential for being located in a source area. The excavations revealed subsurface evidence of petroleum contamination near subsurface infrastructure. The following test pits had evidence of petroleum contamination near subsurface infrastructure and the observations from each are detailed below:

- TP-PRA-DD12A (Standard Oil): Excavated near a steel UST. The excavation and surface exposures determined that the tank was approximately 11 feet long by 4 feet in diameter. Debris was encountered in the excavation. Groundwater was encountered at approximately 2.75 ft bgs and had sheen with a slight hydrocarbon-like odor. Samples for metals, SVOCs, VOCs, and VPH were collected from 2-2.5 ft bgs. One metal and one SVOC analyte exceeded SLs.

- TP-PRA-DD15A (Historical Potential Diesel Unloading Point and Former Pump House): Debris was present near the surface with staining and there was a diesel-like odor within the smear zone. Once exposed there was a noticeable sheen on the groundwater surface. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 0-0.5 ft bgs. Metals were collected from 6-7 ft bgs and SVOCs, and EPH/VPH samples were collected from 8.5-8.75 ft bgs. SVOC, EPH, and VPH analytes exceeded SLs.

- TP-PRA-DD17A (Oil Sump): The excavation was 5 feet in depth with a saturated gravel layer (3.5-3.75 ft bgs) that had a moderate odor. In addition, there was crushed brick 2.5-3.5 ft bgs, and other debris near the surface. Samples for metals, SVOCs, VOCs, and VPH were collected from 0-0.5 ft bgs. Metals, SVOCs, VOCs, and EPH/VPH samples were collected from 3.5-4 ft bgs. SVOC and EPH analytes exceeded SLs.

- TP-PRA-DD20A (Oil House & Fuel Line): The excavation did not expose any structures or piping. The top 1.5 ft was observed to be brown fill with potential staining. The east half of the hole was lighter brown soil and the west half darker, stained soil assumed to be associated with the oil house. At depth an oil-like odor was noted in the excavation. Saturated soil (groundwater) was approximately 8 ft bgs. Samples for metals, SVOCs, VOCs, EPH/VPH were collected from 0-0.5 ft bgs, 1-2 ft bgs and 2-3 ft bgs. SVOCs and VPH samples were collected from 11-12 ft bgs. SVOC, EPH and metals exceeded SLs.

- TP-PRA-DD21 (Fueling Area & Southern End of Fuel Line): One steel conduit at 1.5 ft bgs, one 4-inch potential water line with gravel around it at 4.5 ft bgs, and one transite pipe at 5 ft bgs were encountered. Dark staining was observed from the surface to depth above the piping runs. Hydrocarbon odors increased in strength with depth and PID reading results were greater than 100 ppm from ground surface to groundwater. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 11-11.5 ft bgs. Metals, SVOC, EPH, and VPH constituents exceeded SLs.

- TP-PRA-DD22A (South End of Fuel Line & Refueling Area): One transite pipe at 2 ft bgs and two cast iron pipes at 4 ft bgs were encountered. Also, round wood timbers and an old pipe trench were visible on the west side of the excavation. Staining was observed with depth and a diesel-like odor was noted at 10 ft bgs. A PID reading of 108.4 ppm was recorded in the 7.5-10 ft bgs interval. Samples for metals, SVOCs, VOCs, EPH/VPH and TCLP were submitted from 2-3 ft bgs, 2.5-3.25 ft bgs, and 10-11 ft bgs. Metals, SVOCs, EPH, and VPH constituents exceeded SLs.

- TP-PRA-EE12A (Standard Oil-near tanks): The excavation exposed possible fill material with crushed brick and intermixed black soil. PID readings were comparable to background. Groundwater was not encountered. Samples for metals, SVOCs, VOCs, and VPH were collected from 0-0.5 ft bgs. Metals, SVOCs, VOCs, and EPH/VPH samples were collected from 6-7 ft bgs. Metals and SVOCs exceeded SLs including a lead concentration of

3420 mg/kg in the 6-7 ft bgs interval, which is among the highest lead concentrations in subsurface soil reported at the PRA.

- TP-PRA-EE14A (Fuel Line): A 2-inch transite pipe at 1.5 ft bgs and a 4-inch cast iron pipe were observed in a N-S orientation, and a pipe trench (dark brown soil) was noticeable on the sidewall. No staining was noted around the piping. Staining was noted from 9.25-9.75 ft bgs and a slight gasoline-like odor was noted in the water saturated soil which was encountered approximately 9.5 ft bgs. Samples for EPH/VPH were collected from 9-9.75 ft bgs. Both EPH and VPH constituents exceeded the SLs.
- TP-PRA-EE15A (Fuel Line): A 6-inch cast iron pipe, not cased in wood, was exposed at 7.5 ft bgs. In addition, the pipe trench was visible in the sidewalls which could be identified by dark soil surrounded by lighter soil down to the depth of the pipe. The pipe was oriented in a N-S direction. Staining and a gasoline odor were identified in a water saturated zone, right below the pipe, from 8-9 ft bgs. Analytical samples were not collected.
- TP-PRA-EE20A (Fuel Line): The excavation exposed one transite pipe with four single strand solid wires inside at 1.75 ft bgs. In addition three cast iron pipes (4-inch, 2-inch, 2-inch diameters) were exposed at approximately 5.5 ft bgs. The cast iron pipe was stacked with the 4-inch pipe on top and wood wrapped. The piping was oriented in a general N-S direction. In addition, the pipe trench was visible in the sidewalls as darker soil in lighter brown soils. Groundwater was encountered approximately 11 ft bgs. There was sheen on the groundwater with an associated hydrocarbon odor. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 10-11 ft bgs. Metals, SVOC, EPH, and VPH constituents exceeded SLs.
- TP-PRA-EE22A (Refueling Area): No pipe or railroad structures were encountered. The soil was stained from 1-2 ft bgs; however, no significant PID reading was noted. There was a sheen observed on the groundwater and a strong hydrocarbon-like odor. Groundwater was encountered approximately 11.5 ft bgs. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 11-12 ft bgs. Metals, SVOC, and EPH analytes exceeded SLs.
- TP-PRA-FF15A (ASTs): The excavation was located on the north side of a former AST location with gray staining and a strong hydrocarbon odor in the smear zone and groundwater which was approximately 10.4 ft bgs. Concrete debris was also exposed from 2-4 ft bgs. Samples for metals, SVOCs, VOCs, and EPH/VPH were collected from 0-0.5 ft bgs and 1-2 ft bgs. SVOCs and EPH/VPH samples were collected from 9.5-10 ft bgs. SVOC, EPH, and VPH constituents exceeded SLs.

13.2 SURFACE SOIL

Prior to the RI, 187 surface soil and solid samples were collected from the PRA and analyzed for 25 analytes. Five analytes were determined to be COPCs since they were detected above the current SLs for surface soil. The historical surface soil samples were primarily analyzed for metals and did not address the noted petroleum hydrocarbon releases of the past (three samples were also analyzed for SVOCs and VOCs). The following five analytes are the historical COPCs for the PRA:

- Metals
    - Arsenic, Total
    - Barium, Total
    - Cadmium, Total
    - Lead, Total
    - Mercury, Total

Metals concentrations exceeding the SLs were widespread across the PRA, although most frequent in samples from north of Cottonwood Creek and in the southern portion of the PRA near the historical depot and refueling operations area (Figure 13-1). As discussed in the DSR, these elevated metals sample results from 1993 (1993 Pioneer Technical Services Report – DEQ, 2014) were analyzed in the laboratory, but with high detection limits for arsenic and lead, and only 15% of the metals surface soil samples at the surface soil sample locations from 2011 were analyzed in the laboratory and the rest were analyzed with X-ray fluorescence (2011 Kirk Engineer Report - DEQ, 2014). Lead exceeded the SLs at each of the sample locations with historical exceedances, and arsenic also exceeded the SLs at over half of these locations. However, many samples from the central portion of the PRA, even those on the elevated area, were reported with metals concentrations less than SLs.

To assess the current conditions at the PRA, 145 surface soil samples, including 6 duplicates, were collected at 69 locations across the city property and on nearby private properties and on the Grant-Kohrs Ranch during the RI field work. The results of this RI sampling effort illustrate the current conditions and current COPCs for the PRA. Of the 145 samples, 51 of the surface soil samples were collected as 5-point composites to get a broader assessment of surface soil contamination across the PRA; however, some point-location samples and test pits were also sampled to establish surface soil conditions. Two properties were sampled in a different grid fashion along the property boundaries of the property and at the drip zones of existing buildings in accordance with the EPA Superfund Lead-Contaminated Residential guidance handbook as requested by DEQ (EPA 2003). These two properties were selected due to their proximity to the PRA and the activities at the locations. The former passenger depot is currently a church with a daycare facility and therefore, a smaller sampling grid was selected and subsequently more metals samples were collected from this property. Additionally, the residence just west of the southern end of the depot, 111 W. Milwaukee Ave., Deer Lodge, MT, was also sampled for lead and other metals.

COPCs are listed in Table 13-1. The analytical results are presented in Tables 13-2 through 13-6 and Appendix M. Figures 13-1 (metals), 13-2 (SVOCs), 13-3 (VOCs), and 13-4 (EPH/VPH) visually illustrate the analytical results as exceedances of the surface soil SLs or sampled locations that were non-exceedances for each analyte group. From the comparison of the analytical results to the current surface soil SLs, there are 15 current COPCs identified for surface soil for the PRA. The following analytes are the COPCs for the PRA surface soil:

- Metals
    - Arsenic, Total
    - Barium, Total
    - Cadmium, Total
    - Lead, Total
- SVOCs
    - Benzo(a)anthracene
    - Benzo(a)pyrene
    - Benzo(b)fluoranthene
    - Dibenzo(a,h)anthracene
    - Indeno(1,2,3-cd)pyrene
    - 1-Methylnaphthalene
    - 2-Methylnaphthalene
    - PCB-1260-Aroclor
    - 4,4 DDT
- EPH /VPH
    - C9-C18, Aliphatic, Adjusted
    - C11-C22, Aromatic, Adjusted

There are an additional 76 analytes that were not detected above the analytical detection limit, but had a reporting limit above the current surface soil SLs (Table 13-1). Benzene was the only analyte that had reporting limit exceedances that was identified as COPCs in other media (subsurface soil and soil vapor). However, since all the reporting limit exceedances were below the detection limit and there were no detected exceedances in the same media nearby on the

Facility, benzene is not considered a COPC for surface soil for the PRA. The silver concentration also exceeded the leaching to groundwater SL at one location at the PRA; however, since the frequency of detection for silver was less than 5%, silver is not a COPC.

PRA Surface Soil - Metals

A total of 145 surface soil samples, including 6 duplicates, were analyzed for metals at 69 different locations across PRA. The metals surface soil exceedances for the PRA extend from the northern hayfields on the Grant-Kohrs Ranch to the southern area of the PRA near the historical depot and in undeveloped city property to the east and west of the elevated refueling area (Figure 13-1). Surface soil metals concentrations did not exceed SLs on the property south of W. Milwaukee Ave.

Arsenic - There were 15 samples with analytical results exceeding the site-specific background level of 65 mg/kg-dry out of 138 surface soil arsenic samples (Figure 13-5). Elevated arsenic concentrations were mostly observed along and east of the elevated former CMSPP rail line. The highest concentration of arsenic was reported for PRA-GG17 from 0-0.5 ft bgs at 910 mg/kg-dry. The 1-2 ft bgs interval at the same location had an arsenic result of only 6 mg/kg.

Barium - Barium's lowest SL is the MT background threshold for inorganics of 429 mg/kg-dry, which exceeds the leaching to groundwater SL (Appendix J). Ten surface soil sample concentrations exceeded this SL (Figure 13-6). These samples were primarily from the 1-2 ft bgs interval, and were located across the PRA. Surface soil barium concentrations at the PRA do not exceed direct contact SLs, as the maximum concentration reported (1,280 mg/kg-dry) is less than the residential RSL of 1,500 mg/kg.

Cadmium - The sample from GG17A (0-0.5 ft bgs) was the only surface soil sample result (5 mg/kg-dry) at the PRA to exceed the cadmium leaching to groundwater SL (3.8 mg/kg) (Figure 13-7). The surface soil sample results did not exceed the direct contact SLs.

Lead - Lead exceeds the leaching to groundwater SL of 140 mg/kg-dry for 14 samples. Most of the lead samples exceeding the SL were from the southern part of the PRA (Figure 13-8). Three lead samples exceeded the residential RSL of 400 mg/kg, and one sample exceeded the industrial RSL of 800 mg/kg. The highest concentrations of lead in the surface soil are located around the lead sample area of the former depot, as discussed in Section 13.2.1.

PRA Surface Soil - SVOCs

In general, SVOCs exceed the SLs across the PRA and are primarily PAHs. There is one pesticide COPC and one PCB COPC in surface soil at the PRA.

PAHs - Several SVOC COPCs are PAHs and are constituents of petroleum fuel products: benzo(a)anthracene (Figure 13-9), benzo(a)pyrene (Figure 13-10), benzo(b)fluoranthene (Figure 13-11), dibenzo(a,h)anthracene (Figure 13-12), indeno(1,2,3-cd)pyrene (Figure 13-13), 1-methylnaphthalene (Figure 13-14), and 2-methylnaphthalene. SVOC analytical data are shown on Table 13-3. These seven PAH COPCs for the PRA surface soil are detected above the residential RSLs and RBCA RBSLs for direct contact for residential. Forty-two samples were analyzed in the surface soil for PAHs and, of those samples, 16 had PAH detections exceeding SLs. Two results from test pit TP-PRA-DD20A (0-0.5 ft), benzo(a)pyrene and dibenzo(a,h)anthracene, also exceeded the RBCA RBSL commercial SLs.

PCBs - Eight surface soil samples were analyzed for PCBs during the RI. Figure 13-15 details the locations of the samples, which were primarily collected during test pit activities. One PCB congener, PCB-1260-Aroclor, exceeded the residential RSL in the test pit PRA-DD20A from 0-0.5 ft bgs. This location is between the former depot and commercial storage property in the parking area.

Pesticides/herbicides - In one of the six surface soil samples for pesticides and herbicides, the insecticide 4,4 DDT was detected at 0.12 mg/kg-dry at PRA-EE11 from 0-0.5 ft bgs, which is above the leaching to groundwater SL of 0.00737 mg/kg-dry, but not above the residential RSL of 1.9 mg/kg-dry. This is on the western edge of the elevated former CMSPP rail bed that is currently used for City of Deer Lodge storage, but north of the former USTs and east of the former chemical storage areas (Figure 13-16). The remaining samples were below detection limits, but their laboratory reporting limit was above the leaching to groundwater SL, so they are shown as exceedances also on Figure 13-16.

PRA Surface Soil - VOCs

VOCs were not detected in surface soil samples at concentrations exceeding SLs. However, benzene is a COPC for subsurface soil and soil gas and the surface soil had 12 sample results with reporting limits that exceeded the SLs.

PRA Surface Soil - EPH/VPH

Two EPH fractions were found to exceed the SLs for the surface soil at the PRA, C9-C18 aliphatics and C11-C22 aromatics. Out of 23 samples at the PRA surface soil, two samples from test pits TP-PRA-DD20A from 0-0.5 ft bgs and TP-PRA-DD21 from 1 to 2 ft bgs exceed the C9-C18 aliphatic fraction for the RBCA RBSL direct contact residential SL. TP-PRA-DD20A had a deeper surface soil sample from 1-2 ft bgs and a subsurface soil sample from 2-3.5 ft bgs that did not exceed the RBCA RBSL for residential, but had another exceedance at 11-12 ft bgs. This test pit is located between the former depot and the commercial storage property in the adjacent parking lot (Figure 13-4).

The highest surface soil concentration of EPH fractions was a 15,500 mg/kg-dry C9-C18 aliphatics result from TP-PRA-DD21 at 1-2 ft bgs that also exceeds the RBCA RBSLs for excavation and commercial. A deeper surface soil sample at the same location from 11-11.5 ft bgs also exceeds the RBCA RBSLs for residential, excavation, and commercial. This test pit is located in the southern area of the PRA in the parking lot between the former depot and the current commercial offices just north of W. Milwaukee Ave. These areas seem to delineate a potential surface and subsurface EPH fraction contaminated zone in soils, soil gas, and groundwater that extend from just west of the former depot at TP-PRA-DD20A and SG-206S to the south near TP-PRA-DD21 and west toward monitoring well MRMW01, which has an EPH fraction exceedance.

13.2.1 RESIDENTIAL/CHURCH YARD SAMPLES

Seven samples were collected from the residential and church yards as described in Section 5.3.2. Six surface soil areas were sampled for metals, PAHs, SVOCs, and VOCs. One surface soil sample within the drip zone of the Depot was collected at the 0 to 0.5 ft interval and sampled for metals. Opportunity samples for additional analytes were not taken, since no odors or staining were observed during residential or church yard sample collection. Three analytes were detected at concentrations exceeding SLs: barium, lead, and benzo(a)pyrene. Barium concentrations exceeded MT background threshold values (which exceed the leaching to groundwater SL) in three intervals from the PRA-FF19B location and one interval from the PRA-FF20B, but did not exceed the direct contact SLs (Table 13-2).

Lead - Lead concentrations from four samples exceeded the leaching to groundwater SL of 140 mg/kg-dry: PRA-CC22A (1-1.5 ft), PRA-CC22B (0-0.5 ft), PRA-FF19B (1-1.5 ft), and PRA-FF19B (1.5-2 ft) (Table 13-2). Total lead concentrations did not exceed the direct contact SLs in the samples from the residence at 111 W. Milwaukee Ave. Lead concentrations exceeded both the residential and industrial direct contact SLs in the sample from PRA-FF19B (1-1.5 ft), and the residential direct contact SL in the sample from PRA-FF19B (1.5-2 ft). Sampling locations are shown on Figure 13-17. PRA-CC22A was the grid encompassing the residential lot at 111 W. Milwaukee Ave, while PRA-CC22B was a drip zone sample around the house at the lot. PRA-FF19B is the grid representing the play area at the Depot Church. Samples were taken of the soil beneath several inches of wood chips and a fabric barrier in the play area. The 0-0.5 ft and 0.5-1 ft intervals from this sample location did not exceed lead SLs.

Benzo(a)pyrene - Five samples exceeded the RBCA RBSL for residential for benzo(a)pyrene (0.02 mg/kg-dry): PRA-CC22A (0-0.5 ft), PRA-CC22B (0-0.5 ft), PRA-CC22C (0-0.5 ft), PRA-EE19 (0-0.5 ft), and PRA-FF19B (0-0.5 ft) (Table 13-3). Sampling locations are shown on Figure 13-18. PRA-CC22A was the grid encompassing the residential lot at 111 W. Milwaukee Ave, while PRA-CC22B and PRA-CC22C were drip zone samples around the house and shed, respectively. PRA-EE19 was the grid encompassing the lot at the Depot Church. PRA-FF19B is the grid representing the play area at the Depot Church. Samples were taken of the soil beneath several inches of wood chips and a fabric barrier in the play area.

Residential and church yard surface soil samples were not analyzed for EPH/VPH fractions, while a surface soil sample from nearby test pit TP-PRA-DD20A exceeded screening levels for the C9-C18 aliphatic EPH fraction. However, petroleum contamination of surface soil at the residence and church appear unlikely, as samples exceeding screening levels were typically obviously contaminated (e.g., heavily stained, strong petroleum odor).

13.3 SUBSURFACE SOIL

Prior to the RI surface soil sampling, the PRA had subsurface soil sample results from 48 soil sample locations at various depths from 2 to 11.5 ft bgs from 1995 until 2010, which were analyzed for 41 analytes. Of the 41 analytes, 12 were determined to be COPCs since they had detected values above the current SLs for subsurface soil:

- Metals
  - Barium, Total
- SVOCs
  - Benzo(a)anthracene
  - Benzo(b)fluoranthene
  - Benzo(k)fluoranthene
  - Dibenzo(a,h)anthracene
  - Indeno(1,2,3-cd)pyrene
  - Naphthalene
- VOCs
  - Benzene
- EPH/VPH
  - C11-C22, Aromatic
  - C9-C10, Aromatic
  - C9-C12, Aliphatic
  - C9-C18, Aliphatic

COPCs are listed in Table 13-7. The analytical results for historical subsurface samples at the PRA are presented in Tables 13-8 through 13-12.

There is only one location with a metals exceedance for the historical PRA analytical subsurface sample set, which is comprised of six subsurface soil samples. The single exceedance is for barium CDL-OWS-5 at 8 ft bgs, which is near the RI sample location TP-PRA-DD17A (Figure 13-19) and a former oil sump.

There was one historical subsurface sample location at CDL-UST-1 at 8 ft bgs that had SVOC exceedances for five of the six historical SVOC COPCs: benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)pyrene. One naphthalene exceedance was observed for a historical soil sample location at CDL-PH-1 (Figure 13-20).

The VOC exceedances are limited to benzene exceedances in the historical subsurface data for the PRA. Benzene was detected in 5 of the 21 samples from the historical data, but the reporting limit was above several of the SLs for an additional 10 samples. The detections are primarily from soil borings in the central area of the PRA, but the highest concentration was 3,190 mg/kg at CDL-OWS-5 at 8 ft bgs, near the current LNAPL recovery trench (Figure 13-21).

For EPH/VPH historical COPCs, (Figure 13-22), the EPH fraction exceedances primarily run along the north/south spine of the elevated former CMSPP operational area. However, some of the historical exceedances also are found west of the former depot area near the current Deer Lodge City Shop. Most of the historical EPH/VPH data within the undeveloped fields to the west of the former operations area do not have historical exceedances. The four analytes with exceedances are C11-C22 aromatics, C9-C10 aromatics, C9-C12 aliphatics, and C9-C18 aliphatics. There are historical analytical results for 60 to 69 samples for each analyte with between 15 and 30 samples that exceed their RBCA RBSL for residential. Historical results for both C9-C18 aliphatics and C11-C22 aromatics also exceed the SLs for RBCA RBSL for commercial and RBCA RBSL for excavation.

Subsurface soil samples were collected across the City property at the PRA and on nearby private properties and on the Grant-Kohrs Ranch during the RI field work. Tables 13-8 through 13-12 and Appendix M report the 75 subsurface soil sample results and 5 duplicates from the RI. Each location is a discrete sample associated with a subsurface location and a depth. Figures 13-19 through 13-22, visually illustrate the analytical results as exceedances of the subsurface soil SLs or non-exceedances. From the comparison of the analytical results to the subsurface soil SLs, there are 17 current COPCs identified for surface soil for the PRA:

- Metals
    - Arsenic, Total
    - Barium, Total
    - Lead, Total
- SVOCs
    - Benzo(a)anthracene
    - Benzo(a)pyrene
    - Benzo(b)fluoranthene
    - Dibenzo(a,h)anthracene
    - Indeno(1,2,3-cd)pyrene
    - 1-Methylnaphthalene
    - 2-Methylnaphthalene
    - Naphthalene
- VOCs
    - Benzene
    - Ethylbenzene
- EPH/VPH Fractions
    - C5-C8, Aliphatic, Adjusted
    - C9-C12, Aliphatic, Adjusted
    - C9-C18, Aliphatic, Adjusted
    - C11-C22, Aromatic, Adjusted

There are an additional 64 analytes that were not detected above the analytical detection limit, but had a reporting limit above the current surface soil SLs. However, none of these analytes with reporting limit exceedances was identified as COPCs in other media at the PRA. Tables 13-8 through 13-12 include those analytes and the COPC table for subsurface soils for the PRA (Table 13-7) summarizes the COPCs.

PRA Subsurface Soil Metals

Metals concentrations exceeded SLs in 21 of 50 subsurface soil sample locations at the PRA. Arsenic, barium, and lead were identified at the PRA at levels exceeding SLs in subsurface soils. The metals subsurface soil exceedances for the PRA range from the northern area in grid PRA-GG02 to a sample that is south of W. Milwaukee Ave. at PRA-DD-24 (Figure 13-19). The metals exceedances in the subsurface of the PRA are primarily along the elevated area of the former CMSPP operations at the PRA, but are also found in several locations off the elevated area. There does not appear to be much correlation between surface and subsurface soil metals concentrations.

Arsenic - Arsenic exceeded the site-specific background SL of 65 mg/kg-dry at both TP-PRA-DD22A from 10-11 ft bgs and TP-PRA-DD12A from 2-2.5 ft bgs (Figure 13-23). TP-PRA-DD12A is near the location of the former UST and petroleum storage area of the Standard Oil bulk plant tanks at the western edge of the elevated former operations area. TP-PRA-DD22A is located in the private property parking lot near the former depot and just north of W. Milwaukee Ave. This test pit is near where historical petroleum releases occurred during fueling operations at the depot.

Barium - The barium concentration exceeded the SLs at TP-PRA-EE12A. The barium concentration of 2,690 mg/kg-dry at 6-7 ft bgs exceeds both the site-specific SL and the residential RSL (Figure 13-24). The barium concentrations were less than the SLs at the other sample locations.

Lead - Lead exceeded the SL at 6-7 ft bgs at TP-PRA-EE12A and at 10-11 ft bgs at TP-PRA-DD22A (Figure 13-25). The lead concentration reported for the sample at TP-PRA-EE12A (3,420 mg/kg-dry) was over one order of magnitude greater than the next highest subsurface sample at the PRA, and was the highest lead concentration of surface or subsurface soil at the PRA. The test pit was within the elevated area and the top several feet were likely fill, but the depth of the sample (6-7 ft bgs) could have been within native soils. TP-PRA-DD22A was located near the south end of the PRA, likely fuel lines were encountered at approximately 4 ft bgs. The sample was taken from 10-11 ft bgs, and appeared to be within the water table, with a moderate diesel odor noted.

PRA Subsurface Soil SVOCs

During the RI, 43 subsurface soil samples at 34 locations at the PRA were analyzed for SVOCs. The SVOC COPCs for the PRA subsurface soil are benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-cd)pyrene, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene.

PAHs - These eight SVOC subsurface soil COPCs for the PRA are PAHs and are constituents of petroleum fuel products. The majority and highest concentrations of PAHs are found in three test pit locations at the PRA:

TP-PRA-DD20A, TP-PRA-DD21, and TP-PRA-DD22A. TP-PRA-DD21 is the only sample with exceedances of the eight SVOC COPCs at 11-11.5 ft bgs which is located in the central area of the parking lot for the former depot and just west of the former refueling operations area. At least one sample at TP-PRA-DD21 has the highest concentrations of benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, naphthalene, 1-methylnapthalene, and 2-methylnapthalene at 11-11.5 ft bgs. These concentrations primarily exceed the residential RSL and the RBCA RBSL for residential soil. This coincides with observations of petroleum hydrocarbon odors and staining in the test pit and is within the smear zone.

More specifically, for benzo(a)anthracene, the PRA subsurface soil exceeded the RSL and RBCA RBSL for residential soil in three samples (Figure 13-26). For benzo(b)fluoranthene, the PRA subsurface soil exceeded the same SLs for four detected sample results (Figure 13-27). Indeno(1,2,3-cd)pyrene follows this same pattern with one exceedance of the same SLs (Figure 13-28). However, for dibenzo(a,h)anthracene there were two detected concentrations in samples above the RSL and RBCA RBSL for residential soil, but also laboratory reporting limits were over the SLs for 11 sample results that were below the detection limit (Figure 13-29). Naphthalene also exceeds the RSL and RBCA RBSL for residential SLs in eight sample results for the PRA, but also exceeds the leaching to groundwater 0-10 ft SL for one sample in PRA-DD16 from 7.5 to 8 ft bgs. Both methylnaphthalene COPCs follow this same trend and also exceed the leaching to groundwater SL for 11 sample results for 1-methlynaphthalene and 15 sample results for 2-methlynaphthalene (Figures 13-30 and 13-31, respectively). Only benzo(a)pyrene has exceedances for both the residential SLs and the industrial or commercial SLs (Figure 13-32). A total of nine detected results exceed the residential SLs, but of those two exceed the RSL for industrial soil and the RBCA RBSL commercial soil SLs. The three exceedances for the commercial and industrial SLs are in TP-PRA-DD20A and TP-PRA-DD22A.

PRA Subsurface Soil VOCs

During the RI there were 24 subsurface soil samples analyzed for VOCs at the PRA. The VOC constituent list consisted of 94 analytes. In total there were two detected VOC exceedances found, benzene (0.0743 mg/kg) and ethylbenzene (10.2 mg/kg). Both samples were from soil boring PRA-BB20 from 3.5 to 4 ft bgs (Figure 13-33). This location is within the current City of Deer Lodge shop parking area and not far from a UST that was removed in 1995 and investigated at that time (DEQ 2013). In that 1995 investigation by DEQ, over an inch of LNAPL was evident on the water table during the UST excavation, and BTEX was not analyzed in soil, but the benzene concentrations in the excavation water was below the detection limit of 1 ug/L and ethylbenzene was 4 ug/L (DEQ 2013). Based on maps from DEQ LUST files, it appears that the location for PRA-BB20 is potentially upgradient of the leaking UST area. While this appears to be a localized exceedance, this sample is on the western edge of the RI sample grid and no additional VOC samples were collected nearby north, south, or west of this location. However, evidence of PAHs is present to the west of here in the groundwater at MRMW01 and upgradient from there to the former depot area in soils and soil gas.

PRA Subsurface Soil EPH/VPH

The EPH and VPH COPCs for the PRA include four EPH fractions and naphthalene. Naphthalene exceedances are discussed with the SVOCs. The four EPH fractions that were found to have exceeded the SLs for the subsurface soil at the PRA: C5-C8 aliphatics, C9-C12 aliphatics, C9-C18 aliphatics, and C11-C22 aromatics. As Figure 13-22 illustrates, the EPH fraction exceedances range from the south side of Cottonwood Creek in PRA-FF08 to the north side of W. Milwaukee Ave. in TP-PRA-DD22A, and from as far west as grids PRA-CC12 and PRA-CC21 and as far east as the subsurface soil samples west of the active BNSF ROW at PRA-FF17.

Both C5-C8 aliphatic and C9-C12 aliphatic fractions have nine sample result exceedances of the RBCA RBSL for residential soil; however, C5-C8 aliphatics also has five exceedances of the leaching to groundwater 0-10 ft SL and three exceedances for the RBCA RBSL for commercial soil (Figure 13-34). The greatest exceedances at both locations are both at TP-PRA-DD21 from 11-11.5 ft bgs. The next four highest results are from TP-PRA-FF15A, TP-PRA-DD13A, TP-PRA-EE20A, and TP-PRA-FF11B. These also exceed the leaching to groundwater SL and all of the exceedance results are located between 8.5 and 11 ft bgs within the smear zone and at the saturated zone. Figure 13-35 shows a similar spatial and depth pattern for exceedances for C9-C12 aliphatic fractions.

C9-C18 aliphatic fractions has the most EPH exceedances at 21 detected results that were above the RBCA RBSL for residential soil, of which 17 are above the RBCA RBSL for commercial soil, and 11 exceed the RBCA RBSL for excavation (Figure 13-36). The highest concentration is again found at TP-PRA-DD21 from 11-11.5 ft bgs at 15,500 mg/kg-dry. This is double the next highest result at TP-PRA-FF15A of 7,170 mg/kg-dry. The next highest sample is at PRA-DD16 at 7.5-8 ft bgs at 6,620 mg/kg-dry. This location is downgradient and west of the current LNAPL area for the PRA. This sample is consistent with field observations of the smear zone at PRA-DD16 just above a saturated zone at 7.5 ft and observations of gray sands and gravels and a strong odor at 7 to 12 ft bgs. The highest concentrations are observed at the smear zone within the majority of the samples, but extend to subsurface samples off the elevated bench as far west as PRA-CC21 at 5-6 ft bgs near the access gate to the city shop and as far east as TP-PRA-FF15A at 9.5-10 ft bgs.

The last EPH COPC for the PRA subsurface soil is C11-C22 aromatic and follows a similar spatial and depth pattern of exceedances to the C9-C18 aliphatic fraction. Figure 13-37 illustrates the concentrations for each location, but the highest result is at PRA-DD16 from 7.5-8 ft bgs at 4,800 mg/kg-dry. This soil boring is down gradient and to the west of the current recovery trench for the LNAPL within the central area of the PRA. This sample was collected from within the saturated zone.

13.4 GROUNDWATER

Prior to the RI groundwater sampling events, groundwater at the PRA had been analyzed for 65 different analytes. Of the 65 analytes, 4 were determined to be COPCs since they had detected values above the current SLs for groundwater. The following 4 analytes are the historical COPCs for the PRA:

- Metals
    - Arsenic, Total
- EPH Fractions/VPH
    - C11-C22, Aromatic
    - C19-C36, Aliphatic
    - C9-C18, Aliphatic

The total arsenic concentration exceeded the DEQ-7 standard in one sample collected in 2010 from well MW3_PRA which is located northwest of the former water UST (Figure 4-7). The EPH/VPH fraction concentrations that exceeded SLs were in a sample collected in 2010 from well MW5_PRA which is located north of a former oil sump and near the current product recovery trench (Figure 4-7).

To assess the current conditions at the PRA, groundwater samples were collected from 19 wells across the area during the RI field work. The results of this RI sampling effort illustrate the current conditions and current COPCs for the PRA. COPCs are listed in Table 13-13. Groundwater samples were collected using low-flow sampling techniques. The analytical results are presented in Tables 13-14 through 13-18 and Appendix M. Figures 13-38 through 13-41 visually illustrate the analytical results as exceedances of the groundwater SLs or non-exceedances. From the comparison of the analytical results to the groundwater SLs, there are seven current COPCs identified for groundwater for the PRA:

- Metals
    - Arsenic, Dissolved
    - Iron, Dissolved
    - Iron, Total

  - Manganese, Dissolved
  - Manganese, Total
- SVOCs
  - 2-Methylnaphthalene
- EPH Fractions/VPH
  - C9-C18, Aliphatic, Adjusted
  - C11-C22, Aromatic, Adjusted

There are an additional 21 analytes that were not detected above the analytical detection limit, but had a reporting limit above the current groundwater SLs (Table 13-13). Only 3 analytes, 4,4-DDT, benzo(a)pyrene, and dibenzo(a,h)anthracene, were identified as COPCs in other media at the PRA (soils).

<u>PRA Groundwater Metals</u>

The metals groundwater exceedances for the PRA are located throughout the PRA (Figure 13-38). Metals concentrations in groundwater exceeded SLs in samples from all but three wells; however, the metals exceeding the SLs at most of these wells were limited to manganese. Elevated manganese concentrations may be related to biodegradation of petroleum, as the wells with exceedances were generally near the historical diesel unloading point and historical PRA refueling areas. In the following section each metal COPC is discussed with respect to the concentration and location of SL exceedances in the MRA surface soil.

<u>Arsenic</u>: Out of 40 samples collected during the RI, dissolved arsenic concentrations exceeded the DEQ-7 standard of 0.01 mg/L in samples collected from three wells: MW3_PRA, MW-203, and MW-206 (Figure 13-42). The arsenic concentration exceeded the standard in only one sample from each of these wells. The highest dissolved arsenic concentration detected was 0.015 mg/L in the sample from MW-206. Dissolved arsenic was detected in samples, but less than the standard in 27 of the 38 samples.

<u>Iron</u>: Dissolved and total iron were detected above the RSL for Tapwater SL of 14 mg/L in samples from two wells at the PRA (Figure 13-43). Samples from monitoring well MW-203 exceeded SLs for both dissolved and total iron during both the June and August 2014 sampling events. MW-203 is located approximately in the center of the PRA and is south of the historical diesel unloading area. MW3_PRA is located near the north end of the PRA and the concentration of total iron exceeded the SL in August 2014.

Manganese: Dissolved and total manganese were detected above the SL for Tapwater SL of 0.43 mg/L in samples from 16 of the 19 wells sampled at the PRA (Figure 13-44). The highest concentrations were detected at monitoring well MW-203. The product recovery trench is located just west of well MW-203. Elevated manganese may be related to biodegradation of petroleum. Dissolved manganese concentrations tend to increase in aquifers with petroleum contamination after oxygen has been depleted, as manganese can be used by some bacteria as an alternative electron acceptor.

PRA Groundwater SVOCs

The only SVOC at the MRA that exceeded SLs was the PAH 2-methylnaphthalene, which is a constituent of petroleum fuel products (Figure 13-45). Monitoring well MW1_PRA was the only well with a detected concentration of 2-methylnaphthalene (47 ug/L) that exceeded the RSL Tapwater SL of 36 ug/L. MW1_PRA is located near the north end of the PRA east of the Standard Oil bulk plant. The April 2014 sample from MW1_PRA exceeded the SL, but the August 2014 2-methylnaphthalene concentration was less than the SL.

PRA Groundwater VOCs

During the RI, groundwater from 19 wells was analyzed for up to 72 VOCs at each well. No VOCs were detected above SLs at the PRA during either groundwater sampling event in 2014 (Figure 13-40). VOCs have not historically been detected above SLs at the PRA.

PRA Groundwater EPH Fractions/VPH

In addition to the SVOC PAH 2-methylnaphthalene discussed above, two EPH fractions were found to have exceeded the SLs for groundwater at the PRA (Figure 13-41). Both C9-C18 aliphatic and C11-C22 aromatic fractions exceeded the RBCA RBSL groundwater SL at monitoring wells MW1_PRA and MRMW01 (Figure 13-46). The C9-C18 aliphatic fraction was detected in one sample from MRMW01 above the SLs from a sample group of 16 samples at the PRA.

Samples from well MW-203, which is adjacent to the LNAPL recovery trench, did not exceed SLs for EPH/VPH fractions. However, there is evidence of LNAPL within the trench piezometers and recovery well, approximately 25 feet to the west.

Field Parameters

Parameters were collected in the field for each well sampled at the PRA (Table 13-18). Parameters collected included pH, temperature, DO, conductivity, and ORP. Groundwater at the PRA is consistently around neutral with pH measurements ranging from 6.43 SU at well MRMW12 in August 2014 to 7.1 SU at well MW4_PRA in April 2014.

Temperatures varied with seasons and ambient temperatures, ranging from 3.3 degrees Celsius at well Park Street MW-11 in April 2014 to 16.17 degrees Celsius at well MRMW11 in August 2014. ORP ranged from a low of -109.1 mV at well MRMW01 in August to a high 223.2 mV at well Milwaukee Ave MW-07 in April. DO ranged from 0.19 mg/L at well MRMW02 in April to 4.11 mg/L at well MRMW11 in August. Conductivity in the field ranged from 358 uS/cm at well MW4_PRA to 6,321 mV at well MW-203. The groundwater across the PRA generally is considered Class I under ARM 17.30.1006 with natural specific conductance less than 1,000 uS/cm. However, five wells had conductivity measurements greater than 1,000 uS/cm. Two wells at the PRA (MW2_PRA and MW-203) have a specific conductance above 2,500 uS/cm. Both wells are near the free product recovery trench and may be influenced by free product in the area.

13.5 LNAPL

An historical potential diesel fuel unloading point and three above ground diesel storage tanks have been identified approximately in the center of the PRA near the former pump house. At least four diesel or gasoline tanks have been removed from the PRA since 1981. As detailed in the DSR (DEQ, 2013a), several investigations have been performed to assess petroleum contamination at the PRA. Due to the presence of free product on groundwater, in 2011 the EPA installed additional groundwater monitoring wells, a product recovery trench, and product recovery wells at the PRA. For the purposes of the RI, the monitoring wells have been used to measure water levels and record the presence of free product.

During the August 2014 sampling event, product was observed in the product recovery wells and monitoring wells MRMW08 and MRMW09 (Figure 4-7). LNAPL observed in monitoring wells at the PRA was described as watery with a yellow color. It was noted that the LNAPL had a diesel or kerosene type odor. No LNAPL was observed in monitoring wells outside of the recovery trench area (RT-RW-01, RT-RX-02, RT-PZ01 through RT-PZ-06), MRMW08, and MRMW09. However, MW6_PRA has had a sheen and strong odor during gauging. Fluid level measurements including LNAPL thickness and groundwater levels are shown in Table 13-19.

13.6 SEDIMENT

Historical sediment sampling at the PRA consists of 14 samples collected along Cottonwood Creek and the Clark Fork. Of those 14 samples, 14 of them were analyzed for SVOCs, 12 were analyzed for VOCs, 8 were analyzed for metals, and 6 were analyzed for the EPH/VPH carbon fractions. In total, 36 constituents were reported, resulting in 18 COPCs (Figure 4-9):

- Metals
    - Arsenic, Total
    - Cadmium, Total
    - Chromium, Total
    - Lead, Total
    - Mercury, Total
    - Selenium, Total
    - Silver, Total
- SVOCs
    - Acenaphthene
    - Anthracene
    - Benzo(a)anthracene
    - Benzo(a)pyrene
    - Benzo(b)fluoranthene
    - Chrysene
    - Dibenzo(a,h)anthracene
    - Fluoranthene
    - Fluorene
    - Indeno(1,2,3-cd)pyrene
    - Pyrene

Eight historical sediment samples taken across the PRA were analyzed for metals, each of which had detection exceedances of at least one metals constituent. Lead, arsenic, and cadmium were the primary metals constituents detected across the PRA at values exceeding the SLs.

The historical sediment SVOC exceedances at the PRA occurred mainly where the historical and operating railroad tracks cross Cottonwood Creek. More specifically, locations MR-SED-3 (located in grid cell HH7 on Figure 4-9) and

MR-SED-4 (located in grid cell FF7 on Figure 4-9). These two locations account for 17 of the 20 SVOC detection exceedances. The remaining SVOC exceedances occurred at SD-2_PRA (1 exceedance, located near MR-SED-4) and SE-6 (2 exceedances, located about 450 feet upstream of MR-SED-3).

Based on the historical PRA sample locations with detection exceedances, nine sediment samples were collected in 2014 near the historical and current railroad crossings of Cottonwood Creek (sample locations depicted on Figure 4-9). In 2014, analytical results indicated the following four constituents are sediment COPCs for the PRA:

- Metals
    - Arsenic, Total
    - Chromium, Total
    - Lead, Total
- SVOCs
    - Benzo(b)fluoranthene

COPCs are listed in Table 13-20. As part of the COPC evaluation for sediment, the concentrations of exceedances that are upstream of the Facility were compared to those directly at the CMSPP bridge area or downstream. Both arsenic and chromium had upstream sediment exceedances; however, the highest concentrations were observed on the Facility in the low-lying wetlands area or just downstream of the CMSPP bridge. Since the highest concentrations were within Facility boundaries or downstream, these were retained as COPCs. There were six additional analytes that were not detected, but detection limits exceeded the SLs. Of these, cadmium and the petroleum constituents indeno(1,2,3-cd)pyrene and naphthalene are COPCs in other media at the PRA (surface and subsurface soil). Analytical results are reported in Tables 13-21 through 13-24 and Appendix M. Analyte group results are shown on Figures 13-47 through 13-50.

PRA Sediment Metals

Arsenic was the most common COPC for metals; it was detected above the SL at nine of the ten sampled locations (Figure 13-51). Chromium and lead, the other COPCs identified in the 2014 PRA sediment sampling, had three and two exceedances respectively, and were found in conjunction with arsenic exceedances (Figures 13-52 and 13-53, respectively).

PRA Sediment SVOCs

Only one location at the PRA, PRA-SD115, had a non-metal exceedance during the 2014 sediment sampling. This location had an exceedance of the SVOC benzo(b)fluoranthene. PRA-SD115 can be found in grid cell FF7 on Figure 13-48, near the historical sediment sample location MR-SED-4 and just downstream of the former railroad bridge. As previously noted, MR-SED-4 contained numerous SVOC detection exceedances.

PCBs were sampled from each sediment location at the PRA, and were not detected at levels exceeding SLs.

PRA Sediment VOCs

VOCs were not detected at concentrations exceeding SLs (Figure 13-49).

PRA Sediment EPH/VPH

EPH/VPH fractions were not detected at concentrations exceeding SLs (Figure 13-50).

13.7 SURFACE WATER

Surface water sampling at the MRH facility began in April 1990 (MSE, 1990). There were three historical surface water samples collected at the PRA (MR-SW-3, MR-SW-4, and MRSW02_093010). These locations are depicted on Figure 4-9. The three historical PRA surface water samples were analyzed for 29 different constituents. There were no detection exceedances for any of the constituents and therefore no historical COPCs identified at the PRA.

During the RI, an additional five surface water samples were taken from four locations at the PRA. Surface water samples taken during 2014 were analyzed for 10 metals constituents, 73 SVOC constituents, 72 VOC constituents, and 13 EPH/VPH constituents; a total of 168 unique constituents.

At the PRA there were three COPCs identified during the 2014 surface water sampling, including:

- Metals
    - Arsenic, Total
    - Iron, Total
    - Manganese, Total

COPCS are listed on Table 13-25. There were 35 additional analytes that were not detected but detection limits exceeded SLs. Of these analytes, six PAHs and PCB-1260-Aroclor were identified as COPCs in surface soil.

Analytical results are included on Tables 13-26 through 13-29. Figures showing analyte group data are included as Figures 13-47 through 13-50.

The two sample locations where iron concentrations exceeded SLs were PRA-SW112 and PRA-SW113 located to the west (downstream) and east (upstream), respectively, of where the active BNSF railroad crosses Cottonwood Creek. The arsenic and manganese exceedances were detected at PRA-SW120, in the wetlands area between the former rail line and the existing rail line.

There were no surface water detection exceedances for SVOCs (including PCBs), VOCs, or EPH/VPH constituents at the PRA. However, there were 30 SVOC constituents (out of 73) and 5 VOC constituents (out of 72) with reporting limits that exceeded the SL. Based on the COPC selection criteria, these constituents are not considered COPCs because they were not detected above SLs in any of the other media samples.

13.8 SOIL GAS

As detailed in Section 5.8, soil gas samples were taken during the RI to evaluate possible vapor contamination. The soil gas points were installed near potential receptors to evaluate the vapor contamination pathway. Locations of the soil gas points are depicted on Figure 4-7. As described in Section 8.2.3, up to ten soil gas probes were proposed for installation at five locations at the MRA, but only five soil gas probes were installed at four locations due to high groundwater. Only two soil gas probes were sampled during the two sampling events, as groundwater was too high to sample the other probes. Sample locations on the PRA include SG-206S (5.2-5.7 ft) and SG-210S (5.5-6 ft). The two PRA soil gas probes were sampled for the first time in June 2014, and a second time in August 2014.

Each of the soil gas samples was analyzed for 78 VOCs and VPH fractions. Of the 78 constituents, 11 have been identified as COPCs for the PRA. There were also 46 constituents that had at least one instance when the method reporting limit was unable to meet the SL. Of those 46 constituents, 15 of them were unable to meet the SL for any of the samples; however, none of these analytes was a COPC in other media at the PRA. COPCs are listed in Table 13-31. Analytical results are presented in Table 13-32.

The 11 COPCs identified for the PRA are slightly different than those identified for the MRA. The following analytes were identified as soil gas COPCs for the PRA:

- VOCs
    - Benzene
    - C5-C8, Aliphatic, Adjusted
    - C9-C10, Aromatic, Adjusted
    - C9-C12, Aliphatic, Adjusted
    - Cyclohexane
    - Ethylbenzene
    - Isopropylbenzene
    - Naphthalene
    - Nonane
    - n-Propylbenzene
    - Propene

Out of the four PRA samples collected there were 28 total VOC detection exceedances. The majority of the exceedances occurred at location SG-206S. This probe is adjacent to the former depot building. The hydrocarbon fractions (C5-C8 Aliphatic, Adjusted, C9-C10, Aromatic, Adjusted, and C9-C12, Aliphatic, Adjusted) accounted for 9 of the 20 PRA detection exceedances. In general, vapor concentrations were greater during the August sampling event than the February sampling event. Maps showing ethylbenzene, C5-C8 Aliphatic, C9-C10 Aromatic, and C9-C12 Aliphatic are included as Figures 13-54 through 13-57, respectively.

Benzene, C5-C8, Aliphatic, Adjusted, C9-C12, Aliphatic, Adjusted, ethylbenzene, and naphthalene are COPCs in subsurface soil at the PRA, which may be the source of soil gas concentrations. The remaining soil gas COPCs were detected in at least one groundwater, surface soil, or subsurface soil at the PRA except for cyclohexane, propene, and nonane, which were not analyzed in matrices besides soil gas.

13.9 RAILROAD BALLAST

On the BNSF property, railroad ballast samples were collected from the active railway and ROW at the PRA. Railroad ballast samples were collected by hand. The samples were 5-point composite samples with two aliquots collected on the east side of the tracks, two on the west side of the tracks, and one in the center along a 100-ft linear grid section of track. Samples were collected from randomly generated 100-ft linear grid sections. Five samples of railroad ballast were collected from the PRA. The railroad ballast samples were collected from the surface environment (0-6 inches bgs) at each aliquot location. Ballast samples below 6 inches bgs were not collected. Ballast samples were analyzed for VOCs and SVOCs.

Trihydro coordinated with BNSF to collect the railroad ballast samples. BNSF provided a flagger during the sample collection and a representative from Olympus (BNSF’s consulting firm) was onsite during collection of the ballast samples.

Detected concentrations from samples collected at the PRA did not exceed SLs. Reporting limits for several analytes were higher than some SLs, most often leaching to groundwater SLs (Table 13-33). No COPCs were identified for the ballast on the active railroad line on the PRA.

13.10 ASBESTOS-CONTAINING MATERIAL

Two samples of potential ACM were collected from the PRA (Appendix B). Samples were collected from a pipe joint sealant and a 2-inch transite pipe that was discovered during test pitting activities at the PRA. The samples were collected and analyzed to determine the percentage of asbestos. The analysis was performed in accordance with EPA Method 600/R-93/116, which employs polarized light microscopic (PLM) techniques. The quantification of asbestos in the sample is intended to be an estimate only and limit of detection for this method is approximately 1% by volume.

Results of the PLM indicated that the transite pipe contained approximately 70-80% Chrysotile asbestos and 2-5% Crocidolite asbestos. The pipe sealant did not contain asbestos above 1% according to PLM analysis, but was reported to contain trace Chrysotile following analysis by TEM. The transite pipe is still in place at the PRA below the ground surface.

14.0 CONTAMINANT FATE AND TRANSPORT

This section presents fate and transport information for COPCs at the MRH Facility. Facility physical characteristics, contaminant characteristics, and an analysis of the fate and transport processes are combined in the evaluation of contaminant fate and transport. The contaminant fate and transport processes at the MRH Facility are addressed in the following sections:

- Section 14.1 describes the general physical and chemical characteristics of the COPCs.
- Section 14.2 describes the general toxicological characteristics of the COPCs.
- Section 14.3 describes the fate and transport processes of the COPCs, particularly a presentation of destructive and nondestructive attenuation processes.
- Section 14.4 describes the Conceptual Site Model, including a summary of sources and release mechanisms, pathways for exposure, receptors, and the approach to risk analysis.

14.1 CHARACTERISTICS OF CONTAMINANTS OF POTENTIAL CONCERN

The COPCs as identified in the RI are shown in Sections 12 and 13. The RI considered four groups of COPCs the most significant from a risk and remediation standpoint and these are discussed in this section: Metals, SVOCs, VOCs, and EPH/VPH. The following subsections discuss the physical and chemical characteristics along with the toxicological effects of each of the COPCs. In addition, the typical breakdown products and parent compounds are described.

14.1.1 METALS

Metals and metalloids occur in all ecosystems. Natural occurring concentrations vary according to local geology. Some metals are essential as nutrients but all metals can be toxic at some concentration. Metals can occur naturally or as a result of human activity including mining, industry, pesticide use, and waste disposal. Metals can be transported to surface waters by runoff from impacted soils. Some metals are more likely than others to migrate to groundwater through soil.

Arsenic

Arsenic is classified as a metalloid, having properties of both a metal and a nonmetal. However, it is usually referred to as a metal (ATSDR 2007a). Arsenic is a naturally occurring element that is found in combination with either inorganic or organic substances to form many different compounds. Inorganic arsenic compounds are found in soils, sediments, and groundwater. These compounds occur naturally or as a result of mining, ore smelting, and industrial use of arsenic. Historically, inorganic forms of arsenic have been used in pesticides and paint pigment. Arsenic has also been used in wood preservatives, in alloys with lead and other metals, and as a treatment for a variety of ailments. Today, usage of arsenic-containing pesticides and wood preservatives is restricted. Coal-fired power plants and incinerators often release arsenic to the environment. Naturally occurring arsenic in soils is often strongly sorbed to sediments, particularly fine-grained material that contains clay. Many arsenic compounds can dissolve in water allowing arsenic to enter aquatic environments (ATSDR 2007a).

Barium

Barium is a silvery-white metal that occurs naturally in many different compounds. Barium complex greases have historically been used for the lubrication of railroad tracks and wheels of railway cars. Barium compounds are used by the oil and gas industries to make drilling muds. Barium compounds are also used to make paint, brick, ceramics, glass, and rubber. Barium sulfate is sometimes used to perform medical tests and to take x-rays of the gastrointestinal tract. The most common barium compounds (barium sulfate and barium carbonate) generally do not mix well in water. However, other, less common barium compounds dissolve more easily in water (ATSDR 2007b).

Cadmium

Cadmium is a natural element in the earth's crust. It is usually found as a mineral combined with other elements such as oxygen (cadmium oxide), chlorine (cadmium chloride), or sulfur (cadmium sulfate, cadmium sulfide).

All soils and rocks, including coal and mineral fertilizers, contain some cadmium. Most cadmium used in the United States is extracted during the production of other metals like zinc, lead, and copper. Cadmium does not corrode easily and has many uses, including batteries, pigments, metal coatings, and plastics (ATSDR 2012a).

Chromium

Chromium is a naturally occurring element found in rocks, animals, plants, and soil. It can exist in several different forms. Depending on the form it takes, it can be a liquid, solid, or gas. The most common forms are chromium(0), chromium(III), and chromium(VI). No taste or odor is associated with chromium compounds (ATSDR 2012b).

The metal chromium, which is the chromium(0) form, is used for making steel. Chromium(VI) and chromium(III) are used for chrome plating, dyes and pigments, leather tanning, and wood preserving (ATSDR 2012b).

Lead

Lead is a naturally occurring metal found in all parts of the environment. A large amount of lead in the environment comes from human activities including burning fossil fuels, mining, and manufacturing. Lead is used in the production of items such as batteries, ammunition, and metal products. Lead does not break down in the environment, but lead compounds can be changed depending on conditions (ATSDR 2007c).

Mercury

Mercury is a naturally occurring metal which has several forms. Metallic mercury is a silver-white, shiny, odorless liquid. At ambient temperatures, mercury is liquid, but readily volatilizes to a colorless, odorless gas. Mercury combines with other elements to form inorganic mercury salts which are usually white powders. Mercury can also combine with carbon to form organic compounds. The most common organic mercury compound is methylmercury which is primarily produced by microorganisms in soil and water. Metallic mercury is used in thermometers, some dental fillings, batteries and to produce chlorine gas and caustic soda (ATSDR 2012a).

14.1.2 SVOCS

Polycyclic Aromatic Hydrocarbons (PAHs)

The compounds benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenzo(a,h)anthracene, indeno(1,2,3-CD)pyrene, 1-methylnaphthalene, 2-methylnaphthalene, and naphthalene belong to the group of compounds known as PAHs. PAHs are defined as hydrocarbons containing two or more aromatic rings. PAHs are released to the environment from natural and manmade sources. Manmade sources now provide a much larger release volume than do natural sources. PAHs are common constituents of petroleum hydrocarbon mixtures such as diesel, motor oil, and asphalt. PAHs also result from incomplete burning of coal, oil and gas, garbage, or other organic substances such as tobacco or charbroiled meat. They are also found in creosote, dyes, paints, plastics, insulating materials, building materials, and rubber. In general, PAHs have low water solubility and may increasingly sorb to soil or particles within groundwater with increasing soil organic carbon. The less organic carbon found in the soil system, the more mobile are the PAH compounds. Sorption to soil particles is the primary process responsible for their removal from aqueous systems. The Henry's Law constants of PAHs range from 10^{-4} to 10^{-8} atm-m^3/mol. The Koc values for the high-molecular-weight PAHs are in the range of 105 to 106, which indicates a strong tendency to adsorb to organic carbon present in soil (ATSDR 1995). Sorption of PAHs to soil and sediment increases with increasing organic carbon content and is also directly dependent on particle size. Smaller particles with higher surface-area-to-volume ratios are more efficient at sorbing PAHs. Sorption has been correlated with bioconcentration in aqueous organisms (ATSDR 1995).

Polychlorinated biphenyls

PCBs are mixtures of up to 209 individual chlorinated compounds (congeners) that do not occur naturally. Many PCB mixtures in the US are known by the trade name Aroclor. Aroclor 1260 was discovered at the MRH Facility. PCBs have been used in transformers, capacitors, and other electrical equipment. Production of PCBs in the United States stopped in 1977 due to suspected harmful health and environmental effects. PCBs can enter the environment from use and disposal, accidental spills and leaks of products containing PCBs. PCBs do not readily break down in the environment and are persistent organic pollutants. They can bioaccumulate in fish and aquatic organisms, reaching levels thousands of times higher than in surrounding water. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs also bind strongly to soil. Aroclor 1260 has a Henry's law constant of 4.6 x 10^{-3} atm-m^3/mol. (ATSDR 2000).

14.1.3 VOLATILE ORGANIC COMPOUNDS

VOCs are organic compounds that readily evaporate into air. At normal temperatures and atmospheric pressure, vapors easily escape from volatile liquid chemicals. VOCs include gasoline, benzene, toluene, trichloroethene, and vinyl chloride. Many VOCs are man-made chemicals that are used and produced in the manufacture of paints, pharmaceuticals, refrigerants, and industrial solvents. VOCs are often components of petroleum fuels, hydraulic fluids, paint thinners, and dry cleaning agents. VOCs are common contaminants in groundwater and soil gas.

Trichloroethene

Trichloroethene, also known as trichloroethylene or TCE, is a man-made, colorless, volatile liquid. TCE is nonflammable and has a sweet odor. The most significant uses for TCE are as a solvent/degreaser and in the production of chemicals such as the refrigerant HFC-134a. TCE has a vapor pressure of 69 mm Hg and readily volatilizes to air. The Henry's law constant of TCE has been measured as 0.00985 atm-m^3/mol at 25°C, which suggests that TCE partitions rapidly to the atmosphere from surface water. The soil adsorption coefficient (Koc) for TCE is estimated to range between 49 and 460 (ATSDR 2006).

Vinyl Chloride

Vinyl chloride is likely present as a result of anaerobic biodegradation of TCE found in soil. Vinyl chloride has a relatively high vapor pressure (2,660 mm Hg) and readily volatilizes to air. The Henry's law constant of vinyl chloride has been measured as 0.0278 atm-m3/mol at 24.8 °C, which suggests that vinyl chloride should partition rapidly to the atmosphere (ATSDR 2006). The soil adsorption coefficient (Koc) for vinyl chloride is estimated to range between 14 and 131 (ATSDR 2006) which suggests that it is highly mobile in soil and has the potential to migrate to groundwater.

14.1.4 PETROLEUM HYDROCARBONS, EPH AND VPH

"Petroleum hydrocarbons" is a term used to describe a large family of several hundred chemical compounds that originally come from crude oil (ATSDR 1999). Petroleum hydrocarbons are typically used as fuels, solvents, or chemical intermediates. The volatility of a compound generally decreases with an increase in carbon number range and boiling range. For the RI, petroleum hydrocarbons are generally classified in two groups: EPH and VPH.

The EPH group includes diesel-range organic compounds, motor oil range compounds, Bunker C, and other extractable fuels. EPH found in the environment at the MRH Facility is associated with leaks from piping and storage tanks, spills, and maintenance activities. The EPH or diesel-range organic compounds and motor oil range compounds are composed primarily of aliphatic hydrocarbons that fall in the C10 to C20 range. As much as approximately 25 percent of petroleum hydrocarbons may be composed of aromatic hydrocarbons consisting of alkylated benzenes and naphthalenes. Petroleum hydrocarbons are generally less dense than water. Diesel range organic compounds are less volatile, less water soluble, and less mobile than gasoline range organic compounds. Diesel-range organic compounds and motor oil range compounds have a stronger tendency for adsorption to soil organic carbon.

The VPH group includes lighter gasoline-range organic compounds, jet fuel, mineral spirits, and other volatile fuels. VPH is found at the MRH Facility associated with petroleum products used or stored at the MRH Facility. VPH or gasoline-range organic compounds are composed of both aromatic and aliphatic hydrocarbons. Volatile aliphatic hydrocarbons are collectively quantified within two ranges: C5 through C8, and C9 through C12. Volatile aromatic hydrocarbons are collectively quantified within the C9 to C10 range. Target VPH analytes include benzene, toluene, ethylbenzene, xylenes (BTEX).

14.2 GENERAL TOXICOLOGICAL INFORMATION

This section describes general toxicological information of chemicals identified as COPCs. Much of the narrative that follows cites the Agency for Toxic Substances and Disease Registry (ATSDR) which puts a heavy emphasis on direct ingestion and dust inhalation. Note that dermal contact can also be a significant source of human exposure for many of the COPCs.

14.2.1 METALS

Arsenic

Human exposure to arsenic contamination generally occurs through ingestion of contaminated food or water or inhalation of contaminated dust. Ingesting high levels of arsenic can result in death. Exposure to lower levels can cause nausea, decreased production of red and white blood cells, abnormal heart rhythm, and damage to blood vessels.

Inhalation of high levels of arsenic can result in irritated throat and lungs. Ingesting or breathing low levels for an extended period of time can result in darkening of the skin and the appearance of small abnormalities on skin on palms, soles, and torso. Dermal contact can result in redness or swelling. Several studies have shown that ingestion of inorganic arsenic can increase the risk of cancer in skin, liver, bladder, and lungs. The Department of Health and Human Services (DHHS) and the EPA have determined that inorganic arsenic is a known carcinogen (ATSDR 2007a).

Barium

Human exposure to barium can occur from ingesting contaminated food or water or inhalation. The health effects of barium compounds depend on how well the compound dissolves in water. Barium sulfate, which does not dissolve well in water, is generally not harmful. Ingestion of barium-contaminated water can result in vomiting, cramps, diarrhea, difficulties breathing, and muscle weakness. Ingestion of very large amounts of barium-contaminated food or water can result in changes to heart rhythm, paralysis, or death. Barium is not likely to be a carcinogen in humans (ATSDR 2007b).

Cadmium

Exposure to cadmium can occur from ingesting contaminated food or water and inhalation. Eating food or drinking water with very high levels severely irritates the stomach, leading to vomiting and diarrhea. Breathing high levels of cadmium can severely damage the lungs.

Long-term exposure to lower levels of cadmium in air, food, or water leads to a buildup of cadmium in the kidneys and possible kidney disease. Other long-term effects are lung damage and fragile bones (ATSDR 2012a).

Chromium

Chromium can be found in air, soil, and water. Chromium can easily change from one form to another depending on conditions. Exposure to chromium can occur from ingesting contaminated water or food, inhalation, or dermal contact. Chromium(III) is an essential nutrient that helps the body use sugar, protein, and fat. Irritation and ulcers have been observed in animals following the ingestion of chromium (VI) compounds (ATSDR 2012b). Breathing high levels of chromium(VI) can cause irritation to the lining of the nose, nose ulcers, runny nose, and breathing problems, such as asthma, cough, shortness of breath, or wheezing. The concentrations of chromium in air that can cause these effects may be different for different types of chromium compounds, with effects occurring at much lower concentrations for chromium(VI) compared to chromium(III). Some people are sensitive to chromium(VI) and chromium(III) and can have allergic reactions consisting of redness and swelling of skin (ATSDR 2012b).

Lead

Exposure to lead can come from ingesting contaminated food or water or inhalation of dust. Lead effects on the body are the same regardless of entry method. The nervous system is the primary target for lead toxicity. Exposure to high levels can severely damage the brain and kidneys and can result in death ATSDR 2007c).

DHHS has determined that lead and lead compounds are reasonably anticipated to be human carcinogens and the EPA has determined that lead is a probable human carcinogen. The International Agency for Research on Cancer (IARC) has determined that inorganic lead is probably carcinogenic to humans and that there is insufficient information to determine whether organic lead compounds will cause cancer in humans (ATSDR 2007c).

Mercury

Exposure to mercury can come from ingesting contaminated food, inhalation, or dermal contact. Exposure to high levels of mercury can permanently damage the brain, kidneys, and developing fetus. The nervous system is very sensitive to all forms of mercury. Methylmercury and metallic mercury vapors are the most harmful forms of mercury because these forms reach the brain. Symptoms of damage to brain function may include irritability, shyness, tremors, and memory problems. Short-term exposure to high levels can cause lung damage, nausea, vomiting, diarrhea, increases in blood pressure, skin rashes, or eye irritation. The EPA has determined that some forms of mercury (mercuric chloride and methylmercury) are possible human carcinogens (ATSDR 1999a).

14.2.2 SVOCS

PAHs

Exposure to PAHs can come from ingestion of contaminated food or water, inhalation, and dermal contact. Animals exposed to PAHs have shown reproduction problems and harmful effects to skin, body fluids, and the ability to fight disease. These effects have not been shown in people. The DHHS has determined that some PAHs may reasonably be expected to be carcinogens. The toxicity of PAHs is generally expressed relative to the toxicity of benzo(a)pyrene. In addition to benzo(a)pyrene, six other PAHs are classified by EPA as probable human carcinogens. The six PAHs include benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenzo(a,h)anthracene, and indeno(1,2,3-cd)-pyrene (EPA 1993). With the established carcinogenicity of benzo(a)pyrene, the other six compounds have been estimated to be 1 to 1,000 times less carcinogenic (EPA 1993). As a result, general toxicological information for PAHs is typically discussed as benzo(a)pyrene.

Numerous epidemiologic studies have shown a clear association between exposures to various mixtures of PAHs containing benzo(a)pyrene (for example, coke oven emissions, roofing tar emissions, and cigarette smoke) and increased risk of lung cancer and other tumors. However, each of the mixtures also contained other potentially carcinogenic PAHs; therefore, it is not possible to evaluate the contribution of benzo(a)pyrene alone to the carcinogenicity of these mixtures (ATSDR 1995).

PAHs can be accumulated in aquatic organisms from water, sediments, and food. In general, bioconcentration was greater for the higher molecular weight compounds than for the lower molecular weight compounds (EPA 2006).

PCB

Exposure to PCBs can come from ingestion of contaminated food or water, inhalation, and dermal contact. Long-term exposure to PCBs may have serious effects on the liver, immune system, endocrine system, reproductive system, and thyroid hormone levels, which in turn may affect normal growth and development. Exposure may damage the nervous system, causing headaches, numbness, weakness, and tingling in the arms and legs. Dermal exposure with PCBs can cause acne and skin rashes. The DHHS has concluded that PCBs may reasonably be anticipated to be carcinogens. PCBs have been classified as probably carcinogenic, and carcinogenic to humans (group 1) by the EPA and IARC, respectively (ATSDR 2000).

PCBs do not readily break down in the environment and are persistent organic pollutants. They can bioaccumulate in fish and aquatic organisms, reaching levels thousands of times higher than in water (ATSDR 2000).

14.2.3 VOCS

The health effects of volatile organic compounds can vary greatly according to the compound, which can range from being highly toxic to having no known health effects. The health effects of VOC exposure depends on the nature of the compound and length and severity of exposure.

According to the Thirteenth Report on Carcinogens published by the National Toxicology Program, benzene is a human carcinogen. People at the highest risk of long-term exposure to VOCs are industrial workers who have prolonged exposure to the compounds in the workplace; cigarette smokers; and people who have prolonged exposure to emissions from heavy motor vehicle traffic. (ATSDR 2006).

Long-term exposure to volatile organic compounds can cause damage to the liver, kidneys, and central nervous system. Short-term exposure to volatile organic compounds can cause eye and respiratory tract irritation, headaches, dizziness, visual disorders, fatigue, loss of coordination, allergic skin reactions, nausea, and memory impairment.

TCE

Exposure to TCE can come from inhalation or ingestion of contaminated water, or inhalation/dermal contact during use as an industrial solvent. Moderate exposure to TCE can cause headaches, dizziness, and sleepiness. Exposure to large amounts can result in damage to nerves, liver, and kidneys, coma, or death. IARC and the EPA determined that there is convincing evidence that TCE exposure can cause kidney cancer. TCE is currently listed in the 13th Report on Carcinogens as reasonably anticipated to be a human carcinogen (ATSDR 2014).

Vinyl Chloride

Exposure to vinyl chloride can come from inhalation, ingestion of contaminated water, and skin contact. Inhaling high levels of vinyl chloride can result in drowsiness, dizziness, difficulty breathing, liver or nerve damage, immune reactions, blood flow problems, and death. The long-term effects of drinking vinyl chloride-contaminated water are unknown. Dermal contact can result in numbness, redness, and swelling. DHHS has determined that vinyl chloride is a known carcinogen. Studies in workers who have breathed vinyl chloride over many years showed an increased risk of liver, brain, lung cancer, and some cancers of the blood have also been observed in workers. (ATSDR 2006)

14.2.4 PETROLEUM HYDROCARBONS, EPH/VPH

Exposure to petroleum hydrocarbons can come from inhalation, ingestion of contaminated water, or dermal contact. Health effects from exposure to petroleum hydrocarbons depend on many factors (ATSDR 1999). These factors include the types of chemical compounds in the petroleum hydrocarbons, how long the exposure lasts, and the amount of the chemicals contacted. Very little is known about the toxicity of many petroleum hydrocarbon compounds.

The compounds in some petroleum hydrocarbon fractions can affect the blood, immune system, liver, spleen, kidneys, developing fetus, and lungs (ATSDR 1999b). Certain petroleum hydrocarbon compounds can be irritating to the skin and eyes and can cause neurological effects consisting primarily of central nervous system depression. Other petroleum hydrocarbon compounds, such as some mineral oils, are not very toxic and are used in foods. The IARC has determined that one petroleum compound (benzene) is carcinogenic to humans. Other compounds are probably or possibly carcinogenic or have not been classified by the IARC. (ATSDR 1999b)

14.3 CONTAMINANT FATE AND TRANSPORT PROCESSES

General fate and transport processes that may attenuate concentrations of contaminants present in environmental media include dispersion, dilution, sorption, volatilization, abiotic degradation, and biodegradation. These processes can be categorized into two groups: nondestructive attenuation mechanisms and destructive attenuation mechanisms. These attenuation mechanisms are discussed in the following sections, with emphasis on the fate and transport processes that are applicable at the MRH Facility.

14.3.1 ATTENUATION MECHANISMS

Nondestructive attenuation mechanisms result in decreasing aqueous contaminant concentrations, but no destruction of contaminant mass. These processes include sorption of contaminants to the aquifer matrix, dispersion or spreading of the contaminant mass in the aquifer during transport, dilution of the contaminant mass by mixing with unimpacted water, and volatilization of dissolved contaminants to soil vapor.

Destructive attenuation mechanisms of organic contaminants result in the removal of contaminant mass by biological and abiotic processes.

Sorption: Sorption immobilizes contaminant mass by processes that fix or sorb compounds to the aquifer matrix. Organic carbon and clay minerals with large surface area-to-volume ratios generally act as sites of adsorption. Sorption slows or retards the contaminant mass relative to the bulk groundwater velocity. Sorption is quantified using the partitioning coefficient (Kd) or retardation factor (EPA 1999).

Dispersion: Dispersion describes the longitudinal and transverse spreading of the contaminant plume. Dispersion is caused by variations in flow velocity during advective transport of contaminants. Dispersion results in the three-dimensional mixing of the contaminants, but does not affect the total mass present in the plume.

The dominant dispersion process in relatively fast-moving groundwater systems such as at the MRH Facility is mechanical mixing along tortuous flow paths in the aquifer matrix. Measurements of dispersivity are extremely difficult, and estimates are often based on plume length (EPA 1998).

Dilution: Dilution of contaminant mass may occur along the flow path of plumes through infiltration of recharge from precipitation or recharge from the Clark Fork River, resulting in dilution of contaminant concentrations along a flow path. Site-specific dilution rates of the contaminant mass have not been quantified at the MRH Facility. In addition, dissolved chemicals leaching from contaminated vadose zone soils may be diluted by unimpacted groundwater underlying the contaminated soils (EPA 1999). Contaminant mass may volatilize across the water table, resulting in loss of contaminant mass to the vapor phase in the vadose zone. Volatilization of COPCs from groundwater and through the vadose zone can result in intrusion of COPCs from soil gas to subsurface structures and indoor air. There is potential for vapor intrusion at the MRH Facility.

The following subsections provide information on the nondestructive attenuation mechanisms applicable to arsenic, vinyl chloride, PAHs/PCB, and EPH/VPH.

<u>Biological processes</u>: Biological processes proceed by two broad mechanisms: (1) the use of the contaminant as a primary growth substrate by microorganisms, or (2) where contaminants are fortuitously degraded by cometabolism with another substrate without producing energy for the microorganism. Abiotic processes include hydrolysis where halogens are replaced by hydroxyl (OH) groups. Abiotic processes are not considered to be as dominant except in particular reductive environments for some contaminants such as carbon tetrachloride and chlorinated ethanes, including trichloroethane (EPA 1998).

The following subsections provide information on the destructive attenuation mechanisms applicable to arsenic, barium, cadmium, chromium, lead, mercury, PAHs, PCBs, TCE, vinyl chloride, and petroleum hydrocarbons.

14.3.2 FATE AND TRANSPORT OF METALS

Arsenic

Arsenic tends to sorb to soil and sediment and is typically transported by wind or runoff. Downward migration of arsenic tends to be more common in sandy or gravelly soil. Various soil characteristics can affect arsenic’s ability to migrate through soil, but the most influential parameter appears to be the iron content of soil. Arsenic adsorbs to iron and manganese oxides and may be released under reducing conditions which can occur in sediment or flooding conditions. Arsenic transport can be enhanced by pH. A study by Darland and Inskeep (1997) showed transport of arsenic being strongly retarded at pH 4.5 to 6.5, but was very rapid at 8.5.

Arsenic in soil may be transported by wind or in runoff or may leach into the subsurface soil. However, because many arsenic compounds tend to partition to soil or sediment under oxidizing conditions, leaching usually does not transport arsenic to any great depth (EPA 1982c; Moore 1988; Pantsar-Kallio and Manninen 1997; Welch 1988). Arsenic is largely immobile in agricultural soils; therefore, it tends to concentrate and remain in upper soil layers indefinitely. Downward migration has been shown to be greater in a sandy soil than in a clay loam (Sanok 1995). Arsenic cannot be destroyed in the environment. Arsenic can change form through oxidation, reacting with other molecules, or by microbial action.

Arsenic in water can undergo a complex series of reactions, including precipitation, oxidation-reduction, ligand exchange, and biotransformation. Factors influencing these reactions can include pH, iron concentrations, temperature, salinity, and a variety of other parameters (EPA 1979).

Arsenic in soil exists in various oxidation states and chemical species, depending upon soil pH and oxidation-reduction potential. Under most environmental conditions, inorganic As(V) will exist as a mixture of arsenate anions, H_2AsO_4 and $HAsO_4^{2-}$, and inorganic As(III) will exist as H_3AsO_3. The arsenic cycle in soils is complex, with many biotic and abiotic processes controlling its overall fate and environmental impact (ATSDR 2007a).

Barium

Most barium released to the environment is in forms that do disperse widely. In the atmosphere, barium is likely to be in particulate form and likely to be removed by wet and dry deposition. In water, barium is most likely to precipitate out of solution as an insoluble salt, such as $BaSO_4$ or $BaCO_3$. It is estimated that only 0.006% of the total barium input into oceans from freshwater sources remains in solution (Chow 1978). Uptake of barium by fish and marine organisms is also an important removal mechanism. Barium has been found to bioconcentrate in marine plants by a factor of 400-4,000 times and in marine animals and algae by a factor 100 – 260. Barium is not very mobile in most soil systems due to the formation of water-insoluble salts and an inability of the barium ion to form soluble complexes with fulvic and humic acids (WHO 2001). The rate of transportation of barium in soil is dependent on the characteristics of the soil material. Soil properties that influence the transportation of barium to groundwater are cation exchange capacity, calcium carbonate ($CaCO_3$) content and pH.

Elemental barium undergoes oxidation in the atmosphere and is readily oxidized in moist air. Appreciable levels of barium sulfate occur because natural water often contains high sulfate concentrations, especially ocean water. Since the solubility of barium sulfate is low, only trace amounts of barium dissolve in surface water (Bodek 1988). Barium reacts with metal oxides and hydroxides in soil and is subsequently adsorbed onto soil particulates. Barium can also form salts with acetate, nitrate, chloride, and hydroxide ions in soil. The mobility of barium in soils increases upon formation of these water soluble salts (Bodek 1988).

Cadmium

Cadmium is expected to partition primarily to soil (80–90%) when released to the environment. Although particulate and vapor cadmium may be released to the air, the net flux to soil will be positive as cadmium will eventually deposit onto soils (Morrow 2001). Cadmium is more mobile in water than most metals. In unpolluted waters, most cadmium will exist in dissolved state as the hydrated ion $[Cd(H_2O)_6]^{2+}$. In unpolluted waters, cadmium can be removed from solution by exchange of cadmium for calcium in the lattice structure of carbonate minerals (EPA 1979). In polluted or organic-rich waters, adsorption of cadmium by humic substances and other organic complexing agents plays a dominant role in transport, partitioning, and remobilization of cadmium (EPA 1979). The cadmium concentration in water is inversely related to the pH and the concentration of organic material in the water (EPA 1979). Precipitation and sorption to mineral surfaces, hydrous metal oxides, and organic materials are the most important processes for removal of cadmium to bed sediments. Mobility of cadmium in soil is affected by oxidation-reduction reactions, pH, and formation of complexes. Adsorption increases with pH. Under acidic conditions, cadmium may leach to groundwater. Cadmium tends to more strongly sorb to soil in wet conditions and is more available to plant uptake in dry conditions (ATSDR 2012a).

Cadmium bioaccumulates at all levels of the food chain. Accumulation has been reported in grasses, crops, earthworms, cattle, horses, and wildlife (ATSDR 2012a).

Common cadmium compounds found in the atmosphere are stable and are not subject to photochemical reactions. Most cadmium (80%-90%) in air will partition to soil. In fresh water, cadmium is present primarily as the cadmium(+2) ion and as inorganic compounds. Interaction with acids or light in aerobic conditions can result in insoluble compounds being changed to soluble salts. Transformation processes for cadmium in soil are mediated by sorption from and desorption to water, and include precipitation, dissolution, complexation, and ion exchange (McComish and Ong 1988). Important factors affecting transformation in soil include the cation exchange capacity, pH, and content of clay minerals, carbonate minerals, oxides, organic matter, and oxygen (McComish and Ong 1988).

Chromium

Chromium in the atmosphere is primarily present in particulate form. Removal from air is done through wet and dry deposition. The mass mean aerodynamic diameter (MMAD) of chromium aerosols or particulates emitted from several industrial sources are ≤10 μm and it has been estimated that chromium-containing particulates emitted from these industrial sources can remain airborne for 7–10 days and are subject to long-range transport (Kimbrough et al. 1999). Most chromium released to water will be deposited in sediment as chromium compounds and cannot volatilize from water. Chromium does not biomagnify in the aquatic food chain, although it can bioaccumulate [ATSDR 2012b]).

The mobility of chromium in soil is dependent upon the speciation of chromium, which is a function of oxidation-reduction potential and the pH of the soil. In most soils, chromium will be present predominantly in the chromium(III) oxidation state. This form has very low solubility and low reactivity, resulting in low mobility in the environment. Under oxidizing conditions, chromium(VI) may be present and is relatively mobile, however chromium is generally one of the least mobile metals.

In the atmosphere, chromium(VI) may be reduced to chromium(III) at a significant rate by vanadium (V^{2+}, V^{3+}, and VO_2^+), Fe^{2+}, HSO_3^-, and As^{3+} (Kimbrough 1999). Conversely, chromium(III), if present as a salt other than Cr_2O_3, may be oxidized to chromium(VI) in the atmosphere if 1% of the manganese in atmospheric aerosols is present as MnO_2

(EPA 1990). The estimated atmospheric half-life for chromium(VI) reduction to chromium(III) was reported in the range of 16 hours to about 5 days (Kimbrough 1999).

Reduction of chromium(VI) to chromium(III) can occur under suitable conditions in the aqueous environment, if an appropriate reducing agent is available. The most common reducing agents present in aqueous systems include: organic matter; hydrogen sulfide; sulfur, iron sulfide; ammonium; and nitrate (Kimbrough 1999). The reduction half-life of chromium(VI) in water with soil and sediment ranged from 4 to 140 days, with the reaction typically occurring faster under anaerobic rather than aerobic conditions. The fate of chromium in soil is dependent on the chromium species as well as redox potential and pH of the soil. Chromium is most commonly present in the chromium(III) state which has low solubility and reactivity. In deeper soil where anaerobic conditions exist, chromium(VI) will be reduced to chromium(III) by S^{-2} and Fe^{+2} present in soil. The reduction of chromium(VI) to chromium(III) is possible in aerobic soils that contain appropriate organic energy sources to carry out the redox reaction, with the reduction of chromium(VI) to chromium(III) facilitated by low pH (EPA 1990).

Lead

Non-organic forms of lead are present in the atmosphere primarily in the particulate form. Particle size is an extremely important factor in determining the atmospheric transport of lead. Large particles, particularly those with aerodynamic diameters of >2 μm, settle out of the atmosphere fairly rapidly and are deposited relatively close to emission sources (e.g., 25 m from the roadway for those size particles emitted in motor vehicle exhaust in the past); smaller particles may be transported thousands of kilometers (ATSDR 2007b).

The amount of soluble lead in water depends on the pH and dissolved salt content. The total solubility is approximately 30 ug/L in hard water and 500 ug/L in soft water with a pH greater than 5.4. A significant fraction of lead carried by river water is expected to be in an undissolved form, which can consist of colloidal particles or larger undissolved particles of lead carbonate, lead oxide, lead hydroxide, or other lead compounds incorporated in other components of surface particulate matters from runoff. Lead may occur either as sorbed ions or surface coatings on sediment mineral particles, or it may be carried as a part of suspended living or nonliving organic matter in water (ATSDR 2007b).

Adsorption mineral interfaces, precipitation of sparingly soluble solid forms of the compound, and the formation of relatively stable organic-metal complexes affect the fate of lead in soil. These processes are dependent on factors including pH, soil type, particle size, organic matter content of soil, and the amount of lead present in soil. Lead is more soluble and mobile in low pH environments. Most lead is retained strongly in soil, and very little is transported through runoff to surface water or leaching to groundwater except under acidic conditions.

Information is limited regarding the chemistry of lead in air. It is not completely clear how the chemical composition of lead changes during dispersion.

Lead can be found in multiple forms in water making the chemistry highly complex. Lead has a tendency to form compounds of low solubility with the major anions found in natural waters. In the environment, the divalent form (Pb2+) is the stable ionic species of lead. Hydroxide, carbonate, sulfide, and, more rarely, sulfate may act as solubility controls in precipitating lead from water. At pH<5.4, the formation of lead sulfate limits the concentration of soluble lead in water, while at pH>5.4, the formation of lead carbonates limits the amount of soluble lead (EPA 1979).

Lead in its naturally-occurring mineral forms is a very minor component of many soils in the United States. Additional sources of lead are incorporated to soils from atmospheric wet and dry deposition. Once lead compounds encounter components of the soil, further reactions can occur, resulting in a complex variety of lead compounds. The speciation of lead in soils is dependent upon the properties of the soil. Lead does not break down in the environment, but lead compounds can be changed depending on conditions.

Mercury

The state and form of mercury compounds in the environment depends on the medium, the redox potential, and pH. Metallic or elemental mercury is the most reduced form of mercury. More than 95% of mercury in the atmosphere is gaseous mercury (Hg0) and is the form most involved in long range transport. About 5% of atmospheric mercury is associated with particulates and has a shorter atmospheric residence time. Mercury is removed from the atmosphere by both wet and dry deposition (ATSDR 1999a).

In soils and water, mercury typically exists as mercuric mercury (Hg^{+2}) or mercurous mercury (Hg^{+1}) in various complexes with varying solubilities. The transport and partitioning of mercury in water is influenced by the form of the compound. Volatile forms (metallic mercury, dimethylmercury) will volatilize to the atmosphere. Solid forms will partition to particulates and be transported to sediments. Methylmercury and other mercury fractions are strongly bound to organic matter in water and may be transported in runoff water from contaminated lakes to other surface waters and soils (Lee and Iverfeldt 1991).

Sorption of mercury in soil is related to the organic content or the soil or sediment. Inorganic mercury sorbed to particulate matter is not readily desorbed. Leaching is a relatively insignificant transport process in soils. However, surface runoff is an important mechanism for moving mercury from soil to water.

The most common organic form of mercury, methylmercury, is soluble, relatively mobile, and quickly enters the aquatic food chain. Methylmercury accumulates to a greater extent in biological tissue than inorganic forms of mercury. Methylmercury in surface waters is rapidly accumulated by aquatic organisms; concentrations in carnivorous fish at the top of both freshwater and marine food chains are biomagnified on the order of 10,000–100,000 times the concentrations found in ambient waters (Callahan 1979). The bioaccumulation potential for methylmercury in fish is influenced by the pH of the water, with a greater bioaccumulation seen in waters with lower pH (Ponce and Bloom 1991).

Metallic mercury vapor, the most common form of atmospheric mercury, is oxidized by ozone to forms and removed by precipitation. The overall residence time of metallic mercury vapor in atmosphere is estimated to be 6 days to 2 years (ATSDR 1999a).

Biotransformation is the most important transformation process of mercury in water. Any form of mercury in water can be converted to methylmercuric ions through microbial action. Sulfur-reducing bacteria are responsible for most of the mercury methylation in the environment (Gilmour and Henry 1991).

Mercury in soils undergoes similar chemical and biological transformations as in water. Mercuric mercury usually forms various complexes with chloride and hydroxide ions in soils. The specific complexes formed depend on the pH, salt content, and composition of the soil solution. Increased levels of organic carbon and sulfate ions increase the methylation of mercury in sediments and soils. The presence of chloride ions can reduce methylation.

14.3.3 FATE AND TRANSPORT OF SVOCS

PAHs

PAHs in the atmosphere are removed by wet and dry deposition. The PAH compounds found at the MRH Facility are generally compounds that have a higher molecular weight and are generally found in the particle phase. These PAHs tend to be removed from water by binding to suspended particles or sediments. The heavier PAHs are less likely to volatilize from water or soil to the atmosphere.

Because of their low solubility and high affinity for organic carbon, PAHs in aquatic systems are primarily found sorbed to particles that either have settled to the bottom or are suspended in the water column.

Sorption of PAHs to soil and sediments increases with increasing organic carbon content and with increasing surface area of the sorbent particles. However, of 14 PAHs studied in two soils, volatilization was found to account for about

20 percent of the loss of 1-methylnaphthalene and 30 percent of the loss of naphthalene. Volatilization was not an important loss mechanism for benzo(a)anthracene, benzo(b)fluoranthene, dibenzo(a,h)anthracene, benzo(a)pyrene, and indeno(1,2,3-c,d)pyrene (Park 1990).

PAHs have been detected in groundwater either as a result of migration directly from contaminated surface waters or through the soil (Ehrlich 1982; Wilson 1986). PAHs have also been shown to be transported laterally within contaminated aquifers (Ehrlich 1982).

The processes that transform and degrade PAHs in the atmosphere include photolysis and reaction with nitrogen oxide, nitric anhydride, hydroxyl radicals, ozone, sulfur dioxide, and peroxyacetyl nitrate (Back 1991). PAHs have a wide range of volatilities and therefore are distributed in the atmosphere between the gas and particle phases. The PAHs at the MRH Facility are generally heavier compounds that exist in the particle phase. The two primary reactions transforming PAHs in the atmosphere are photooxidation and reactions between PAHs adsorbed on the particle surfaces and oxidant gases. Degradation of PAHs on particle surfaces by ozone has been found to be an important pathway for their removal from the atmosphere (ATSDR 1995).

The most important processes that contribute to degradation of PAHs in water are photooxidation, chemical oxidation, and biodegradation by aquatic microorganisms (Neff 1979). Hydrolysis is not considered an important degradation process for PAHs. The rate and extent of photodegradation varies widely among the PAHs (Neff 1979). There is no easily defined trend in the rates of photolysis that could be correlated with the chemical structure of PAHs.

PAHs in water can be chemically oxidized by chlorination and ozonation. The PAH-related by-products that result from chlorination are not fully known. Ozonation in water is generally slower and less efficient than chlorination in degrading PAHs (Neff 1979).

Environmental factors that may influence the rate of PAH degradation in soil and sediment include organic content, temperature, pH, oxygen concentration, PAH concentrations and the contamination history of the soil, soil type, moisture, nutrients, and other substances that may act as substrate co-metabolites (Sims and Overcash 1983). The size and composition of microbial populations in turn can be affected by these factors.

PCBs

PCBs are globally circulated and are present in all environmental media. Atmospheric transport is the most important mechanism for dispersion of PCBs. PCBs enter the atmosphere through volatilization from soil or water and are present in the vapor phase and sorbed to particles. PCBs are removed from the atmosphere through wet or dry deposition. The most common source of PCBs in surface water is atmospheric deposition. Once in water, PCBs are transported via diffusion and currents. PCBs are removed from water by sorption to suspended solids or volatilization. PCBs can also leave water by concentrating in biota (ATSDR 2000).

PCBs' ability to be degraded in the environment depends on the degree of chlorination of the biphenyl molecule as well as the isomeric substitution pattern. The dominant transformation process in the atmosphere is the reaction PCBs have with hydroxyl radicals. Photolysis appears to be the only viable abiotic degradation process in water. Biodegradation in the environment, although slow, occurs under both aerobic and anaerobic conditions. In sediments, aside from the aerobic surface layer, anaerobic microbial degradation will be primarily responsible for transformation, particularly of the more highly chlorinated congeners. Aerobic biodegradation in soil, surface water, and sediments is limited to the less chlorinated congeners (ATSDR 2000).

14.3.4 FATE AND TRANSPORT OF VOCS

TCE

TCE is moderately soluble in water, and experimental data have shown that scavenging by rainwater occurs rapidly (Jung 1992). TCE can, however, be expected to revolatilize back to the atmosphere after being deposited by wet deposition. Evaporation from dry surfaces can also be predicted from the high vapor pressure. The Henry's law constant value of 9.85×10^{-3} atm-m^3/mol at 25°C suggests that TCE partitions rapidly to the atmosphere from surface water. The major route of removal of TCE from water is volatilization (EPA 1985).

Experimentally measured soil organic carbon sorption coefficients (Koc values) for TCE generally range from 49 to 460 (Brigmon 1998; ATSDR 2014). These Koc values indicate medium to high mobility of TCE in soil. TCE is highly mobile in sandy soil.

The dominant process by which TCE degrades in the atmosphere is the reaction with hydroxyl radicals. These reactions are light and temperature dependent and can, therefore, vary with seasons.

Most TCE in surface water is expected to volatilize to the atmosphere. Biodegradation and hydrolysis are not significant processes for TCE transformation in water. TCE is denser than water and what is not volatilized at the surface will submerge in water.

The majority of TCE present on soil surfaces will volatilize to the atmosphere or leach into the subsurface. Once TCE leaches into the soil, it appears not to become chemically transformed or undergo covalent bonding with soil components. Because TCE is a dense nonaqueous phase liquid, it can move through the unsaturated zone into the saturated zone where it can displace soil pore water (Wershaw et al. 1994). Degradation of TCE by anaerobes via reductive dechlorination can be problematic because a common product is vinyl chloride, a known carcinogen (Ensley 1991). Under reducing conditions, dechlorination of TCE to dichloroethene (DCE) can occur relatively rapidly; however, the dechlorination of DCE to vinyl chloride, and vinyl chloride to ethane requires stronger reducing conditions. The effectiveness of chlorinated solvents to serve as electron acceptors is proportional to the number of chlorine molecules attached. For example, TCE is more likely to serve as an electron acceptor and lose a chlorine atom through reductive dechlorination than DCE or vinyl chloride. Stronger reducing conditions of SO_4^{2-} reduction or methanogenesis are required for the biodegradation of vinyl chloride to innocuous products.

As discussed in Section 14.3.1, TCE can also be destroyed through reductive biological processes. Typically microbial activity is responsible for the reduction of TCE to degradation products, but even transition metals and major reductive aquifer components may be responsible. Reductive dechlorination of TCE can result in incomplete dechlorination and produce degradation products such as DCE and vinyl chloride. While TCE is a human health hazard and listed carcinogen, vinyl chloride is also carcinogenic and has lower SLs than TCE.

Vinyl Chloride

As discussed in Section 14.1.3, vinyl chloride is mobile in soil and has the potential to migrate to groundwater. Most vinyl chloride present on soil surfaces will volatilize to the atmosphere. The presence of other contaminants, such as organic solvents, can affect the mobility of vinyl chloride in the soil. PCE and TCE can partially degrade to form vinyl chloride in aqueous environments. Volatilization of vinyl chloride from an aqueous system is a significant transport mechanism under ambient conditions.

The primary degradation mechanism for vinyl chloride in the atmosphere is the reaction with the photochemically generated hydroxyl radicals. Photolysis is unlikely to occur due to the fact that gas phase vinyl chloride does not absorb light wavelengths above 220 nm and atmospheric ozone blocks out almost all sunlight with wavelength below 295 nm.

Hydrolysis is not a significant fate for vinyl chloride because the volatilization rate is much higher. Vinyl chloride can undergo microbial degradation under aerobic conditions which eliminates the contaminants as opposed to transferring them across media. *Rhodococcus* sp. strains SM-1 and Wrink, which were isolated from a trichloroethylene-degrading bacterial mixture, and *Rhodococcus rhodochrous* ATCC 21197 were shown to degrade >99.9% of vinyl chloride within 7 days (Malachowsky 1994; ATSDR 2006). Biodegradation occurs more rapidly in aerobic or methanotrophic environments than in anaerobic environments (ATSDR 2006).

14.3.5 FATE AND TRANSPORT OF PETROLEUM HYDROCARBONS

Petroleum products released to the environment migrate through soil via two general pathways: (1) as bulk oil flow infiltrating the soil under the forces of gravity and capillary action (bulk migration), and (2) as individual compounds separating from the bulk petroleum mixture and dissolving in air or water (compound migration).

Bulk Migration

When bulk oil (or NAPL) flow occurs, it results in little or no separation of the individual compounds from the product mixture, and the infiltration rate is usually fast relative to the dissolution rate (Eastcott 1989). Many compounds that are insoluble and immobile in water are soluble in bulk oil and will migrate along with the bulk oil flow. Factors that affect the rate of bulk oil infiltration include soil moisture content, vegetation, terrain, climate, rate of release, soil particle size, and oil viscosity. As bulk oil migrates through the soil column, a small amount of the product mass is retained by soil particles. The bulk product retained by the soil particles is known as “residual saturation.” Residual saturation can act as a continuing source of contamination as individual compounds separate from the bulk product and migrate independently in air or groundwater (Bauman 1988). When the amount of product released to the environment is small relative to the volume of available soil, the downward migration of the bulk product may cease before it affects groundwater. Adverse impacts to groundwater may occur if rainwater infiltrates through soil that contains residual saturation and initiates the downward migration of individual compounds (ATSDR 1999).

The downward migration of NAPL will slow as water-saturated pore spaces are encountered. If the density of the bulk product is less than that of water, the product (LNAPL) tends to float along the interface between the saturated and unsaturated zones and spread horizontally in a pancake-like layer, usually in the direction of groundwater flow. In contrast, organic liquids with a density greater than water (DNAPL) will continue to migrate downward through the water table aquifer under the influence of gravity. Downward migration ceases when the product is converted to residual saturation or when an impermeable surface is encountered.

Bulk oil flow is affected by numerous product-specific and site-specific factors. As a consequence, product distribution in the subsurface is typically heterogeneous and complex.

Compound Migration

As the bulk product migrates through the soil column, individual compounds may separate from the mixture and migrate independently. Chemical transport properties such as volatility, solubility, and sorption potential are often used to evaluate and predict which compounds will likely separate from the mixture. The VPH fractions of petroleum hydrocarbons are most likely to separate from the bulk oil flow.

Since petroleum products are complex mixtures of hundreds of compounds, the compounds characterized by relatively high vapor pressures tend to volatilize and enter the vapor phase. The exact composition of these vapors depends on the composition of the original product (ATSDR 1999).

In general, compounds with a vapor pressure in excess of 10^{-2} millimeters of mercury (mm Hg) are more likely to be present in the air phase than in the liquid phase. Conversely, compounds characterized by vapor pressures less than 10^{-7} mm Hg are more likely to be associated with the liquid phase. Compounds that possess vapor pressures that are less than 10^{-2} mm Hg, but greater than 10^{-7} mm Hg, will tend to exist in both the air and the liquid phases (Knox 1993). The rate of volatilization is also a function of air and soil temperature, humidity, wind speed, soil type, moisture content, oil composition, solar radiation, and thickness of the oil layer.

Solubility generally decreases with increasing molecular weight of the hydrocarbon compounds (EPH). For compounds having similar molecular weights, the aromatic hydrocarbons are more water soluble and mobile in water than the aliphatic hydrocarbons (ASTM 1995) and branched aliphatics are less water soluble than straight-chained aliphatics. The compounds most likely to be measured in water when in contact with gasoline, kerosene, and fuel oil #2 are the light fraction, aromatic hydrocarbons such as benzene, toluene, ethylbenzene, and xylenes.

Lighter petroleum products such as gasoline make up the VPH fraction and contain constituents with higher water solubility and volatility and lower sorption potential than do heavier petroleum products such as fuel oil. The VPH-fraction hydrocarbons tend to migrate readily through soil, potentially threatening or affecting groundwater supplies. In contrast, EPH-fraction hydrocarbons, such as fuel oil, are generally more persistent in soils because of their relatively low water solubility and volatility and high sorption capacity.

Hydrocarbon compounds identified at the MRH Facility include EPH fractions C9-C18 aliphatics and C11-C22 aromatics in surface soil, subsurface soil, and groundwater and VPH fractions C5-C8 aliphatics, C9-C12 aliphatics, and naphthalene in subsurface soil.

Indigenous microbes found in many natural settings have been shown to be capable of degrading organic compounds. The final products of microbial degradation are carbon dioxide, water, and microbial biomass (ATSDR 1999).
The rate of petroleum hydrocarbon degradation depends on the chemical composition of the product released to the environment as well as site-specific environmental factors. Generally the straight chain hydrocarbons and the aromatics are degraded more readily than the highly branched aliphatic compounds (Havlicek 1988).

A large proportion of the VPH fraction of the petroleum product may be degraded as the compounds go into solution. As a result, the remaining product may become enriched in the alicyclics, the highly branched aliphatics, and PAHs with many fused rings (ATSDR 1999b). Bacteria that decompose petroleum products using oxygen as an electron acceptor are important in the degradation process. The rate of biodegradation will depend, in part, on the supply of oxygen to the contaminated area, because aerobic metabolism is much faster than anaerobic metabolism. When there is an insufficient amount of dissolved oxygen available, organisms that can use other electron acceptors may degrade the contaminants, but at slower rates. The ideal pH range to promote biodegradation is close to neutral (6 to 8). The moisture content of the contaminated soil will affect biodegradation of oils through dissolution of the residual compounds, dispersive actions, and the need for microbial metabolism to sustain high activity. The moisture content in soil affects microbial locomotion, solute diffusion, substrate supply, and the removal of metabolic by-products (ATSDR 1999b).

Excessive moisture will limit the gaseous supply of oxygen for enhanced decomposition of petroleum hydrocarbons. Generally, as the temperature increases, biological activity tends to increase up to a temperature where enzyme denaturation occurs. The optimal temperature for biodegradation to occur ranges from 18 ºC to 30 ºC. Nutrients must also be present in the proper amounts. Nitrogen is usually the limiting nutrient governing the rate of decomposition.

14.4 CONCEPTUAL SITE MODEL

The conceptual site model (CSM) provides a summary of how and where contaminants are expected to move and the impacts they may have. The CSM presents known and potential contaminant sources and contaminant release and migration mechanisms. The CSM also presents potential contaminant exposure pathways and routes and human and ecological receptors that are expected to be evaluated as part of the risk analysis. Use of the CSM is ongoing, and an iterative approach allows the CSM to evolve and mature as work progresses at the Facility and data gaps are filled.

14.4.1 MRA

The MRA is a former railroad roundhouse and maintenance facility that operated from approximately 1908 to 1980. The area encompasses about 27 acres. Contamination at the MRA appears to primarily be the result of historical operations at the MRA, although there are currently additional operations such as heavy equipment storage, fueling, and maintenance on the Sun Mountain property, occasional use and storage of heavy equipment on Powell County property, and an active rail line on the eastern portion of the MRA all of which may have contributed to the contamination. Contamination on the MRA is generally found at highest concentrations near historical operations and storage areas. For analytes such as metals and PAHs contamination in soil is relatively widespread across the MRA, but is not continuous.

14.4.1.1 PRIMARY SOURCES AND RELEASE MECHANISMS

Maintenance operations, spills or leaks from fuel piping, and ASTs contaminated on-site soils, groundwater, surface water, and sediments with metals, SVOCs, VOCs, and EPH/VPH fractions. Test pitting revealed staining and evidence of petroleum contamination in soil north of the roundhouse and within the historical operations area. PCB contamination was revealed near the former power house and a former oil/dope facility. Metals contamination in soil is present throughout the MRA possibly from wheel truing or other maintenance activities. The presence of metals in soil is also likely due to high native metals content, both in soils native to the Facility and those imported. VOC and EPH/VPH contamination is present at and near the former Bunker C storage area, former ASTs, oil water separators (OWSs), and follows a former stormwater line. An EPA START removal action in 2011 excavated a significant portion of the Bunker C impacted soils. Leaking pipes, ASTs, dumps, and maintenance shops associated with the CMSPP railroad operations may have contributed metals and petroleum related contamination above SLs in soils and groundwater at the MRA. Although the majority of contamination appears to be associated with CMSPP operations, there are also current activities (e.g. equipment fueling and maintenance) and a railroad at the MRA that have the potential to contribute to contamination in soils and/or groundwater.

14.4.1.2 SECONDARY SOURCES AND RELEASE MECHANISMS

In addition to the primary sources discussed above, the secondary sources (media that became contaminated as a result of the original releases) included in the CSM for the MRA are as follows.

Soil

As discussed in Section 10.2, soil at the MRA is characterized as typically quaternary alluvium with layered sands and gravels with cobbles. There are more silts near the surface with some silty and clay layers interspersed, but near the shallow aquifer, soils are primarily gravelly, cobbly sands. The primary sources identified had the potential to contaminate surface soil and subsurface soil. Soil at the MRA is impacted with metals (arsenic, barium, cadmium, chromium, lead, and mercury), SVOCs, VOCs (methylene chloride and trichloroethylene), and EPH/VPH fractions. Contaminants can be released from soil by volatilization, by leaching as precipitation infiltrates the soil, and by overland runoff. Contaminated soil is also potentially transported within or off the Facility by surface water runoff and wind-blown dust.

NAPL

Once spills or leaks or infiltration and percolation have occurred in source areas, NAPL may have formed, such that a discrete phase with its own physical properties may be present within the vadose zone or the shallow aquifer. LNAPL would be present as product floating on the water table or in residual saturation in the groundwater smear zone (the zone between the highest and lowest water table elevations). At this time, the presence of LNAPL has been confirmed at the MRA; the presence of DNAPL has not been confirmed, but is not likely based on concentrations of COPCs in deeper groundwater (monitoring well RHMW-02D) that are well below saturation limits and no evidence of DNAPL was encountered during soil boring and monitoring well installation. Contaminants can be released from NAPL by volatilization and through leaching when contacted by groundwater or infiltrating precipitation. LNAPL may also migrate horizontally and vertically in response to groundwater flow and fluctuations in the water table. As a result of the EPA START excavation, LNAPL, which is primarily Bunker C, at the MRA appears to be limited in extent, primarily as small globules on groundwater, and is not migrating horizontally due to the sheetpile wall. However, the Bunker C LNAPL has the potential to migrate as demonstrated in monitoring well RHMW05 which had what appeared to be large amounts of Bunker C during the spring groundwater monitoring event but had only small globules during the fall.

Dissolved Phase

Contamination may have resulted from gradual infiltration and percolation and leaching from the primary sources, in addition to leaching from secondary soil and LNAPL sources. Contaminants in the dissolved phase can migrate through soil to groundwater. Contaminants in the dissolved phase may migrate differently in the shallow aquifer than in the LNAPL phase.

14.4.1.3 TERTIARY SOURCES AND RELEASE MECHANISMS

In addition to the primary and secondary sources discussed above, the tertiary sources (media that became contaminated as a result of the secondary source releases) included in the CSM for the MRA are as follows.

Groundwater

The shallow unconfined aquifer is between 2 and 12 ft bgs and has hydraulic conductivity in the range of 10-47 ft/day. The shallow aquifer is likely connected to surface water. Contamination has migrated from soils to groundwater and is present in several wells within the MRA. Groundwater is contaminated with metals (arsenic, cadmium, iron, and manganese), SVOCs (dibenzo(a,h)anthracene), and VOCs (vinyl chloride).

Surface Water and Sediments

Contaminated soil carried by surface water runoff may migrate to Tin Cup Joe Creek or contaminated groundwater may recharge Tin Cup Joe Creek on the west side or the Clark Fork River to the east and north of the MRA. Surface water runoff or groundwater recharge may be responsible for surface water and sediment contamination. Metals (arsenic, barium, cadmium, chromium, lead, and silver), SVOCs (PAHs), and VOCs (m,p-xylene) contamination was detected in Tin Cup Joe Creek sediments adjacent to the MRA during RI sampling. No samples were collected from the Clark Fork River sediments because the Clark Fork was addressed as part of the Clark Fork River Operable Unit as part of the Federal Superfund project.

Only metals were detected in surface water sampled at the MRA. Metals (arsenic, iron, lead, manganese, and mercury) were detected above SLs in surface water from the north end of Tin Cup Joe Creek near the northern MRA and from a wetlands area east of the northern MRA.

Soil Gas

Air-filled soil pore spaces may become contaminated with vapors once subsurface soil and groundwater become contaminated. Some of the COPCs will preferentially migrate through soil gas. This phenomenon is a result of chemical and physical properties, including vapor pressure, that dictate that a vapor phase migrates upward, rather than remaining either bound to soil or staying dissolved in a saturated phase in the soil or capillary fringe of the aquifer. Therefore, soil gas becomes contaminated and, through volatilization, can be released to overlying air as a tertiary mechanism. In particular, soil gas can find preferential migration pathways along utility lines in subsurface utility trenches. Thus, the subsurface soil along utility corridors is particularly vulnerable to collection and migration of soil gas. Soil gas monitoring points were installed and soil gas sampling was conducted as part of the RI. VOC contamination was detected in soil gas from monitoring points at the northern MRA.

14.4.1.4 PATHWAYS FOR EXPOSURE

If a source has been released to a Facility medium and receptors are exposed, then an exposure pathway is complete. Discussed below are the media-based pathways of potential concern for the MRA. Exposure pathways may be more thoroughly evaluated as part of the risk analysis. A figure illustrating each potential pathway is included as Figure 14-1.

Groundwater

One of the primary media known to be contaminated at the MRA is groundwater. Therefore, all complete groundwater-related exposure pathways may be considered in the CSM and risk analysis.

Groundwater - Human Exposure

Potential human exposure routes include ingestion (drinking water uses for residents and workers), inhalation (of vapors during showering or other uses), and dermal contact (during washing, bathing, and other uses) with contaminated shallow groundwater (and potentially vapor intrusion). In addition, a utility/construction worker may contact subsurface groundwater during dewatering or emergency repairs. Therefore, it is important to consider exposures for a utility/construction worker in the risk analysis.

Groundwater - Ecological Exposure

No ecological exposures to groundwater exist at the MRA; however, see the discussion below on surface water and sediment.

Surface Water and Sediment

Results for surface water samples did indicate the presence of elevated concentrations of Facility-related contaminants. Creek bed sediment in Tin Cup Joe Creek has most likely become contaminated through groundwater migration or overland (runoff) migration. As addressed in data gaps in Section 15.2, samples that were upgradient of the roundhouse area still had elevated levels of contaminants and need to be compared to further upgradient or off-site samples.

Surface Water and Sediment - Human Exposure

Human exposure routes include ingestion and dermal exposures for recreational users accessing the Clark Fork River or Tin Cup Joe Creek.

Surface Water and Sediment – Ecological Exposure

Ecological exposures may include sediment contamination in Tin Cup Joe Creek. Terrestrial ecological receptors (wildlife) would be expected to access the river and creeks, resulting in drinking water (ingestion) exposure. Elevated concentrations of metal contaminants were measured in surface water.

Soils

Soil data indicate that surface soil (surface samples collected from 0 to 2 ft bgs) contamination is present throughout the MRA. Therefore, exposure pathways may be evaluated in the risk analysis for both surface soils (through aboveground spills and leaks) and subsurface soils (through subsurface leaks and leaching).

Soils - Human Exposure

RI sampling has shown that surface soil has been contaminated throughout the Facility, possibly as a result of site-wide train maintenance activities (wheel truing), the re-working of surface topography, addition of fill material, other operations, or the spread of contaminants throughout the Facility (including dust that migrates from Facility soils onto adjacent areas).

Current and future residential, current and future industrial, and recreational exposures to source area surface soils via incidental ingestion, inhalation, and dermal contact are expected to be complete. A trespasser is not included because the recreational exposure will be protective of trespassers. In addition, a utility or construction worker may contact subsurface soils both within and outside source areas that could be more contaminated (because of the physical and chemical properties of the COPCs) than would surface and near-surface soils. Therefore, it is important to consider exposures for a utility/construction worker.

Soils - Ecological Exposure

Ecological exposures to soils include ingestion (for wildlife) and direct contact (for plants and invertebrates). EPA normally considers two potentially complete exposure pathways to soil for birds and mammals: (1) incidental ingestion of soils during feeding, and grooming and preening; and (2) ingestion of food contaminated as a result of the uptake of soil contaminants. (See the biota section below.) Soil pathways included are soil particulate inhalation and dermal contact. Note, however, that much of the Facility consists of areas of altered landscapes that do not provide valuable habitat. Areas of more desirable habitat are found nearby in areas that are not directly affected by contamination at the Facility.

Inhalation of particulates is not a noted pathway for exposure since respirable particles (larger than 5 microns) are most likely ingested as a result of mucociliary clearance (ingestion from respiratory tract to digestive tract) rather than being inhaled and thus already accommodated in the soil ingestion pathway for ecological receptors. In addition, inhalation of contaminants associated with dust particles is expected to contribute less than 0.1 percent of total risk compared with oral exposures at equal exposure concentrations.

Birds and mammals may also be exposed to contaminants in soils via dermal contact. Exposure pathways may be more thoroughly evaluated as part of an ecological risk assessment.

Air

As described above, soil and groundwater contamination can migrate from the surface soils (as particulates or vapors to be inhaled) or even from the subsurface (from vadose zone soils and the capillary fringe of underlying groundwater).

Air - Human Exposure

Inhalation exposures (both indoor and outdoor vapors) are included in the CSM for future residential and utility workers, and for current and future industrial workers.

Air - Ecological Exposure

The inhalation exposure pathway does not need to be considered for ecological receptors because inhalation of contaminated air by ecological receptors typically contributes minimally to the overall risk.

Vegetation

Exposure through vegetation-related pathways is possible for many inorganic and organic contaminants that are known to accumulate in vegetation. Aquatic and wetland vegetation would similarly be expected to take up COPCs from sediment or ephemeral surface waters, such as metals, which were measured in surface water above SLs.

Biota

Ultimately, biota that are directly exposed to contaminated media (such as earthworms that live in contaminated near-surface soils or invertebrates in sediment in the Clark Fork River or Tin Cup Joe Creek) may take up, or bioaccumulate, contaminants. This uptake can be important when contaminants transfer through the food web to higher trophic level consumers, such as omnivorous mammals and birds that feed on the earthworms or to fish that consume invertebrates in sediment. Biota-related pathways are included for the human recreational exposure (via biota [fish] ingestion) and ecological (terrestrial, aquatic, and wetland) receptors.

14.4.1.5 HUMAN RECEPTORS

Specific receptors and scenarios are envisioned for the exposure pathways and routes described in Section 14.4.1.4 above to characterize the long-term (chronic) risks posed by contamination at the MRA, as described below. Exposure pathways may be more thoroughly evaluated as part of the risk analysis.

Resident

A “typical” resident is included in the CSM to visualize how MRH Facility contamination might affect residents of Deer Lodge, in particular residents bordering the northern MRA.

Industrial Worker

A “typical” industrial worker is included in the CSM to visualize how the MRA Facility contamination might affect industrial/commercial workers in Deer Lodge. Sun Mountain Lumber operates a facility on the south portion of the MRA.

Recreational User

A recreational user (who might access soils and surface water bodies) scenario (sometimes called a “trespasser” or “site visitor” scenario) is also envisioned at the MRA (in particular the northern MRA where Powell County plans to develop a recreational park).

Utility/Construction Worker

A utility/construction worker (who might access subsurface soils and groundwater) scenario is also envisioned for use at the MRA. Exposure assumptions are based on values provided in the EPA exposure factors handbook (DEQ 2013) and other EPA and DEQ guidance, as appropriate.

Ecological Receptors

As noted above, ecological receptors conceptually included at this time include birds and mammals for ingestion of soils and sediments during grooming and preening, feeding, and for ingestion of food contaminated as a result of uptake of contaminants in soil and sediments. In addition, direct contact of plants and invertebrates in soil with contaminated surface soils provide an exposure pathway. Surface water contamination was found above levels considered protective of biota in some instances; therefore, ingestion and direct contact of surface water present a potential exposure pathway.

14.4.2 PRA

The PRA is a former passenger depot and refueling area that operated until approximately 1980. The area encompasses about 24 acres. Contamination at the PRA appears to primarily be the result of historical railroad operations at the Facility, although there are additional activities that may have contributed to the contamination such as vehicle maintenance and equipment storage and a former bulk plant on what is now City property, and an active rail line along the eastern portion of the PRA where there was also another former bulk plant. Contamination is generally found at highest concentrations near historical railroad operations and storage areas. Metal and PAH contamination in soil is relatively widespread across the PRA, but is not continuous.

14.4.2.1 PRIMARY SOURCES AND RELEASE MECHANISMS

Refueling, leaks from ASTs and piping, and off-loading of diesel fuel contaminated soil at the PRA with metals, SVOCs, VOCs, and EPH/VPH fractions. Metals contamination was found in surface soils throughout the PRA including within the BNSF ROW. SVOC contamination was found in soil following fuel pipelines traveling north/south across the PRA, although releases appeared to be primarily surface spills rather than pipeline leaks. PCB contamination was revealed in surface soil near the former oil house. Pesticide contamination was located on the northern portion of the PRA, west of the former rail line however; there is no historical evidence of pesticide use during CMSPP operations. LNAPL is present in subsurface soil near a historical diesel unloading area. Metals, SVOCs, PCBs, and EPH/VPH fractions contamination was found at the southern end of the PRA near the former passenger depot and refueling area. Leaking pipes, ASTs, dumps, and refueling operations associated with the CMSPP railroad operations may have contributed metals and petroleum related contamination above SLs in Facility soils and groundwater at the PRA. Although the majority of contamination appears to be associated with CMSPP operations, there are also current activities (eg. equipment maintenance and railroad) and materials at the PRA that have the potential to contribute to contamination in soils and/or groundwater. There were also two historical bulk plants, one on City property and the other partially on BNSF ROW.

14.4.2.2 SECONDARY SOURCES AND RELEASE MECHANISMS

In addition to the primary sources discussed above, the secondary sources (media that became contaminated as a result of the original releases) included in the CSM for the PRA are as follows.

Soil

As discussed in Section 10.2, soil at the PRA consists primarily of unconsolidated sand and gravel. Loam-type soils comprise approximately 2/3 of the PRA soils, whereas the other 1/3 are flood plain soils. The loams are a mix of soils associated with flood plains, stream terraces, and alluvial fans and vary quite widely in their capacity to drain and transmit water. The primary sources identified had the potential to contaminate surface soil and subsurface soil. Soils at the PRA are impacted with metals (arsenic, barium, cadmium, chromium, lead, and silver), SVOCs (PAHs and PCB), VOCs (benzene), pesticides (dieldrin), and EPH/VPH fractions contamination. Contaminants can be released from soil by volatilization and by leaching as precipitation infiltrates the soil. Contaminated soil is also potentially transported within or off the PRA by surface water runoff and wind-blown dust.

NAPL

Once spills or leaks or infiltration and percolation have occurred in source areas, NAPL may have formed, such that a discrete phase with its own physical properties may be present within the vadose zone or the shallow aquifer. LNAPL would be present as product floating on the water table or in residual saturation in the groundwater smear zone (the zone between the highest and lowest water table elevations). At this time, the presence of LNAPL has been confirmed at the PRA. Potential DNAPLs such as chlorinated solvents were not identified at concentrations exceeding SLs in groundwater. Therefore, it is unlikely that DNAPL is present at the PRA, although it has not been confirmed. Contaminants can be released from NAPL by volatilization and through leaching when contacted by groundwater or infiltrating precipitation. LNAPL may also migrate horizontally and vertically in response to groundwater flow and fluctuations in the water table. LNAPL, which appears to primarily consist of light diesel-type petroleum at the PRA, appears to be limited in extent. LNAPL has been observed primarily near the historical diesel unloading area, and bulk horizontal migration does not appear to be occurring based on LNAPL measurements collected during the RI, despite the fact that the product recovery trench is not operating.

Dissolved Phase

Contamination may have resulted from gradual infiltration and percolation and leaching from any of the primary sources, in addition to leaching from secondary soil and LNAPL sources. Contaminants in the dissolved phase can migrate through soil to groundwater. Contaminants in the dissolved phase may migrate differently in the shallow aquifer at the PRA than in the LNAPL phase.

14.4.2.3 TERTIARY SOURCES AND RELEASE MECHANISMS

In addition to the primary and secondary sources discussed above, the tertiary sources (media that became contaminated as a result of the secondary source releases) included in the CSM for the PRA are as follows.

Groundwater

The shallow unconfined aquifer is between 2 and 10 ft bgs and has a hydraulic conductivity ranging from 12 to 40 ft/day. The shallow aquifer is likely connected to surface water. Contamination appears to be localized to specific wells within the PRA. Limited groundwater contamination (manganese) was found during RI sampling in downgradient off-site wells. Groundwater at the PRA is contaminated with metals (arsenic, iron, manganese), SVOCs (2-methylnaphthalene), and EPH/VPH (C9-C18, Aliphatics; C11-C22, Aromatics.

Surface Water and Sediments

Contaminated soil carried by surface water runoff or contaminated groundwater (via aquifer transport) may migrate to Cottonwood Creek on the north side or the Clark Fork River to the west of the PRA. Metals (arsenic, chromium, and lead) and SVOC (benzo(b)fluoranthene) contamination was detected in Cottonwood Creek sediments adjacent to the PRA during RI sampling. No samples were collected from the Clark Fork River sediments because the Clark Fork was addressed as part of the Clark Fork River Operable Unit as part of the Federal Superfund project.

Only metals (arsenic, iron, and manganese) contamination was detected in surface water sampled at the PRA. Metals were detected above SLs in surface water from both upstream and downstream of the active railroad crossing at Cottonwood Creek near the north end of the PRA and from a wetlands area east of the PRA between the PRA and the active rail line.

Soil Gas

Air-filled soil pore spaces may become contaminated with vapors once subsurface soil and groundwater become contaminated. Some of the COPCs will preferentially migrate through soil gas. This phenomenon is a result of chemical and physical properties, including vapor pressure, that dictate that a vapor phase migrates upward, rather than remaining either bound to soil or staying dissolved in a saturated phase in the soil or capillary fringe of the aquifer. Therefore, soil gas becomes contaminated and, through volatilization, can be released to overlying air as a tertiary mechanism. In particular, soil gas can find preferential migration pathways along utility lines in subsurface utility trenches. Thus, the subsurface soil along utility corridors is particularly vulnerable to collection and migration of soil gas. Soil gas monitoring points were installed and soil gas sampling was conducted as part of the RI. VOC contamination was detected in soil gas from monitoring points near the passenger depot and refueling area at the PRA. Test pitting revealed large amounts of potential hydrocarbon impacted soils and staining in this area.

14.4.2.4 PATHWAYS FOR EXPOSURE

If a source has been released to a Facility medium and receptors are exposed, then an exposure pathway is complete. Discussed below are the media-based pathways of potential concern for the PRA. Exposure pathways may be more thoroughly evaluated as part of the risk analysis.

Groundwater

One of the primary media known to be contaminated at the PRA is groundwater. Therefore, all complete groundwater-related exposure pathways may be considered in the CSM and risk analysis.

Groundwater - Human Exposure

Potential human exposure routes include ingestion (drinking water uses for residents and workers), inhalation (of vapors during showering or other uses), and dermal contact (during washing, bathing, and other uses) with contaminated shallow groundwater (and potentially vapor intrusion). In addition, a utility/construction worker may contact subsurface groundwater during dewatering or emergency repairs. Therefore, it would be important to consider exposures for a utility/construction worker in the risk analysis.

Groundwater - Ecological Exposure

No ecological exposures to groundwater exist at the PRA; however, see the discussion below on surface water and sediment.

Surface Water and Sediment

Results for surface water samples indicate the presence of elevated concentrations of Facility-related contaminants (metals). Creek bed sediment in Cottonwood Creek has possibly become contaminated through groundwater migration or overland (runoff) migration, although there is evidence of historical upgradient impacts outside of the PRA for metals and SVOCs (e.g., sediment data for sample SE-6). Upgradient samples collected during this RI indicate that one surface water and three sediment samples had metals exceedances, but these samples did not have VOC, SVOC, or petroleum constituent exceedances. The metals exceedances upstream at PRA-SD113, PRA-SD118, PRA-SD119 and PRA-SW113 have metals results similar in magnitude to the downgradient samples. The highest metals sediment sample result was observed on site at PRA-SD120 in the wetlands between the CSMPP elevated area and the active BNSF elevated track.

Surface Water and Sediment - Human Exposure

Human exposure routes include ingestion and dermal exposures for recreational users accessing Cottonwood Creek.

Surface Water and Sediment - Ecological Exposure

Ecological exposures may include sediment contamination in Cottonwood Creek. Terrestrial ecological receptors (wildlife) would be expected to access the river and creeks, resulting in drinking water (ingestion) exposure although similar habitat is found nearby and outside of the contaminated area of the Facility. Elevated concentrations of metal contaminants were measured in surface water and sediment.

Soils

Existing data for soil indicate that surface soil (surface samples collected from 0 to 2 ft bgs) contamination is present throughout the PRA. Therefore, exposure pathways may be evaluated in the risk analysis for both surface soils (through aboveground spills and leaks) and subsurface soils (through subsurface leaks and leaching).

Soils - Human Exposure

Current and future residential, current and future industrial, and recreational exposures to source area surface soils via incidental ingestion, inhalation, and dermal contact are expected to be complete. A trespasser is not included because the recreational exposure will be protective of trespassers. In addition, a utility or construction worker may contact subsurface soils both within and outside source areas that could be more contaminated (because of the physical and chemical properties of the COPCs) than would surface and near-surface soils. Therefore, it is important to consider exposures for a utility/construction worker.

RI sampling has shown that surface soil has been contaminated throughout the PRA, possibly as a result of the re-working of surface topography, addition of fill material, or the spread of contaminants throughout the Facility (including dust that migrates from Facility soils onto adjacent areas).

Soils - Ecological Exposure

Ecological exposures to soils include ingestion (for wildlife) and direct contact (for plants and invertebrates). EPA normally considers two potentially complete exposure pathways to soil for birds and mammals: (1) incidental ingestion of soils during feeding, and grooming and preening; and (2) ingestion of food contaminated as a result of the uptake of soil contaminants. (See the biota section below.) Soil pathways included are soil particulate inhalation and dermal contact. Note, however, that much of the Facility consists of areas of altered landscapes that do not provide valuable habitat. Larger areas of desirable habitat are found nearby in areas that are not directly affected by contamination at the Facility.

Inhalation of particulates is not a noted pathway for exposure since respirable particles (larger than 5 microns) are most likely ingested as a result of mucociliary clearance (ingestion from respiratory tract to digestive tract) rather than being inhaled and thus already accommodated in the soil ingestion pathway for ecological receptors. In addition, inhalation of contaminants associated with dust particles is expected to contribute less than 0.1 percent of total risk compared with oral exposures at equal exposure concentrations. Birds and mammals may also be exposed to contaminants in soils via dermal contact. Exposure pathways may be more thoroughly evaluated as part of an ecological risk assessment or during risk management implementation.

Air

As described above, soil and groundwater contamination can migrate from the surface soils (as particulates or vapors to be inhaled) or even from the subsurface (from vadose zone soils and the capillary fringe of underlying groundwater).

Air - Human Exposure

Inhalation exposures (both indoor and outdoor vapors) are included in the CSM for future residential and utility workers, and for current and future industrial workers.

Air - Ecological Exposure

The inhalation exposure pathway does not need to be considered for ecological receptors in the qualitative ecological risk analysis.

Vegetation

Exposure through vegetation-related pathways is possible for many inorganic and organic contaminants that are known to accumulate in vegetation. Aquatic and wetland vegetation would similarly be expected to take up COPCs from sediment or ephemeral surface waters, such as metals, which were measured in surface water above SLs.

Biota

Ultimately, biota that are directly exposed to contaminated media (such as earthworms that live in contaminated near-surface soils or invertebrates in sediment in Cottonwood Creek) may take up, or bioaccumulate, contaminants. This uptake can be important when contaminants transfer through the food web to higher trophic level consumers, such as omnivorous mammals and birds that feed on the earthworms or to fish that consume invertebrates in sediment. Biota-related pathways are included for the human recreational exposure (via biota [fish] ingestion) and ecological (terrestrial, aquatic, and wetland) receptors.

14.4.2.5 HUMAN RECEPTORS

Specific receptors and scenarios are envisioned for the exposure pathways and routes described in Section 14.4.2.4 above to characterize the long-term (chronic) risks posed by contamination at the PRA, as described below. Exposure pathways may be more thoroughly evaluated as part of the risk analysis.

Resident

A “typical” resident is included in the CSM to visualize how PRA contamination might affect residents of Deer Lodge, in particular residents near the south portion of the PRA.

Industrial Worker

A “typical” industrial worker is included in the CSM to visualize how the PRA contamination might affect industrial/commercial workers in Deer Lodge.

Recreational User

A recreational user (who might access soils and surface water bodies) scenario (sometimes called a “trespasser” or “Facility visitor” scenario) is also envisioned at the PRA.

Utility/Construction Worker

A utility/construction worker (who might access subsurface soils and groundwater) scenario is also envisioned for use at the PRA. Exposure assumptions are based on values provided in the EPA exposure factors handbook (DEQ 2013) and other EPA and DEQ guidance, as appropriate.

14.4.2.6 ECOLOGICAL RECEPTORS

As noted above, ecological receptors conceptually included at this time include birds and mammals for ingestion of soils and sediments during grooming and preening, feeding, and for ingestion of food contaminated as a result of uptake of contaminants in soil and sediments. In addition, direct contact of plants and invertebrates in soil with contaminated surface soils provide an exposure pathway. Surface water contamination was found above levels considered protective of biota; therefore, ingestion and direct contact of surface water present a potential exposure pathway.

15.0 CONCLUSIONS AND RECOMMENDATIONS

This section presents the conclusions of the RI performed at the MRH Facility, and provides recommendations for future actions at the Facility.

15.1 CONCLUSIONS

The primary objective of the RI is to evaluate the nature and extent of contamination in soil, sediment, surface water, groundwater, and soil gas at the Facility using historical data and data collected under this RI. Additional objectives of the RI are to provide data to support human health and ecological risk assessments and provide data to support feasibility analysis of cleanup alternatives. These objectives were achieved, as the RI provides a much more complete and comprehensive understanding of the nature and extent of contamination at the Facility.

This RI report provides lists of COPCs for each medium and each area. In general, the comprehensive list of potential contaminants groups has been reduced to the RI COPCs, which consist primarily of metals and PAHs with a few contaminants of other types. RI data indicate that chlorinated solvents, PCBs, and pesticides/herbicides are present at the Facility at levels exceeding SLs, but the extent and magnitude of these contaminants is relatively limited. The RI also confirmed the extent of LNAPL to areas previously identified with LNAPL. RI data also indicate that metals contamination is widespread in soils, but is not continuous and is not necessarily related to fill material. PAHs and petroleum constituents are concerns in soils at the MRA and PRA, and the highest concentrations and areas of concern are near the historical fueling area or known historical releases. PAHs in groundwater are also of greatest concern near and just downgradient of former fueling areas or areas of known historical releases. Sediment and surface water downgradient of these same areas of concern are also more likely to have petroleum constituents. Finally, the RI included soil vapor investigation results for the first time at the Facility, with results indicating there are contaminants present in soil vapor at concentrations exceeding SLs.

Soil contamination was identified across the Facility, particularly for metals and PAHs. There were some areas near the historical operating and fueling or fuel storage areas of the MRA and PRA with metals and PAH concentrations exceeding multiple SLs, including industrial. However, soil contamination was not continuous and in many parts of the Facility concentrations only exceeded residential and/or leaching to groundwater SLs. The areas of concern center around the central area of the MRA north, east, and southwest from the roundhouse foundation, the northern area of the MRA near the former Bunker C tank area and to the north, west and south of the former depot at the PRA, the LNAPL area in the central area of the PRA, and along the elevated former railroad bed in the northern PRA just south of Cottonwood Creek. The extent of soil contamination exceeding these SLs was not fully defined at the edges of the RI investigation area, especially for metals and PAHs, but if institutional controls were implemented to restrict future residential usage, the current level of delineation may be adequate for portions of the Facility. Contamination was identified at levels exceeding residential SLs at a residence at the southern portion of the PRA. The chlorinated solvent TCE was identified in soil samples at levels exceeding leaching to groundwater SLs and historically was identified in groundwater, but was not found in groundwater at levels above the SLs during the RI. Vinyl chloride, a daughter product of TCE degradation, was found in both soil and groundwater, but in very limited areas.

Groundwater contamination was fairly limited both in extent and magnitude, with the exception of manganese. The extent of EPH/VPH fractions exceeding SLs was much less and concentrated in or just downgradient of the areas with the highest soil concentrations. Vinyl chloride was detected in groundwater at the MRA at levels exceeding the SLs in an area with TCE contamination in soils, but detection limits could not meet SLs across the MRA and PRA.

Similar contaminants to soil were found in sediment (mostly metals and PAHs). The highest concentrations of sediment contaminants for the PRA were in Cottonwood Creek adjacent to the Facility or in the low-lying wetlands between the CSMPP raised operations and the active BNSF ROW and railway. For the MRA, further evaluation/sampling of sediment may be appropriate as some contaminant concentrations were higher in the most upstream sample within Tin Cup Joe Creek just west of the former roundhouse structure or upstream in the ditch that flows into Tin Cup Joe Creek from the Sun Mountain Lumber area west of the former maintenance building. Both of these upstream areas are within Facility boundaries. Evaluation of off-Facility sediment may provide more insight regarding potential upgradient contaminant sources. Surface water COPCs were limited to metals. For the MRA, arsenic and lead and were also found in the highest concentrations within Facility boundaries, but no surface water samples were taken upstream of the Facility in Tin Cup Joe Creek. Only one exceedance occurred on the PRA for surface water contaminants (arsenic) and occurred in the wetlands surface water between the former CSMPP elevated operations area and the active BNSF ROW.

Soil vapor samples identified several VOCs as COPCs, including TCE and gasoline components such as benzene. Soil gas sampling was limited during 2014 due to high groundwater conditions, but additional soil gas probes are in place for future sampling.

Asbestos was found in building material debris within the fenced area of the MRA, as well as in buried pipes at both the MRA and PRA. While the purpose of the survey was to avoid personnel contact with ACM during RI sampling activities rather than to investigate or delineate the extent of ACM, based on the sampling of surface debris suspected to contain ACM it appears likely that ACM is widespread at least within the fenced area of the MRA.

15.2 RECOMMENDATIONS FOR FILLING DATA GAPS

Based on the data collected during and prior to the RI, Trihydro makes the following recommendations for filling data gaps at the MRH Facility:

- Evaluate development of site-specific migration to groundwater cleanup levels, which may also reduce the volume of soil exceeding SLs while remaining protective of groundwater.
- Evaluate development of site-specific risk-based SLs for all or portions of the Facility. Depending on future land use and the implementation of institutional controls, site-specific risk-based SLs may reduce the volume of soil exceeding SLs while remaining protective of human health and the environment.
- Further delineate the extent of metals and PAH contamination in surface soil in those portions of the Facility subject to current or future residential use, as results for samples at the edges of the investigation area exceeded some SLs.
- To collect additional soil gas data, continue to monitor groundwater levels and attempt to collect samples from the soil vapor probes that were beneath the groundwater during the RI during periods of low groundwater.
- Perform additional evaluation of soil vapor concentrations, especially on the southern PRA near potential receptors. Indoor air standards were used as soil gas SLs, which is conservative as attenuation is likely to occur between soil vapor and indoor air concentrations, if a complete pathway exists. Additional evaluation might include activities such as additional indoor air sampling or evaluation of buildings (i.e., utility entrances, basement/slab construction, etc.).
- Further delineate the mobility and extent of pesticides and herbicides at the MRA near MRA-J10, which had a surface soil exceedance of dieldrin for leaching to groundwater SLs.
- Evaluate operation of the LNAPL recovery trench at the PRA, possibly by manually removing LNAPL or using the existing mechanical equipment, to reduce this source of hydrocarbons to soil gas and groundwater.
- Perform more comprehensive asbestos survey and removal activities, particularly on Powell County property at the MRA, as ACM surface debris appears to remain.
- Perform additional residential sampling at residences near the southern PRA according to the Lead-Contaminated Sites Handbook (EPA 2003), as lead concentrations exceeded SLs at the residence where this sampling was performed during the RI.
- Perform additional groundwater sampling to evaluate seasonal and temporal changes in groundwater contamination, as the RI was only able to collect groundwater samples during two events, and did not include sampling during fall/winter conditions.

- Perform additional upgradient sampling for surface water and sediment in Tin Cup Joe Creek on the MRA to compare to on-site surface water analytical results. This assessment would need to happen in spring to early summer as the creek is intermittent and dependent on the upstream irrigation diversions starting in early summer.
- Evaluate if the Facility or parts of the Facility are designated as a wildlife refuge or management area or if they contain threatened or endangered species. This information is necessary to complete for an ecological risk evaluation. Depending on the results of screening evaluations using Facility data collected as part of this RI, additional evaluation of these pathways may be warranted in subsequent ecological risk analyses or during risk management implementation.

16.0 REFERENCES

Administrative Rules of Montana (ARM). et seq. 2014. Rule 24.183.1101, Uniform Standards for Monumentation found on the internet at http://www.mtrules.org/gateway/ruleno.asp?RN=24.183.1101. Effective Date 11/21/2014.

Agency for Toxic Substances and Disease Registry (ATSDR). 1995. Toxicological profile for polycyclic aromatic hydrocarbons (PAHs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1997. Toxicological Profile for Chloroform. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1999a. Toxicological Profile for Mercury. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 1999b. Toxicological Profile for Total Petroleum Hydrocarbons (TPH). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2000. Toxicological profile for polychlorinated biphenyls (PCBs). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2006. Toxicological Profile for Vinyl Chloride (Update). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2007a. Toxicological Profile for Arsenic (Update). Atlanta, GA: U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2007b. Toxicological Profile for Barium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2007c. Toxicological profile for Lead. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2012a. Toxicological Profile for Cadmium. Atlanta, GA: U.S. Department of Health and Human Services. Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2012b. Toxicological profile for Chromium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2014. Toxicological Profile for Trichloroethylene (TCE). Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

ASTM. 1995. E 1739-95: Standard guide for risk-based corrective action applied at petroleum release sites. Published November 1995. Editorial changes made throughout in December 1996. American Society for Testing and Materials. West Conshohocken, PA.

Back SO, Field RA, Goldstone ME, et al. 1991. A review of atmospheric polycyclic aromatic hydrocarbons: Sources fate and behavior. Water Air Soil Pollut 60(3-4):279-300.

Bauman BJ. 1988. Soils contaminated by motor fuels: Research activities and perspectives of the American Petroleum Institute. In: Petroleum contaminated soils, vol. 1. Chelsea, MI: Lewis Publishers, 3-19.

Bodek I, Lyman WJ, Reehl WF, et al, eds. 1988. Environmental inorganic chemistry: Properties, processes, and estimation methods. New York, NY: Pergamon Press, 7.3.1-7.3-4, B2-B7, B11-B13, B17-B18.

Brigmon RL, Bell NC, Freedman DL, et al. 1998. Natural attenuation of trichloroethylene in rhizosphere soils at the Savannah River Site. J Soil Contam 7(4):433-453.

Callahan MA, Slimak MW, Gabel NW, et al. 1979. Water related environmental fate of 129 priority pollutants, introduction and technical background, metals and inorganics, pesticides and PCBs. Washington, D.C: U.S. Environmental Protection Agency, Office of Water Waste and Management. Document no. EPA 440/4-79-029a., 14-1 -14-15.

Chow TJ, Earl JL, Reed JH, et al. 1978. Barium content of marine sediments near drilling sites: A potential pollutant indicator. Mar Pollut Bull 9:97-99.

Darland JE, Inskeep WP. 1997. Effects of pH and phosphate competition on the transport of arsenate. J Environ Qual 26(4):1133-1139.

DEQ 2005. SRS Low-Flow Purging and Sampling Guidelines. Montana Department of Environmental Quality. April 2005.

DEQ 2008. Technical Guidance General Field Data Needs for Fate and Transport Modeling. Montana Department of Environmental Quality. September 2008.

DEQ 2009. Montana Tier 1 Risk-Based Corrective Action Guidance for Petroleum Releases. Montana Department of Environmental Quality. September 2009.

DEQ 2010. Montana Department of Environmental Quality Data Validation Guidelines for Evaluating Analytical Data. Montana Department of Environmental Quality. Updated August 5, 2010.

DEQ, 2011. Montana Vapor Intrusion Guide. Montana Department of Environmental Quality, Remediation Division. April 22, 2011.

DEQ, 2013a. Data Summary Report, Milwaukee Roundhouse CECRA Facility, Deer Lodge, MT. Montana Department of Environmental Quality, Remediation Division. August 12, 2013.

DEQ, 2013b. Ecological Risk Assessment Guidance. www.deq.mt.gov/StateSuperfund/PDFs/Ecorisk.pdf. December, 2013.

DEQ, 2015. Frequently Asked Questions. http://deq.mt.gov/StateSuperfund/frequentlyaskedquestions.mcpx#3. Updated April 1, 2015.

Eastcott L, Shiu WY, Mackay D. 1989. Modeling petroleum products in soils. In: Petroleum contaminated soils, Vol. 1. Chelsea, MI: Lewis Publishers, Inc., 63-80.

Ensley BD. 1991. Biochemical diversity of trichloroethylene metabolism. Annual Rev Microbiology 45:283-299.

EPA. 1979. Water-related environmental fate of 129 priority pollutants: Vol. I. Introduction and technical background, metals and inorganics, pesticides and PCBs. Washington, DC: U.S. Environmental Protection Agency, Office of Water Planning and Standard. EPA440479029a.

EPA. 1985. Health assessment document for trichloroethylene-final report. Washington, DC: U.S. Environmental Protection Agency. PB85249696.

EPA. 1990. Noncarcinogenic effects of chromium: Update to health assessment document. Research Triangle Park, NC: Environmental Criteria and Assessment Office, Office of Health and Environmental Assessment, U.S. Environmental Protection Agency. EPA600887048F.

EPA. 1993. Provisional guidance for quantitative risk assessment of polycyclic aromatic hydrocarbons. Environmental Criteria and Assessment Office. Cincinnati, OH. Final Draft. ECAO-CIN-842. March 1993.

EPA. 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, U.S. Environmental Protection Agency, EPA600R98128.

EPA. 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. EPA/OSWERNo.9200.4-17P,Office of SolidWaste and Emergency Response, Washington, DC.

EPA. 2003. Superfund Lead-Contaminated Residential Sites Handbook. Final: August 2003. Environmental Protection Agency. EPA OSWER 9285.7-50.

EPA. 2011. Exposure Factors Handbook: 2011 Edition. September 2011. Environmental Protection Agency. EPA600090052F.

EPA. 2015. Regional Screening Levels (Formerly PRGs) found at http://www.epa.gov/region9/superfund/prg/. January 2015.

Ehrlich GG, Goerlitz DF, Godsy EM, et al. 1982. Degradation of phenolic contaminants in ground water by anaerobic bacteria: St. Louis Park, MN. Ground Water 20:703-710.

Fetter, 1994. Fetter, CW. 1994. Applied Hydrogeology – Third Edition. Prentice Hall Press.

Gilmour CC, Henry EA. 1991. Mercury methylation in aquatic systems affected by acid deposition. Environmental Pollution 71(2-4):131-169.

Havlicek SC. 1988. Characterization of fuels and fuel spills. Central coast analytical services, San Louis Obispo, California.

Hydrometrics. 2013. Project Report – Background Concentrations of Inorganic Constituents in Montana Surface Soils. Prepared for MT DEQ. September 2013.

Jung HG, Kim HH, Song BG, et al. 2012. Trichloroethylene hypersensitivity syndrome: A disease of fatal outcome. Yonsei Med J 53(1):231-235.

Kimbrough DE, Cohen Y, Winer AM, et al. 1999. A critical assessment of chromium in the environment. Crit Rev Environ Sci 29(1):1-46.

KirK. 2011. Milwaukee Roundhouse Area Recreational Subarea Metals Contaminated Soil Removal Construction Completion Report – Milwaukee Roundhouse Area. August 2011.

Knox RC. 1993. Spatial moment analysis for mass balance calculations and tracing movement of a subsurface hydrocarbon mound. Ground Water Monitoring & Remediation, 13(3):139-147.

Konizeski, 1968. Konizeski, RL, McMurtrey, RG, Brietkrietz, A. 1968. Geology and Groundwater Resources of the Deer Lodge Valley Montana. US Geological Survey Water-Supply Paper Prepared in cooperation with the Montana Bureau of Mines and Geology, Butte, Montana.

Lee YH, Iverfeldt A. 1991. Measurement of methylmercury and mercury in run-off, lake and rain waters. Water Air Soil Pollut 56:309-321.

Malachowsky KJ, Phelps TJ, Teboli AB, et al. 1994. Aerobic mineralization of trichloroethylene, vinyl chloride, and aromatic compounds by Rhodococcus species. Appl Environ Microbiol 60(2):542-548.

McComish MF, Ong JH. 1988. Cadmium. In: Bodek I, Lyman WJ, Reehl WF, et al., eds. Environmental inorganic chemistry: Properties, processes, and estimation methods. New York, NY: Pergamon Press, 7.5-1 to 7.5-12.

Montana Code Annotated (MCA). et seq. 2014. Montana Code Annotated Title 37, Professions and Occupations. Chapter 67, Engineers and Land Surveyors. Section 101, Definitions. available on the internet at http://leg.mt.gov/bills/mca/37/67/37-67-301.htm. April 2014.

Montana Natural Heritage Program (MTNHP). 2014. Current Wetland and Animal and Plant Species of Concern available on the internet at http://mtnhp.org/. November 2014.

Montana Risk-Based Corrective Action (RBCA) Risk-Based Screening Levels (RBSLs) September 2009.

Morrison and Maierle, Inc. (MMI). 2013. City of Deer Lodge Final Report, PRA – Public Water Supply Monitoring Wells. October 2013.

Morrow H. 2001. Cadmium and cadmium alloys. In: Kirk-Othmer encyclopedia of chemical technology. John Wiley & Sons, Inc., 471-507. http://www.mrw.interscience.wiley.com/emrw/9780471238966/kirk/article/cadmcarr.a01/current/pdf?hd=All%2Ccadmium. April 29, 2008.

MSE, Inc. 1990. Final Report for Milwaukee Roundhouse Area Deer Lodge, Montana, Report – Milwaukee Roundhouse Area. August 1990.

Neff JM. 1979. Polycyclic aromatic hydrocarbons in the aquatic environment - sources, fates and biological effects. London, England: Applied Science Publishers, Ltd.

Nimick DA. 1993. Hydrology and water chemistry of shallow aquifers along the upper Clark Fork, Western Montana. US Geological Survey, Water Resources Investigations: WRI 93-4052.

Park KS, Sims RC, DuPont RR, et al. 1990. The fate of PAH compounds in two soil types influence of volatilization abiotic loss and biological activity. Environ Toxicol Chem 9(2):187-196.

Pioneer Technical Services (Pioneer). 1993. Expanded Site Inspection Report for the Milwaukee Roundhouse Area Site, Deer Lodge, Montana, Report – Milwaukee Roundhouse Area. October 1993.

Ponce RA, Bloom NS. 1991. Effect of pH on the bioaccumulation of low level, dissolved methylmercury by rainbow trout (Oncorhynchus mykiss). Water Air Soil Pollut 56:631-640.

PTS. 1997. Deer Lodge, Montana Exposure-Based Environmental Monitoring Data Summary Report for Inorganic Data Report – Milwaukee Roundhouse Area. October.

Risk Assessment Information System, 1994, Formal Toxicity Summary for Benxo(a)pyrene, Oak Ridge Operations Office.

Sims RC, Overcash MR. 1983. Fate of polynuclear aromatic compounds (PNAs) in soil-plant systems. Res Rev 88:1-68.

Tetra Tech EMI (TTEMI), 2011. Summary Report of Human Health Risk Assessment, Milwaukee Roundhouse Area Site, Deer Lodge, MT. September 2011.

Trihydro, 2014. Final Remedial Investigation Work Plan, Milwaukee Roundhouse CECRA Facility, Deer Lodge, MT. Trihydro Corporation. April 2014.

US Army Corps of Engineers (Corps). 2012. Nationwide Permit Program 2012 found at http://www.usace.army.mil/Missions/CivilWorks/RegulatoryProgramandPermits/NationwidePermits.aspx.

US National Park Service (NPS). 2004. Grant-Kohrs Ranch National Historic Site Cultural Landscape Report – Riparian Woodland. July 2004.

US Fish and Wildlife Service (FWS). 2014. National Wetlands Inventory Mapper found on the internet at http://www.fws.gov/wetlands/. November 2014.

Wershaw RL, Aiken GR, Imbrigiotta TE, et al. 1994. Displacement of soil pore water by trichloroethylene. J Environ Qual 23:792-798.

WHO. 2001. Barium and barium compounds. Geneva, Switzerland: World Health Organization. http://www.inchem.org/documents/ehc/ehc/ehc221.htm. April 01, 2005.