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Phase IIIA Environmental Site Assessment

Council Bluffs Yard
Council Bluffs, Iowa
PIN Numbers: 5771865 and 5772732

Prepared by:

The RETEC Group, Inc.
413 Wacouta Street, Suite 400
St. Paul, Minnesota 55101

RETEC Project Number: CNIC3-16706-600

Prepared for:

Chicago Central & Pacific Railroad
17641 So. Ashland Avenue
Homewood, Illinois 60430-1345

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Prepared by:

Daryl R. Beck, P.E., Project Engineer

Reviewed by:

Curt D. Mann, Environmental Engineer

Jonathan S. Murer, Senior Hydrogeologist

April 2004

Executive Summary

Executive Summary

The RETEC Group, Inc. (RETEC) conducted a Phase IIIA Environmental Site Assessment (ESA) for a portion of the Chicago Central & Pacific (CCPR) Railroad's Council Bluffs yard located in Council Bluffs, Iowa (Site).

The primary objectives of Phase IIIA ESA are as follows:

- Delineate the extent of both the free-phase hydrocarbon plume and the dissolved phase plume, and evaluate if the contamination is migrating off-Site
- Evaluate the effect of impacted soil on the quality of groundwater at the Site
- Investigate and evaluate a series of remedial options for managing the Site impacts

<u>Physical Characteristics of Site</u>

Surface drainage at the Site is mainly overland to either low areas on or around the Site, to surface drainage ditches, or storm sewers. Stormwater eventually drains to the Missouri River located approximately one mile to the west of the Site.

Three mappable stratigraphic units were encountered during the Phase IIIA ESA. The three units are the fill unit, the clay unit and the sand unit. Based upon data collected during the Phase IIIA ESA, groundwater generally flows toward the west/northwest.

<u>Phase IIIA ESA Results – Fuel Area</u>

Soil Impacts

Phase IIIA ESA soil sample locations, and the parameters that exceeded applicable regulatory standards at those sample locations, are listed below:

- MW-11 (13 to 15') – acenaphthene, phenanthrene, and naphthalene
- MW-12 (23 to 25') – OA2 as diesel fuel, phenanthrene, and naphthalene
- MW-13 (7 to 9') - OA2 as diesel fuel, acenaphthene, phenanthrene, and naphthalene
- MW-15 (17 to 19') – phenanthrene
- MW-17 (21 to 23') - OA2 as diesel fuel, acenaphthene, phenanthrene, and naphthalene

- MW-18 DUP (14 to 15’) - phenanthrene
- MW-20 (12 to 14’) – acenaphthene and phenanthrene

Groundwater Impacts

During the Phase IIIA ESA sampling activities, nineteen groundwater samples were submitted for laboratory analysis. Phase IIIA ESA groundwater sample locations, and the parameters that exceeded applicable regulatory standards at those sample locations, are listed below:

- MW-1 – benzene, phenanthrene, and fluorene
- MW-2 – acenaphthene and fluorene
- MW-6 – acenaphthene, phenanthrene, and fluorene
- MW-10R – fluorene
- MW-11 – phenanthrene
- MW-17 – OA2 - diesel fuel, benzene, anthracnene, phenanthrene, and fluorene
- MW-18 - acenaphthene, phenanthrene, and fluorene
- MW-20 - acenaphthene, phenanthrene, and fluorene
- MW-21 – fluorene

Migration of Free-Phase Hydrocarbons

It is estimated that approximately 150,000 gallons of recoverable free-phase hydrocarbons may be present in the subsurface of the Fuel Area. AOC-specific data indicate that the occurrence of free-phase hydrocarbons is limited in its ability to migrate off of CCPR property. Evidence to support this conclusion is as follows:

- There are presently no significant sources of diesel fuel within the Fuel Area.
- GC-FID/ECD characterization analyses of free-phase hydrocarbon indicate that impacts are associated with an old release.
- The water table at the Site has a low hydraulic gradient.

- Downgradient wells MW-15, MW-14, MW-16, and MW-19 do not contain free-phase hydrocarbons, nor do they exhibit elevated levels of dissolved petroleum hydrocarbons.

Migration of Dissolved Hydrocarbons

AOC-specific data indicate that the distribution of dissolved hydrocarbons is limited in its extent. Data collected during the Phase IIIA ESA to support this conclusion are as follows:

- Downgradient wells MW-14, MW-15, MW-16, and MW-19 do not contain free-phase hydrocarbons, nor do they exhibit elevated levels of dissolved petroleum hydrocarbons.
- Known subsurface conduits (i.e., water supply to the Yard Office) will not influence migration potential.
- Due to the nature of the chemicals associated with diesel fuel, the extent of dissolved impacts resulting from this type of release typically closely corresponds to the extent of free-phase hydrocarbons.
- Dissolved hydrocarbon plume appears to be in geochemical stasis.

Natural Attenuation Assessment

During the Phase IIIA ESA, groundwater samples from the Fuel Area were subjected to a number of natural attenuation assessment analyses. These data, coupled with fate and transport modeling conducted using a commercially available software package, indicate that on-going in-situ biodegradation processes are limiting the extent of dissolved groundwater impacts at the Fuel Area.

Conceptual Design – Fuel Area

Based on the results of the Phase IIIA ESA, a set of remedial options were evaluated to address the free-phase and dissolved hydrocarbon impacts at the Fuel Area. Based on the results of the evaluations, RETEC recommends vacuum-enhanced free-phase hydrocarbon recovery with bioventing (bioslurping) to address free-phase hydrocarbons and monitored natural attenuation to address the dissolved petroleum hydrocarbons following completion of free-phase hydrocarbon removal.

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1 Introduction

1.1 Background

The RETEC Group, Inc. (RETEC) conducted a Phase IIIA Environmental Site Assessment (ESA) of a portion of the Chicago Central & Pacific (CCPR) Railroad's Council Bluffs yard located in Council Bluffs, Iowa (Site). Figure A-1, provided in Appendix A, shows the location of the Site.

The Phase IIIA ESA was performed in accordance with the U.S. Terms of Reference for Phase IIIA ESAs, dated January 10, 2002. The scope of work for the Phase IIIA ESA was presented in the RETEC document, *Proposal for Phase III Environmental Site Assessment – Council Bluffs, Iowa*, dated July 25, 2003 (Proposal). Modifications to the scope of work presented in the Proposal are summarized in Section 2 of this document.

1.2 Site Description

The Site is located in the city of Council Bluffs, Pottawattamie County, Iowa. The Site is a north-south trending property that is approximately 1.6 miles long and 1/8-mile wide. The United States Geological Survey (USGS) Council Bluffs North, Iowa, Quadrangle 7.5 Minute Series Topographic Map shows the Site is located in Township 15 North, Range 14 East, Sections 23 and 26. Figure A-2 shows the general configuration of the area of the Site where the majority of the Phase IIIA ESA activities were conducted. Figure A-3, provided in Appendix A, shows the configuration of the Site as assessed during the Phase II ESA.

As defined in the Phase I ESA, the Council Bluffs yard consists of the following properties and corresponding CCPR Property Identification Numbers (PINs):

- The original Illinois Central Railroad (ICRR) Council Bluffs yard and mainline – PIN 5771865
- The original ICRR yard office and locomotive staging area – PIN 5772732
- Mainline north of Council Bluffs yard PIN 5771862
- East/west Mainline tracks along northern edge of PIN 5771865 - PIN 5771866

Subsurface assessment activities associated with the Phase IIIA ESA were conducted on PINs 5771865 and 5772732. The following section presents pertinent information associated with PIN 5771865.

1.2.1 Original ICRR Council Bluffs Yard and Mainline – PIN 5771865 and PIN 5772732

The original ICRR Council Bluffs yard and mainline consists of a classification yard, locker/office building, tool house, three equipment and material storage buildings, sand tower, coal chute, electric meter house, 500-gallon gasoline aboveground storage tank (AST), 500-gallon diesel fuel AST, and an inactive turntable. The Council Bluffs yard was historically used as a locomotive fueling and light maintenance facility. Former structures associated with these historic operations include a roundhouse, fueling area, and a 200,000-gallon diesel fuel AST.

The original ICRR Council Bluffs yard and mainline comprising PIN 5771865 are approximately defined by the area extending east to the Union Pacific Railroad yard, extending west to the intersection of the rail line and 15th Street North, extending north to the intersection of the rail line and Big Lake Road, and extending south to the intersection of the rail line and Broadway Avenue.

The original ICRR yard office and locomotive staging area are located in PIN 5772732. The yard office, which is currently operated by CCPR, is situated near the intersection of Avenue F and 13th Street North.

1.3 Summary of Previous Investigations

Past environmental studies at the CCPR Council Bluffs yard include a Phase I ESA conducted by RETEC, an environmental investigation associated with the removal of one underground storage tank (UST) conducted in 1997, and a Phase II ESA conducted by Earth Tech, Inc. (Earth Tech) in 2002.

1.3.1 Phase I ESA

The results of the Phase I ESA are summarized in the RETEC document *Phase I Environmental Site Assessment*, dated December 2001. The Phase I ESA summarizes the following information related to the Site:

- Summary of past environmental studies
- Site location and physical setting
- Review of readily available regulatory records
- Summary of Site property uses
- Review of adjacent property uses/information
- Summary of interviews
- Summary of Areas of Concern (AOCs) associated with the Site

The Phase I ESA resulted in the identification of 12 AOCs. Table 1-1 summarizes the AOCs identified during the Phase I ESA, and evaluated during the Phase II ESA. The locations of these AOCs are shown on Figure A-2.

1.3.2 UST Removal Assessment

The Phase I ESA identified one pertinent environmental investigation that had been conducted at the Site.

A report prepared by Apex Environmental, Inc. on September 15, 1997 was reviewed as part of the Phase I ESA. The report described the removal of one 500-gallon gasoline UST located to the northwest of the turntable, within the western portion of PIN 5771865. The tank was removed from the Site on August 20, 1997.

The report indicated that there were no product lines associated with the tank. Removal and inspection of the tank revealed moderate pitting and a 1/8-inch hole. The hole was believed to have been formed during the tank removal. Excavation activities associated with the tank removal resulted in an excavation size of approximately 12 feet wide, by 18 feet long, by 15 feet deep. There were no indications of petroleum-impacted soil during excavation and removal of the tank

Following removal of the tank, a soil sample was colleted from the bottom of the excavation at a depth of approximately 11 feet below ground surface (bgs). The soil sample was submitted for laboratory analysis of benzene, toluene, ethylbenzene, and xylene (BTEX). There were no detections of BTEX parameters above laboratory detection limits. In addition, a groundwater sample was collected during excavation activities from the water that infiltrated into the open excavation. The groundwater sample was analyzed for BTEX. There were no detections of BTEX parameters above the Iowa Department of Natural Resources (IDNR) cleanup levels.

At the request of the IDNR, additional investigation activities were completed at the Site to evaluate groundwater conditions down-gradient of the former UST location. On February 25, 1998, one soil boring was completed approximately 15 feet northwest of the former UST excavation area. The groundwater sample collected from the soil boring was submitted for laboratory analysis of total extractable hydrocarbons (TEH) and BTEX. There were no detections of TEH or BTEX parameters above laboratory detection limits. These analyses indicated that these compounds were below applicable Iowa cleanup guidelines. Approximately one month after removal of the tank, two additional soil borings were completed and a monitoring well installed in the vicinity of the former UST to collect a soil sample and to collect a groundwater sample. The soil sample analysis indicated that BTEX and TEH concentrations were below the applicable Iowa cleanup guidelines. The groundwater sample results indicated that TEH was detected at a level above certain Iowa cleanup goals.

1.3.3 Phase II ESA

Earth Tech conducted a Phase II ESA at the Site in 2002. The results of the Phase II ESA are summarized in the Earth Tech document *Phase II*

Environmental Site Assessment Report – Council Bluffs Yard, dated May 2003. The scope and significant findings of the Phase II ESA, particularly those relevant to the objectives of the Phase IIIA ESA, are summarized below.

PHYSICAL CHARACTERISTICS

Geologic Conditions

The mappable stratigraphic units at the Site were as follows:

- **Fill Material.** This unit was observed in all Phase II ESA borings completed at the Site and ranged in thickness from 0 to 6 feet. The fill unit is composed primarily of locally derived native soils and non-soil debris such as brick, concrete, and railroad ballast.

- **Interbedded Fluvial and Lacustrine Deposit.** The interbedded fluvial and lacustrine deposit unit, composed primarily of dark gray, fine-grained clay and silt, was observed in all of the Phase II ESA soil borings. This unit was encountered at depths ranging from 2 to 6 feet bgs. Interbedded fluvial and lacustrine deposits were observed at the termination depth in 7 of the 9 Phase II ESA soil borings completed at the Site.

- **Fluvial Deposit.** The fluvial deposit unit, composed primarily of poorly graded fine sand, was noted in the majority of the Phase II ESA soil borings. This unit was observed in layers of various thicknessess across the Site, with the most predominant occurrences noted in the northern portion of the Site.

Section 3 of this document provides further details related to geologic conditions observed within AOCs 1, 2, and 8, where the majority of Phase IIIA ESA activities were completed.

Hydrogeologic Conditions

The Phase II ESA reported that groundwater flow within the unconsolidated unit of the Site flows to the west/northwest towards the Missouri River. Section 3 of this document provides further details related to hydrogeologic conditions within AOCs 1, 2, and 8.

LABORATORY ANALYTICAL RESULTS

The Phase II ESA included the collection of 10 subsurface soil samples (including one duplicate sample), eight surface soil samples (including one duplicate sample), eight sediment samples (including one duplicate sample), and 10 groundwater samples (including one duplicate sample). Soil samples were compared to the Statewide Standard for Soil (SSS) developed by the Iowa Land Recycling Program (ILRP). At the advice of the IDNR, the ILRP standards for soil were used to evaluate sediment data. Groundwater samples were compared to the Statewide Standards for Non-Protected Groundwater (SSNGW) developed by the ILRP.

Phase II ESA Soil Results

Of the 18 soil samples collected (10 from the subsurface and eight from the surface), three subsurface samples, all surface soil samples, were found to have detections exceeding the SSS. All of the samples that exceeded the regulatory standards were located at or near AOC-3. Organic exceedances were limited to polycyclic aromatic hydrocarbons (PAHs). The PAH exceedances at AOC-3 ranged from the same order-of-magnitude to three orders-of-magnitude greater than the regulatory standard.

Phase II ESA Sediment Results

Of the sediment samples collected, five were found to have detections exceeding the SSS for benzo(a)pyrene. The five samples were located in AOCs 4, 11, and 12. The benzo(a)pyrene exceedances detected at AOCs 4, 11, and 12 were at the same order-of-magnitude or one order-of-magnitude greater than the regulatory standard.

Phase II ESA Groundwater Results

The analytical results of the groundwater samples collected from the Site monitoring wells indicate that groundwater is impacted above the SSNGW at three wells. All of the wells with groundwater exceedances are located in the yard area. Wells MW-1 and MW-6 are located in the former fueling area (AOC-1) and former lubrication and oil building area (AOC-8). Well MW-3 is located down gradient of the former round house (AOC-3). Groundwater impacts were noted at the following wells during the Phase II ESA are:

- MW-1 (AOC-1) – Groundwater samples collected from MW-1 contained 324 micrograms per liter (µg/l) of benzene and 490 µg/l of naphthalene, which exceed the groundwater standards for benzene of 5 µg/l and naphthalene of 20 µg/l, respectively.

- MW-6 (AOC-8) - Groundwater samples collected from MW-6 contained 48 µg/l of benzene, which exceeds the groundwater standard for benzene of 5 µg/l.

- MW-3 (AOC-3) - Groundwater samples collected from MW-3 contained 101 µg/l of selenium, which exceeds the groundwater standard for selenium of 50 µg/l.

Free-Phase Hydrocarbons

Free-phase petroleum hydrocarbons were not observed in Site monitoring wells during the Phase II ESA.

RATIONALE FOR PHASE IIIA ESA

The Phase II ESA concluded that it would be prudent to conduct supplemental assessment activities at AOCs 1, 2, 3, 8, 11, and 12 due to the petroleum impacts and other parameters detected at these locations.

The following presents the rationale for the recommendation of supplemental assessment activities:

- AOC-1 – exceedance of groundwater regulatory standards and potential for accumulation of free-phase petroleum hydrocarbons
- AOC-2 – potential exceedance of groundwater regulatory standards and potential accumulation of free-phase petroleum hydrocarbons
- AOC-3 - exceedance of groundwater regulatory standards
- AOC-8 - exceedance of groundwater regulatory standards
- AOC-11 – potential existence of petroleum impacts in groundwater
- AOC-12 – exceedance of applicable regulatory standards for sediment and existence of lead in sediment

For planning and future Site management purposes, AOCs 1, 2, and 8 will be considered as one AOC due to their proximity to each other and their related historic functions. These three AOCs will be collectively referred as the Fuel Storage and Distribution Area (Fuel Area).

1.4 Objectives of Phase IIIA ESA

The primary objectives of Phase IIIA ESA are as follows:

- Delineate the extent of both the free-phase petroleum hydrocarbon plume, if present, and the dissolved phase plumes, and evaluate if the contamination is migrating off-Site
- Evaluate the effect of impacted soil on the quality of groundwater at the Site
- Investigate and evaluate a series of remedial options for managing the Site impacts (conceptual design)

To meet these objectives, the following tasks were completed as part of the Phase IIIA ESA:

- Evaluate previous environmental studies - Determine and fill data gaps, if any
- Determine the size of the free-phase petroleum hydrocarbon plume, if present, in the groundwater with monitoring wells and boreholes
- Delineate the dissolved phase plume(s) and determine if plume has migrated off of the Site
- Establish groundwater flow patterns affecting free-phase petroleum hydrocarbon and/or dissolved phase plume including preferential pathways
- Determine if the free-phase petroleum hydrocarbon plume, if present, is mobile and evaluate the potential and possible timing of off-Site migration of free product
- Evaluate hydrogeologic characteristics as needed to aid in development of a conceptual design
- Laboratory analysis of a focused set of soil samples

1.5 Document Organization

Section 1 of this document provides Site background information. Section 2 summarizes the scope of work conducted as part of the Phase IIIA ESA. Section 3 provides a description of the physical characteristics of the Site. Section 4 summarizes the results of the Phase IIIA ESA laboratory analytical program. Section 5 presents a discussion of the results of the Phase IIIA ESA. Section 6 summarizes the conceptual design for the Site. Section 7 summarizes the references used in preparation of this document. Table 1-2 provides a checklist of the required elements of a Phase IIIA ESA report as defined in the applicable U.S. Terms of Reference.

2 Field Investigation Methodology

The field work associated with the Phase IIIA ESA was completed between August and November 2003. The Phase IIIA ESA was performed in accordance with the Proposal and the Site-Specific Health and Safety Plan. Records of Site safety meetings are maintained in the RETEC project file.

2.1 Soil Boring and Soil Sampling Program

2.1.1 Soil Boring and Sampling Procedures

Fourteen soil borings were completed during the Phase IIIA ESA. Twelve soil borings were completed at the Fuel Area (i.e., borings MW-10, MW-10R, and MW-11 through MW-20), one soil boring at AOC-11 (i.e., Temp Well-1), and one soil boring at AOC-12 (i.e., Temp Well-2). Figure A-3 shows the locations where soil borings were completed. Soil borings were advanced using a truck-mounted drilling rig capable of conducting hollow stem auger (HSA) drilling methods. All 14 soil boring locations were used for well installation purposes. Table 2-1 summarizes pertinent information related to each soil boring location. HSA drilling was completed with 4.25-inch inside diameter augers. Samples were collected continuously from the ground surface to the total depth of the boring. Soil samples were collected using 2-inch diameter, 2-foot long split spoon sampling devices. Table 2-2 provides the rationale for the placement of Phase IIIA ESA soil borings and other sampling activities.

Drilling activities were conducted by Maxim, Inc., (Maxim) of Waterloo, Iowa under the supervision of a RETEC geologist. Downhole drilling and sampling equipment was decontaminated between each use. Decontamination procedures are described in Section 2.8 of this document.

2.1.2 Soil Classification and Field Screening

During the field investigation, a field geologist maintained detailed stratigraphic field notes for all soil borings completed. Soil samples retrieved from soil borings were classified using the Unified Soil Classification System (USCS) and the Munsell Color Classification System. During logging, the geologist noted the observed locations of fill material, native unconsolidated materials, and the possible field indications of impacts, including the presence of odors and the existence of staining and/or sheens. Details related to observations made during the soil boring program are summarized on soil boring logs which are provided as Appendix B.

Field screening was conducted on soil samples using the headspace method and a portable photoionization detector (PID). To facilitate field screening, soil samples were placed into re-sealable plastic bags, labeled and set aside for at least 10 minutes to allow headspace development. The bags were shaken for 15 seconds at the beginning and at the end of the headspace development period. Subsequent to headspace development, PID readings were collected from each bagged sample by inserting the PID probe into a small opening in the bag. Field screening equipment was calibrated at the start of each day of field work or more frequently if found to be necessary. The field screening results are documented on the soil boring logs provided in Appendix B.

2.1.3 Soil Analytical Program

Selected soil samples collected during the soil sampling program were submitted for laboratory analyses. Table 2-3 summarizes the soil sample laboratory analytical program. As outlined in the Terms of Reference, determining the extent of soil impacts is not an objective of the Phase IIIA ESA. As such, only a limited number of representative soil samples were submitted for laboratory analysis.

Soil samples were submitted to Pace Analytical Services Inc. (Pace), of Minneapolis, Minnesota. Samples were transported via express courier services in coolers containing ice using standard chain-of-custody procedures. Standard field and quality assurance and quality control (QA/QC) samples were submitted along with the soil boring samples. These field QA/QC samples included blind duplicates and trip blanks. The results of the Phase IIIA ESA laboratory analytical program are summarized in Section 4 of this report.

2.2 Well Sealing

As part of the Phase IIIA ESA, certain monitoring wells installed during the Phase II ESA were sealed. Wells MW-4, MW-5, MW-7, and MW-9 were sealed during the Phase IIIA ESA. Wells were sealed by Maxim in accordance with applicable IDNR regulations. Copies of the IDNR well abandonment forms for each of the wells sealed are provided in Appendix C.

2.3 Monitoring Well Installation

Fourteen monitoring wells were installed during the Phase IIIA ESA. Monitoring wells were constructed to depths ranging from 18.5 to 26 feet bgs. Twelve permanent wells were installed at the Fuel Area, one temporary well was installed at AOC-11, and one temporary well was installed at AOC-12. Table 2-4 summarizes well construction information for each of the newly installed wells. Appendix B provides construction details for the monitoring wells installed during the Phase IIIA ESA. Monitoring well screens were positioned so that the observed water table would be within the screened interval of the well.

Each permanent monitoring well installed during the Phase IIIA ESA was completed with a flush-grade manhole as surface protection. A concrete surface seal was placed at the ground surface around the flush-grade manhole. The flush-grade manholes and concrete surface seals were set in a manner to deter surface water from entering the manhole. A datum point was established for each monitoring well from which all water level measurements were referenced. The measuring points were clearly marked on the top of each riser pipe. Each well was labeled by inscribing the monitoring well ID, monitoring well owner (i.e., CCPR), date installed and consultant name (i.e., RETEC) into the concrete surface pad.

Each monitoring well was developed to remove silt and other fine-grained sediments that may have accumulated within the well during installation. The wells were developed by bailing or pumping. Special care was taken to develop the wells to ensure adequate hydraulic communication between the well and the surrounding formation. The wells were developed until water was relatively free of sediment or until all of the groundwater had been removed.

2.4 Groundwater Sampling Program

2.4.1 Groundwater Sampling Procedures

One round of groundwater sampling was completed during the Phase IIIA ESA. Sampling was completed during two mobilizations on August 25 through September 5, 2003 and on November 13 and 14, 2003. The following provides a general description of the procedures used during the groundwater sampling program.

Prior to sampling, the depth to water and the depth to the bottom of each well were measured to determine the well casing volume. Measurements were collected using an electronic interface probe capable of measuring the water table elevation to an accuracy of 0.01 feet. Using disposable polyethylene and silicone tubing, each well was purged with a peristaltic pump until the field measurements of pH, specific conductance, and temperature had stabilized to within 10 percent of the previous reading, typically amounting to three casing volumes. With the exception of samples for volatile analysis, samples were transferred directly from the tubing to laboratory supplied jars. Samples for volatile analyses were collected using disposable polyethylene bailers.

All non-disposable sampling equipment was decontaminated prior to each use. Field observations and measurements collected during the groundwater sampling program are summarized on the groundwater sampling forms provided in Appendix D.

2.4.2 Groundwater Analytical Program

A summary of the groundwater sample analytical program is presented in Table 2-5. Groundwater samples were submitted to Pace in coolers containing ice, using standard chain-of-custody procedures. Standard field QA/QC samples were submitted along with the groundwater samples. These field QA/QC samples included blind duplicates, equipment/field rinse blanks, and trip blanks. The results of the Phase IIIA ESA groundwater sample analytical program are summarized in Section 4 of this report.

2.5 Free-Phase Hydrocarbon Evaluation

During the initial mobilization of the Phase IIIA ESA field activities, it was noted that free-phase hydrocarbons had accumulated in well MW-6 (AOCs 1, 2, and 8), which was installed during the Phase II ESA in 2002. Free-phase hydrocarbons had not previously been noted in this well in 2002. Based on the discovery of free-phase hydrocarbons in several wells during the initial Phase IIIA ESA mobilization, CCPR requested that RETEC install additional monitoring wells to further evaluate the extent of free-phase and dissolve-phase hydrocarbons, as well as conduct monthly hydrocarbon removal events and recoverability evaluations. During these Phase IIIA ESA activities, free-phase hydrocarbons continued to be observed in well MW-6 and were also noted in newly installed Phase IIIA ESA wells MW-10R, MW-11 through MW-13, MW-17, MW-18, and MW-20.

To characterize the nature of the free-phase hydrocarbons observed at the Site, a hydrocarbon sample was submitted for gas chromatograph/flame ionization detector-electron capture detector (GC/FID-ECD), viscosity, and specific gravity analyses. These analyses were conducted or coordinated by Friedman and Bruya Analytical Laboratories of Seattle Washington. The results of the Phase IIIA ESA free-phase hydrocarbon analytical program are summarized in Section 4 of this report.

To further evaluate the characteristics of free-phase hydrocarbons noted in wells located within the Fuel Area, field recoverability tests were conducted during the Phase IIIA ESA. These tests included conducting hydrocarbon baildown tests at wells MW-11, MW-12, MW-13, MW-17 and MW-18, as well as completing vacuum-enhanced recovery tests at wells MW-11, MW-12, MW-13, and MW-18. The baildown tests consisted of the following task elements:

- Measurement of thickness of free-phase hydrocarbons
- Removal of free-phase hydrocarbons using a peristaltic pump
- Record volume of free-phase hydrocarbons removed during test
- Record returning thickness of free-phase hydrocarbons intermittently after initial hydrocarbon removal activities
- Perform semi-quantitative evaluation of volume and potential recoverability of hydrocarbons

The vacuum-enhanced recovery tests utilized the following methodology:

- Measurement of thickness of free-phase hydrocarbons
- Evacuation of free-phase hydrocarbons using a vacuum truck and down-hole suction pipe
- Record vacuum pressure measurements at wellhead, volume of fluids recovered, and duration of test
- Record returning thickness of free-phase hydrocarbon intermittently after initial hydrocarbon removal activities

Data obtained during the free-phase hydrocarbon field recoverability tests has been utilized to aid in the evaluation of free-phase hydrocarbon recoverability estimates and screening of potential remedial options. The results of this evaluation are presented in Sections 4 and 6 of this document.

RETEC will be completing additional free-phase hydrocarbon recovery and evaluation events in February and March 2004. The results of these events, as well as information obtained during the Phase IIIA ESA, will provided to CCPR as a separate deliverable.

2.6 Aquifer Testing

Rising head slug tests were performed on three wells (wells MW-10R, MW-14, and MW-16) at the Site. Slug tests were performed by placing a slug of known volume into the well and then allowing the water level to return to static conditions. To start the test, the slug was then removed from the well and an in-situ Hermit Data logger and pressure transducer, with an accuracy of 0.001 ft, was used to measure the water level as it returned to its static, pre-test level. The slug test data were analyzed using the Bouwer-Rice method of 1976. The data were used to estimate certain hydraulic characteristics of the uppermost saturated zone at the Site. The downhole equipment used during the slug test activities was decontaminated prior to each use. The results of the slug test analyses are summarized in Section 3 of this report. Slug test field data and hydraulic conductivity analysis data are provided as Appendix E.

2.7 Site Survey

After the Phase IIIA ESA field activities were complete, sampling locations, along with certain other pertinent Site features, were surveyed to determine their horizontal and vertical positions. The survey data gathered during the Phase IIIA ESA were compiled on a Site base map. Surveying services were provided by HGM Associates, Inc. of Council Bluffs, Iowa. Field data prepared by the surveyor are provided in Appendix D.

2.8 Quality Assurance/Quality Control

2.8.1 Field QA Procedures

Decontamination

All non-disposable, hand-held sampling and well purging equipment was field decontaminated using a dilute methanol solution wash and a distilled water rinse. Downhole drilling equipment was hot water pressure-washed between uses.

Instrument Calibration

Field instruments were calibrated each day used, or more frequently when determined to be necessary, by the RETEC field staff.

Quality Assurance Sampling

Quality assurance sampling was conducted and consisted of collecting sample media duplicates, equipment rinseate blanks, matrix spikes, and trip blanks. These data were used to perform data validation activities. The results of RETEC's data validation efforts are summarized in Section 4 of this document.

2.8.2 Laboratory QA Procedures

Pace provided primary laboratory analytical support for the Phase IIIA ESA. The QA program employed by Pace for the project was in compliance with the contract requirements between Pace and CCPR.

2.9 Environmental Protection Plan

Residuals generated during the Phase IIIA ESA included decontamination fluids, well development water, well purge water, and drill cuttings. All decontamination fluids, well development water and purge water was collected and transferred to 55-gallon drums.

Six 55-gallon drums containing soil were generated during Phase IIIA ESA field activities. The drums were transported to the Waste Management facility located in Papillion, Nebraska for proper disposal. Purge and development water that did not exhibit petroleum impacts (i.e., sheen) was placed on the ground surface. Purge and development water that did exhibit petroleum impacts was managed with water generated during the free-phase hydrocarbon recovery evaluation. Miscellaneous trash, which was not exposed to potentially contaminated soil or water, was placed in trash bags and managed by CCPR as standard solid waste. Drill cuttings, which showed no evidence of impacts, were spread on the ground surface near the boring location.

2.10 Modifications to Proposed Scope of Work

Modifications to the proposed scope of work provided in the Proposal are presented in Table 2-6.

3 Physical Characteristics

This section presents a discussion of the geologic, surface water, and hydrogeologic characteristics of the Site. The information generated during the Phase IIIA ESA, and pertinent information generated during the Phase II ESA, was used to develop an understanding of subsurface conditions at the Site.

3.1 Geology

3.1.1 Regional Geology

The Site is located on the alluvial plain of the Missouri River. The alluvial plain deposits are approximately 50 feet thick and are composed of varying amounts of gravel, sand, silt and clay. The Missouri River is located approximately one mile west of the Site and loess hills are located approximately ¼ mile east of the Site. The alluvial deposits of the Missouri River Alluvial plain are underlain by approximately 150 feet of glacial till deposited by pre-Wisconsinan age glaciers.

The near surface deposits of the alluvial plain and the loess hill were deposited as the Wisconsinan glaciers were retreating in North and South Dakota. The melting glaciers produced a large volume of water and sediment that caused the Missouri river to exhibit the characteristics of a wide, shallow, braided river. A braided river is characterized by many sand and silt covered bars that act as a source of the silt for the loess hills. As the wind blew across the sandbars, it picked up silt and clay particles and carried them eastward. The wind blown sediment accumulated to become the loess hills.

The uppermost bedrock unit in the area (below the 200 feet of river sediment and glacial till) is Pennsylvanian age bedrock. There are also small areas of Cretaceous age Dakota Sandstone overlying the Pennsylvanian age bedrock in the area, but the Dakota is not present beneath the Site.

3.1.2 Site Geology

Figure A-4 shows the orientation of a geologic/hydrogeologic cross-section that was developed using data generated during Phase IIIA ESA soil boring and well installation activities. Pertinent information developed during the Phase II ESA has also been considered during preparation of the Site cross-section. Figure A-5 shows cross-section A-A'.

As shown in Figure A-5, three mappable stratigraphic units were encountered during the Phase IIIA ESA. The three units are the fill unit, the clay unit and the sand unit. The cross-section illustrates the inferred positions of these units along the cross-section line. Descriptions of these units are provided below.

- **Fill Unit.** This unit was observed in a majority of the soil borings completed at the Site and where observed, ranges in thickness from 2 to 6 feet. This unit is composed primarily of sand and gravel with variable amounts of silt, clay, and non-soil debris such as wood, and coal slag. The fill unit was not noted to exist at borings TW-1 (located east of the former fueling area) and at borings MW-14 and MW-15 (located at the western extent of CCPR property).

- **Clay Unit.** The clay unit underlies the fill unit and was observed in all of the Phase IIIA ESA soil borings completed. At locations where the underlying sand unit was noted, the clay unit ranged in thickness from 15 to 20 feet and is composed primarily of medium plastic clays and low plasticity silts. Highly plastic clays were also noted to exist in this unit. Isolated horizons of clayey sand and sand were also observed at certain boring locations. This unit was noted to be saturated with water at some locations and is considered an aquitard at the Site.

- **Sand Unit.** The sand unit was observed in 11 of the Phase IIIA ESA soil borings. Where observed, this unit was noted to exist below the clay unit. The top of this unit exists at depths ranging from 17 to 23 feet bgs.

3.2 Surface Water Characteristics

Surface drainage at the Site is mainly overland to either low areas on or around the Site, to surface drainage ditches, or storm sewers. Indian Creek is located on the southeast side of the Site and drains that area to the Missouri River. The Missouri River is located approximately one mile to the west of the Site. A culvert pipe extends under the 7, 8, and 9 tracks to drain the track area to the east into a ditch located between the Site and the adjacent UPRR yard. This ditch drains the eastern side of the Site to the north to Big Lake, which is located approximately 3/4–miles to the north of the Site. Much of the yard area drains toward the “sump” area (AOC-4) located on the west side of the yard. A wetland area is located northwest of the Site. The storm sewers drain to the Missouri River.

3.3 Hydrogeology

3.3.1 Regional Groundwater Flow

The regional shallow groundwater is interpreted to flow toward the west from the loess hills to the Missouri River. This interpretation is based on the topography of the area with the loess hills being the high ground and the Missouri River being the lowest topographic point in the area and the ultimate discharge point for regional groundwater. Small local drainage features such as Indian Creek, located to the south of the Site, may influence the groundwater flow locally.

3.3.2 Area Water Wells

According to the water well search conducted as part of the Phase I ESA, there are no potable water supply wells on, or in the vicinity of, the Site which are currently in use. The only wells on file with the IDNR are shallow monitoring wells. These wells are associated with the adjacent Union Pacific yard. The locational or activity status information provided by the IDNR has not been field verified.

3.3.3 Site Groundwater Flow

Based upon data generated during the Phase IIIA ESA, it is evident that the water table at the Site occurs at an elevation ranging from 964.78 to 964.99 feet above MSL. The water table occurs near the interface of the clay unit and the sand unit. The clay unit at the Site is acting as an aquitard and exhibits a sufficiently low permeability such that the Phase II ESA wells which terminate in the clay unit, exhibit a perched water table. For example, the Phase II ESA wells MW-1 through MW-3 exhibit potentiometric surfaces several feet above the water table measured within Phase IIIA ESA wells, which are typically completed in the sand unit.

Figure A-6 presents the general configuration of the water table at the Site. Figure A-5 shows the general configuration of the water table along the cross-section line. As indicated on Figure A-6, groundwater generally flows towards the west/northwest. The horizontal hydraulic gradient at the Site is estimated to be relatively flat at 3.74×10^{-4} feet per foot (ft/ft). Table 3-1 presents the groundwater elevation data associated with the January 2004 monitoring event. It should be noted that Phase II ESA wells and wells which have not exhibited the occurrence of free-phase hydrocarbons, have been used in the development of the groundwater flow map.

3.3.4 Hydraulic Conductivity and Groundwater Velocities

The average velocity of groundwater through the pores of saturated earth materials can be estimated with the following modification of the Darcy equation:

$$V=KI/n,$$

where:

V=groundwater velocity (ft/day)

K=average hydraulic conductivity (ft/day)

I=hydraulic gradient (dimensionless)

n=effective porosity (dimensionless)

Table 3-2 summarizes the hydraulic conductivity estimates from the slug test data collected during the Phase IIIA ESA. The hydraulic conductivity was estimated using the Bouwer-Rice method of 1976. Appendix E contains the slug test field data and the associated graphical plots for data collected during the Phase IIIA ESA.

As indicated in Table 3-2, the geometric mean of the hydraulic conductivities at the Site is 0.55 feet per day (ft/day).

Because laboratory porosity analyses were not completed for the materials adjacent to the screened interval of monitoring wells, estimated effective porosities were obtained from literature sources and are provided in Table 3-3. Table 3-3 summarizes the groundwater velocity estimate for the Site. Based on the information generated during the Phase IIIA ESA, the average horizontal groundwater flow velocity at the Site is estimated to be 4.6×10^{-4} ft/day. This estimate can be expected to vary somewhat at any given location of the Site.

4 Data Analysis

This section summarizes Phase IIIA ESA laboratory analytical results. Tabulated analytical results are provided in Appendix F. Copies of the Phase IIIA ESA laboratory analytical reports and chain-of-custody forms are provided in Appendix G. Pertinent soil and groundwater data from the Phase II ESA are summarized in tables provided in Appendix H. The results of an IDNR file review, associated with the adjacent UPRR property, are also summarized in this section.

4.1 Regulatory Standards

The laboratory analytical data generated during the Phase IIIA ESA has been tabulated and compared against applicable regulatory standards promulgated by the IDNR. The applicable standards for soil and groundwater are provided in the data tables provided in Appendix F. The SSNGW are the applicable regulatory standards for groundwater and were developed by the ILRP. The SSS are the applicable regulatory standards for soil and were also developed by the ILRP. Because no standard exists for total extractable hydrocarbons in the SSNGW or SSS regulations, Leaking Underground Storage Tank (LUST) Tier 1 values were used to evaluate total extractable hydrocarbons in groundwater and soil analyses.

4.2 Data Validation Results

Upon receipt of the analytical reports, RETEC performed a QA/QC review (i.e., data validation) of the Phase IIIA ESA data. The data validation effort was based on *USEPA Contract Laboratory Program National Functional Guidelines for Organic Data Review*, EPA540/R-99/008, October 1999, *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA540/R-94/013, February 1994 (NFGs) and USEPA regional guidance with respect to the NFGs. The purpose of the data validation effort was to ensure that the data generated during the Phase IIIA ESA are valid for their intended uses. The results of the data validation program are presented in Appendix I. The data validation effort assessed the precision, accuracy, method compliance, and completeness of the data. The Relative Percent Difference (RPD) evaluation for the Phase IIIA ESA data is provided as part of the Appendix I information.

Based on the results of the data validation effort, the data set generated during the Phase IIIA ESA is of acceptable quality and is valid for its intended uses. During the data validation process certain data were qualified as estimated due to these data not meeting certain validation criteria. Additionally, several Iowa Method OA2 (OA2) results for diesel fuel were qualified as false positives due to QA irregularities. However, these data qualifications did not affect the overall data completeness objective for the project. A summary of the data qualifications applied to the data set is provided in Appendix I.

4.3 Laboratory Analytical Results

The following sections provide overviews of the soil and groundwater analytical results from the four AOCs evaluated during the Phase IIIA ESA (i.e., Fuel Area, AOC-3, AOC-11, and AOC-12). It should be noted that the discussion of sampling activities and results will consider pertinent Phase II ESA data.

4.3.1 AOCs 1, 2, and 8 - Former Fuel Storage and Distribution Area (Fuel Area)

Phase IIIA ESA assessment activities conducted in this area (i.e., AOC 1, 2, and 8) included the following:

- Installation of 13 monitoring wells (i.e., MW-10 through MW-21 and MW-10R). Monitoring well MW-10R is a replacement for MW-10 because insufficient groundwater for collecting samples was present in MW-10.

- Submission of 15 soil samples, including two duplicate samples, for laboratory analyses of Iowa Method OA1 (OA1), OA2, PAH, BTEX, total organic carbon (TOC), and grain size distribution.

- Collection of groundwater samples, including two duplicate samples, from 14 monitoring wells which included four wells installed during the Phase II ESA and 10 wells installed during the Phase IIIA ESA.

- Submission of groundwater samples for laboratory analyses including OA1, OA2, PAHs, BTEX, and natural attenuation evaluation parameters.

- Completion of free-phase hydrocarbon baildown tests and vacuum-enhanced removal tests

- Submission of free-phase hydrocarbon sample for characterization analyses including density, viscosity, and GC-FID/ECD analysis

Results of the Fuel Area soil, groundwater, and free-phase hydrocarbon sampling efforts are provided in the following subsections.

Soil and Groundwater Analytical Results

Figures A-7 and A-8 show the locations within the Fuel Area where soil and groundwater analytical data exceed applicable Iowa standards. Pertinent Phase II ESA data is also presented on these figures. The following subsections describe the results of laboratory analyses conducted on soil and groundwater samples.

Iowa Method OA1 Analysis – Gasoline and BTEX

During the Phase IIIA ESA, 14 soil samples were analyzed for OA1 including two duplicate samples. The duplicate samples were collected at soil borings MW-13 and MW-18. Parameters comprising the OA1 analyses include total hydrocarbon (THC) as gasoline and BTEX. Table F-1 summarizes the results of the OA1 analyses performed on soil samples. As indicated in Table F-1, THC as gasoline was detected in samples collected from soil borings MW-10, MW-11, MW-12, MW-13, MW-14, MW-15, MW-17, MW-18, MW-20, and the duplicate sample collected from MW-13 at concentrations ranging from 11 to 2,100 milligrams per kilogram (mg/Kg). The highest concentration of THC as gasoline was detected in the sample collected from boring MW-17. There are no state standards for THC as gasoline. BTEX parameters were detected in samples collected from soil borings MW-11, MW-12, MW-13, and MW-17, but at levels that did not exceed the Iowa standards.

Sixteen groundwater samples were analyzed for OA1 including two duplicate samples. The duplicate samples were collected at wells MW-1 and MW-18. Table F-2 summarizes the results of the OA1 analyses performed on groundwater samples. As indicated in Table F-2, THC as gasoline was detected in samples collected from wells MW-1, MW-2, MW-6, MW-17, MW-18, and both duplicate samples at concentrations ranging from 500 to 5,260 ug/L. The highest concentration of THC as gasoline was detected in the sample collected from MW-17.

BTEX parameters were detected in the groundwater samples collected from wells MW-1, MW-2, MW-6, MW-11, MW-17, MW-18, MW-20, and both duplicate samples. Benzene was detected at a concentration exceeding the Iowa standard of 120 ug/L in samples collected from wells MW-1 and MW-17 and the duplicate sample collected from MW-1. Benzene also exceeded the Iowa groundwater standard in samples collected from MW-1 and MW-6 during the Phase II ESA.

Iowa Method OA2 Analysis - Diesel Fuel

During the Phase IIIA ESA, 14 soil samples were analyzed for OA2 including two duplicate samples. The OA2 analyses include analysis for diesel fuel. The duplicate samples were collected at soil borings MW-13 and MW-18. Table F-1 summarizes the results of the diesel fuel analyses performed on soil samples. As indicated in Table F-1, diesel fuel was detected in the samples collected from borings MW-10, MW-11, MW-12, MW-13, MW-17, MW-18, MW-20, and both duplicate samples. Diesel fuel exceeded the Iowa standard of 3,800 mg/Kg in samples collected from soil borings MW-12, MW-13, and MW-17.

Sixteen groundwater samples were analyzed for OA2 including two duplicate samples. The duplicate samples were collected at wells MW-1 and MW-18. Table F-2 summarizes the results of the diesel fuel analyses performed on groundwater samples. As indicated in Table F-2, OA2 was detected in groundwater samples collected from wells MW-6, MW-11, MW-15, MW-17, MW-18, MW-20, MW-21, and both duplicate samples. The sample collected at well MW-17 exceeded the Iowa Standard of 75 mg/L with a concentration of 4,200 mg/L.

PAH Analyses

During the Phase IIIA ESA, 14 soil samples, including two duplicate samples were collected and analyzed for PAHs. The duplicate samples were collected from soil borings MW-13 and MW-18. Table F-1 summarizes the results of the PAH analyses performed on the soil samples. As indicated in Table F-1, certain PAHs were detected in the samples collected from borings MW-10, MW-11, MW-12, MW-13, MW-15, MW-17, MW-18, MW-20, and both duplicate samples. Acenaphthene was detected at concentrations exceeding the Iowa Standard (i.e., 0.29 mg/Kg) in samples collected from MW-11, MW-13, MW-17, and MW-20. Phenanthrene was detected at concentrations exceeding the Iowa Standard (i.e., 0.29 mg/Kg) in samples collected from MW-11, MW-12, MW-13, MW-15, MW-17, MW-20, and both duplicate samples. Naphthalene was detected at concentrations exceeding the Iowa Standard (i.e., 2.9 mg/Kg) in samples collected from MW-11, MW-12, MW-13, MW-17, and the duplicate sample collected from MW-13.

Sixteen groundwater samples including two duplicate samples were collected. The duplicate samples were collected from wells MW-1 and MW-18. Table F-3 summarizes the results of the PAH analyses performed on groundwater samples. As indicated in Table F-3, PAHs were detected in samples collected from wells MW-1, MW-2, MW-6, MW-8, MW-10R, MW-11, MW-15, MW-17, MW-18, MW-20, MW-21, and both duplicate samples. Anthracene was detected at a concentration of 870 ug/L, exceeding the Iowa standard (i.e., 700 ug/L), in the sample collected from MW-17. Acenaphthene was detected at concentrations exceeding the Iowa Standard (i.e., 4.0 ug/L) in samples collected from MW-2, MW-6, MW-18, MW-20, and the duplicate collected from MW-18. Phenanthrene was detected at concentrations exceeding the Iowa Standard (i.e., 4.8 ug/L) in samples collected from MW-1, MW-6, MW-11, MW-17, MW-18, MW-20, and both duplicate samples. Fluorene was detected at concentrations exceeding the Iowa Standard (i.e., 0.48 ug/L) in samples collected from MW-1, MW-2, MW-6, MW-10R, MW-17, MW-18, MW-20, MW-21, and the both duplicate samples.

TOC Analysis

Two soil samples were analyzed for TOC. Table F-1 summarizes the results for these samples. As indicated on Table F-1, TOC was detected at a concentration of 22,000 mg/Kg and 21,000 mg/Kg at depths of 9 to 11 feet bgs and 13 to 15 feet bgs, respectively, in samples collected from boring MW-11.

Grain Size Distribution

Three grain size distribution tests were conducted on samples collected at MW-10R (22-24 feet bgs), MW-11 (7-9 feet bgs), and MW-11 (15-17 feet bgs). The results of the grain size analysis are provided in Appendix J. The results of the two samples collected from soil boring MW-11 indicate classification as a silty clay. The sample collected from MW-10R was classified as a sandy silt. These results are generally consistent with observations made in the field.

Groundwater Natural Attenuation Assessment Parameters

Nine groundwater samples were analyzed for a set of natural attenuation assessment parameters including: methane, nitrogen compounds, sulfate, phosphorus, BOD, and TOC. Table F-4 summarizes the results for these analyses. As indicated in Table F-4, parameters indicative of on-going natural attenuation processes were detected. A detailed discussion of natural attenuation processes likely occurring in groundwater within the Fuel Area is provided in Section 5 of this report. These results are generally consistent with observations made in the field.

Free-Phase Hydrocarbon Analyses

A sample of free-phase hydrocarbon from well MW-11 was submitted for a set of characterization analyses including: viscosity; density; and GC-FID/ECD analysis.

The data associated with these hydrocarbon characterization analyses are provided in Appendix J.

The results of the viscosity and density analyses are consistent with values associated with weathered diesel fuel. The results of the GC-FID/ECD characterization indicated the presence of medium boiling compounds indicative of a middle petroleum distillate such as diesel fuel. The GC-FID/ECD analysis further indicated that the sample had undergone substantial biological degradation suggesting a relatively old source for the hydrocarbon. Section 4.4 of this document provides further details related to the free-phase hydrocarbons present at the Fuel Area.

4.3.2 AOC-3 Former Roundhouse

Phase IIIA ESA assessment activities conducted at this AOC consisted of resampling monitoring well MW-3, which was installed during the Phase II ESA. During the Phase II ESA, selenium was detected in the groundwater sample collected from MW-3 at a concentration that exceeded the applicable IDNR standard. The groundwater sample collected from MW-3 during the Phase IIIA ESA was analyzed for selenium. Table F-5 summarizes the result of the selenium analysis performed on the groundwater sample. As indicated in Table F-5, selenium was detected at a concentration of 21.6 ug/L, which is below the applicable IDNR standard of 50 ug/L.

4.3.3 AOC-11 UPRR Soil Stockpiles

Phase IIIA ESA assessment activities conducted at this AOC included the following:

- Installation of one temporary monitoring well designated Temp Well-2
- Submission of one soil sample for laboratory analyses including OA1, OA2, and PAHs
- Collection of a groundwater sample from Temp Well-2
- Submission of groundwater samples for laboratory analyses including OA1, OA2, and PAHs

Results of the AOC-11 soil and groundwater sampling efforts are summarized in the following sections.

Soil and Groundwater Analytical Results

The following subsections describe the results of laboratory analyses conducted on soil and groundwater samples.

Iowa Method OA1 Analyses – Gasoline and BTEX

During the Phase IIIA ESA, one soil sample was analyzed for OA1. Table F-1 summarizes the result of the OA1 analyses performed on the soil sample. As indicated in Table F-1, THC as gasoline was detected at a concentration of 6.7 mg/Kg in the sample collected from boring Temp Well-2. There are no state standards for THC as gasoline. BTEX parameters were not detected in the sample.

One groundwater sample was analyzed for OA1. Table F-2 summarizes the result of the OA1 analysis performed on the groundwater sample. As indicated in Table F-2, THC as gasoline was not detected in the sample submitted from Temp Well-2. BTEX parameters were not detected in the sample.

Iowa Method OA2 Analysis - Diesel Fuel

During the Phase IIIA ESA, one soil sample was analyzed for OA2. Table F-1 summarizes the result of the OA2 analysis performed on the soil sample. As indicated in Table F-1, diesel fuel was not detected in the soil sample collected from soil boring Temp Well-2.

One groundwater sample was analyzed for OA2. Table F-2 summarizes the result of the OA2 analysis performed on the groundwater sample. As indicated in Table F-2, diesel fuel was not detected in the groundwater sample collected from Temp Well-2.

PAH Analyses

During the Phase IIIA ESA, one soil sample was analyzed for PAHs. Table F-1 summarizes the result of the PAH analyses performed on the soil sample. As indicated in Table F-1, PAHs were not detected in the sample collected from boring Temp Well-2.

One groundwater sample was analyzed for PAHs. Table F-3 summarizes the result of the PAH analyses performed on the groundwater sample. As indicated in Table F-3, PAHs were not detected in the sample from well Temp Well-2

4.3.4 AOC-12 American Recycling

Phase IIIA ESA assessment activities conducted at this AOC included the following:

- Installation of one temporary monitoring well designated Temp Well-1
- Submission of one soil sample for laboratory analyses including OA1, OA2, and PAHs
- Collection of a groundwater sample from Temp Well-1
- Submission of groundwater samples for laboratory analyses including OA1, OA2, and PAHs

Results of the AOC-12 soil and groundwater sampling efforts are provided in the following sections.

Soil and Groundwater Analytical Results

The following subsections describe the results of laboratory analyses conducted on soil and groundwater samples.

Iowa Method OA1 Analysis – Gasoline and BTEX

During the Phase IIIA ESA, one soil sample was collected from Temp Well-1 and analyzed for OA1. Table F-1 summarizes the result of the OA1 analyses performed on the soil sample. As indicated in Table F-1, THC as gasoline and BTEX parameters were not detected in the sample collected from Temp Well-1.

One groundwater sample was collected from Temp Well-1 and analyzed for OA1. Table F-2 summarizes the result of the OA1 analyses performed on the groundwater sample. As indicated in Table F-2, THC as gasoline and BTEX parameters were not detected in the sample from well Temp Well-1.

Iowa Method OA2 Analysis - Diesel Fuel

During the Phase IIIA ESA, one soil sample was collected from Temp Well-1 and analyzed for OA2. Table F-1 summarizes the result of the OA2 analysis performed on the soil sample. As indicated in Table F-1, diesel fuel was not detected in the sample collected form soil boring Temp Well-1.

One groundwater sample was collected from Temp Well-1 and analyzed for OA2. Table F-2 summarizes the result of the OA2 analysis performed on the groundwater sample. As indicated in Table F-2, diesel fuel was not detected in the groundwater sample collected from Temp Well-2.

PAH Analyses

During the Phase IIIA ESA, one soil sample was collected from Temp Well-1 and analyzed for PAHs. Table F-1 summarizes the results of the PAH analyses performed on the soil sample. As indicated in Table F-1, PAHs were not detected in the sample collected from boring Temp Well-1.

One groundwater sample was analyzed for PAHs. Table F-3 summarizes the results of the PAH analyses performed on the groundwater sample. As indicated in Table F-3, PAHs were not detected in the sample from well Temp Well-1.

4.4 Free-Phase Hydrocarbon Evaluation

4.4.1 Objectives

The objectives of the free-phase hydrocarbon evaluation are to provide estimates of the mobile and total free-phase hydrocarbon volume existing at the Fuel Area and to evaluate the recoverability of the mobile volume. Completion of this effort will support remedial planning decisions for the Site and will allow the selection of an appropriate and cost-effective remedial alternative. Details associated with the field data collection methods, field data, data evaluation methods, and results are presented in Appendix K. The following sections summarize the free-phase hydrocarbon evaluation program.

4.4.2 Field Procedures and Evaluation Methods

Field Procedures

During the Phase IIIA ESA, free-phase hydrocarbons were observed in eight Site wells (i.e., MW-6, MW-10R, MW-11, MW-12, MW-13, MW-17, MW-18, and MW-20). As indicated in Section 2.5, field recoverability tests were conducted as part of the Phase IIIA ESA, and as part of subsequent monthly free-phase hydrocarbon recovery events. Field recoverability tests included free-phase hydrocarbon baildown tests and vacuum-enhanced recovery tests. Fluid level measurements were collected during each mobilization to the Site to evaluate the recovery of free-phase hydrocarbons between recovery testing events as well as to evaluate whether additional free-phase hydrocarbon accumulation had occurred. Additionally, a sample of free-phase hydrocarbons from monitoring well MW-11 was submitted for certain petroleum hydrocarbon characterization analyses. Details related to the procedures used to conduct the baildown tests and the vacuum-enhanced recovery tests are summarized in Section 2.5.

Evaluation Methods

As part of the free-phase hydrocarbon evaluation program, field data (i.e., free-phase hydrocarbon recovery field tests, fluid level gauging, soil boring geology, aquifer testing data) and hydrocarbon characterization laboratory results were utilized in conjunction with applicable hydrocarbon modeling programs to estimate free-phase hydrocarbon volumes and recoverability. Free-phase hydrocarbon volume and recoverability were estimated using the following methods:

- Field Test Data – Free-phase hydrocarbon baildown test results were analyzed in conjunction with certain published values for soil and free-phase hydrocarbon properties

- American Petroleum Institute (API) Model – Industry standard model for evaluating free-phase hydrocarbon volumes and recoverability with model inputs consisting of both Site-specific data and published values for soil and free-phase hydrocarbon properties

Input data for the above evaluation methods, as well as other pertinent Site-specific model input values, are presented in Table 4-1. As part of the free-phase hydrocarbon evaluation, the following parameters were calculated:

- Free-Phase Hydrocarbon Volume using Baildown Test Data

- Free-Phase Hydrocarbon Volume using the API Model and Published Values

- Free-Phase Hydrocarbon Recoverability using Baildown Test Data

- Free-Phase Hydrocarbon Recoverability using the API Model and Published Values

Details related to the calculations of the above parameters are provided in Appendix K.

4.4.3 Free-Phase Hydrocarbon Evaluation Results

Results of the free-phase hydrocarbon volume and recoverability evaluation are presented in Table 4-2. Table 4-2 illustrates the comparatively wide range of estimated total and recoverable free-phase hydrocarbon volumes calculated for the field test data based evaluation (i.e., approximately 190,000 total gallons and 148,000 recoverable gallons) versus the API Model based evaluation (i.e., approximately 64,000 total gallons and 22,000 recoverable gallons).

Four potential hydrocarbon recovery technologies were evaluated as part of this effort. As indicated in Table 4-2, use of the different evaluation data sets (i.e., field test data and API Model data) also results in varying recovery rate estimates for each recovery technology considered.

While free-phase hydrocarbon data collected as part of the Phase IIIA ESA, and subsequent monthly free-phase hydrocarbon recovery events, is useful for comparing potential hydrocarbon recovery options at the Site, the wide range of results obtained from this evaluation illustrate the importance of collecting Site-specific pre-design data (e.g., actual hydrocarbon saturation within the formation) prior to selecting a final remedial option.

Additional details related to the volume and recovery rate estimates are provided in Appendix K. Discussion of potential remedial options for the Site is presented in Section 6.

4.5 AOC-10 Adjacent UPRR Yard

As part of the Phase IIIA ESA, RETEC completed an environmental file review of documents associated with the UPRR Yard located east of the Site. the UPRR Yard was identified in the Phase I ESA as an AOC (AOC-10) based on documented historic releases from a 250,000 gallon diesel fuel AST and associated fueling operations. The following summarizes the review of the IDNR file for this property:

- Free-phase hydrocarbon recovery/gradient control system has been in-place since November 1992.
- Groundwater monitoring has been conducted at the Site since 1993.
- Quarterly groundwater monitoring reports have been submitted to the IDNR through December 2001.
- A Tier 2 Site Closure Report (SCR) was submitted to the IDNR in June 2001 recommending no further action.
- The IDNR approved the UPRR request to decommission the free-phase hydrocarbon recovery system in November 2001.
- The IDNR approved the UPRR request to terminate all groundwater monitoring activities at the property as no exceedances of applicable Iowa standards were noted during the December 2001 groundwater monitoring event.

- Approximately 27,000 gallons of hydrocarbons were recovered during the operational period of the free-phase hydrocarbon recovery system.

Based upon the above information, it is not likely that the adjacent UPRR property is contributing impacts to the Site.

5 Discussion

This section presents a discussion of the Phase IIIA ESA data. This discussion will focus on the following AOC-specific technical issues:

- Magnitude of impacts detected
- Suitability of groundwater monitoring network
- Migration of free-phase hydrocarbons
- Migration of dissolved groundwater impacts
- Natural attenuation assessment

At the conclusion of the AOC-specific discussions, the potentially applicable regulatory framework for the Site will be discussed.

5.1 AOCs 1, 2, and 8 - Former Fuel Storage and Distribution Area (Fuel Area)

5.1.1 Magnitude of Impacts Detected

Magnitude of Soil Exceedances

During the Phase IIIA ESA sampling activities, 15 soil samples were submitted for laboratory analysis. Regulatory exceedances were detected in eight of these samples, including the two duplicate samples. Regulatory exceedances are presented in Table 5-1.

Magnitude of Groundwater Exceedances

During the Phase IIIA ESA, there were sixteen groundwater samples submitted for laboratory analysis. Regulatory exceedances were detected in 11 of these samples, including the two duplicate samples. Regulatory exceedances are presented in Table 5-2.

5.1.2 Suitability of Groundwater Monitoring Network

The monitoring well network within the Fuel Area consists of 15 wells, wells MW-6, MW-10R, MW-11, MW-12, MW-13, MW-17, MW-18, and MW-20 (currently containing free-phase hydrocarbons), MW-21 (crossgradient), and MW-14, MW-15, MW-16, and MW-19 (downgradient). Monitoring wells MW-1 and MW-2 do not contain free-phase hydrocarbons, but are located in areas observed to contain free-phase hydrocarbons. In order to have a well network suitable to monitor the groundwater impacts existing at the Fuel Area, at least one upgradient monitoring well and one cross-gradient monitoring well are needed. Plans are currently being developed to install additional upgradient and cross-gradient monitoring wells.

Because the impacts of interest at these AOCs are related to petroleum hydrocarbons, it is important that monitoring wells be constructed with screens that intersect the water table. Monitoring wells at this location, installed during the Phase IIIA ESA, monitor the water table within their screened intervals, and are effective in evaluating both dissolved phase and free-phase hydrocarbons. Although monitoring wells MW-1, MW-2, and MW-6 appear to be too shallow to accurately evaluate the presence of free-phase hydrocarbons, these wells can be used to illustrate the extent of dissolved phase petroleum impacts within shallow groundwater present in the Fuel Area.

5.1.3 Migration of Free-Phase Hydrocarbons

As described in Section 4, Site data indicate that approximately 190,000 gallons of free-phase hydrocarbons may be present in the subsurface within a discrete area of the Site (i.e., Fuel Area). However, AOC-specific data indicate that the occurrence of free-phase hydrocarbons is limited in its ability to migrate. Evidence to support this conclusion is as follows:

- There are presently no significant sources of diesel fuel within the Fuel Area (e.g., permanent fuel tanks and distribution piping) confirming that the volume of free-phase hydrocarbons in the subsurface cannot increase.

- GC-FID/ECD characterization analyses of free-phase hydrocarbon detected in MW-11 indicate that the material is highly weathered and has been subjected to in-situ degradation processes – this suggests that the free-phase hydrocarbons are associated with an old release.

- The water table has a low hydraulic gradient.

- Downgradient wells MW-14, MW-16, and MW-19 do not contain free-phase hydrocarbons, nor do they exhibit elevated levels of dissolved petroleum hydrocarbons.

- There is only one known subsurface conduit (i.e., water supply to the Yard Office) within the bounds of this AOC. The depth of this conduit is above the water table, limiting the likelihood of significant migration of free-phase hydrocarbons through utility-related preferential pathways. However, this shallow conduit could have acted as a preferential pathway in the past as a result of petroleum releases to the ground surface that may have occurred.

- Due to the nature of the chemicals associated with diesel fuel, the extent of dissolved impacts resulting from this type of release typically closely corresponds to the extent of free-phase hydrocarbons.

Well MW-15 is located approximately 60 feet from the nearest CCPR property boundary. Well MW-15 is located downgradient of the free-phase hydrocarbon plume and upgradient of the Site's western property boundary. Only low-level concentrations of diesel fuel impacts have been detected in groundwater samples collected from MW-15. Therefore, it is unlikely that free-phase hydrocarbons have migrated onto the adjacent property. At least one additional monitoring well along the property boundary just discussed is planned to be installed.

5.1.4 Migration of Dissolved Groundwater Impacts

As indicated in Section 4, several constituents were noted in groundwater samples collected during the Phase IIIA ESA that are indicative of dissolved diesel fuel impacts in groundwater (e.g., fluorene, anthracene, acenaphthene, phenanthrene). As is the case for free-phase hydrocarbons, AOC-specific data indicate that the distribution of dissolved hydrocarbons is limited in its extent. Evidence to support this conclusion is as follows:

- Downgradient wells MW-14, MW-16, and MW-19 do not contain free-phase hydrocarbons, nor do they exhibit elevated levels of dissolved petroleum hydrocarbons.

- There is only one known subsurface conduit (i.e., water supply to the Yard Office) within the bounds of this AOC. However, the depth of this conduit is above the water table, limiting the likelihood of significant migration of free-phase hydrocarbons through utility-related preferential pathways.

- Due to the nature of the chemicals associated with diesel fuel, the extent of dissolved impacts resulting from this type of release typically closely corresponds to the extent of free-phase hydrocarbons.

- Plume of impacts is likely in geochemical stasis - estimated horizontal groundwater flow velocity at the Fuel Area is only 4.6×10^{-4} feet per day and certain Site data suggest that biodegradation is limiting the spread of dissolved impacts at the Site. Section 5.1.5 provides detailed evidence related to in-situ biodegradation processes which are likely ongoing.

Well MW-15 is located approximately 60 feet from the nearest CCPR property boundary. Well MW-15 is located downgradient of the free-phase hydrocarbon plume and upgradient of the Site's western property boundary. Only low-level concentrations of diesel fuel impacts have been detected in groundwater samples collected from MW-15. Therefore, it is unlikely that elevated levels of dissolved impacts have migrated onto the adjacent property.

5.1.5 Natural Attenuation Assessment

During the Phase IIIA ESA, groundwater samples from the Fuel Area were subjected to a number of natural attenuation assessment analyses including nitrate, nitrite/nitrate, sulfate, methane, total Kjeldahl nitrogen, phosphorus, biological oxygen demand (BOD), and TOC. In addition to these laboratory analyses, groundwater samples were subjected to field testing for pH, dissolved oxygen (DO), oxidation-reduction potential (ORP), conductivity, ferrous iron, and temperature. These data have been used to complete a natural attenuation assessment for groundwater. The following sections describe the natural attenuation assessment methods and the associated results.

Assessment Methods

The general approach applied for assessing the capacity for natural attenuation and demonstrating its occurrence in groundwater within the Fuel Area involved the following procedures:

1) The concentrations of dissolved organic constituents were compared to measurements of the following natural attenuation parameters to reveal potential patterns indicative of in-situ biodegradation activity. The significance of each parameter to the evaluation of natural attenuation is briefly described below.

    - DO - DO is a potential electron acceptor for aerobic biodegradation. Microorganisms will preferentially use oxygen as a terminal electron acceptor. When oxygen is not present, or has been consumed, microorganisms may use available alternative electron acceptors in order to metabolize organic compounds through anaerobic biodegradation

    - ORP - ORP values provide a measure of the level of aerobic and anaerobic aquifer conditions. Decreased values in wells within the plume compared to background wells can indicate enhanced microbiological activity

    - Ferrous Iron- Ferric iron is a potential electron acceptor that is reduced to soluble ferrous iron under anaerobic conditions. Increased levels of ferrous iron in wells within the plume compared to background wells are an indication of anaerobic biodegradation via an iron reduction pathway

    - Nitrate/Nitrite - Nitrate is a potential electron acceptor during denitrification. Decreased nitrate and increased nitrite in wells within the plume compared to background wells are an indication of biodegradation via a denitrification pathway

    - Sulfate - Sulfate is a potential electron acceptor that is reduced to sulfide under anaerobic conditions. Decreased levels of sulfate in wells within the plume compared to background wells are an indication of anaerobic microbiological activity

- Methane - Carbon dioxide serves as an electron acceptor during methanogenesis and results in the production of methane. This process generally occurs after depletion of other electron acceptors and is indicative of strongly reducing conditions

- TOC and BOD – The presence of TOC and BOD in groundwater provide an indication of the total amount of dissolved organic material to which subsurface microbial populations are exposed. With respect to TOC, since organic constituents often represent only a fraction of the TOC within the groundwater, measurement of TOC often facilitates the interpretation of electron acceptor and metabolic byproduct data

- Nitrogen/Total Kjeldahl Nitrogen/Phosphorous – These natural attenuation parameters provide an indication of the presence of nutrients in groundwater required for microbial metabolism and the biodegradation of organic substrates. Low nutrient levels may limit microbiological activity and ultimately slow the rates of reduction of groundwater impacts

2) The computer-based BIOSCREEN model developed by Ground Water Services, Inc. and the Air Force Center for Environmental Excellence (BIOSCREEN) was used to evaluate the potential migration of dissolved petroleum hydrocarbons at this AOC. BIOSCREEN is a public-domain model programmed in a Microsoft7 Excel spreadsheet environment and based on the Domenico analytical solute transport model (Domenico, 1987). The model has the ability to simulate constituent attenuation through advection, dispersion, adsorption, and aerobic and anaerobic biodegradation processes. The model can evaluate three different scenarios:

   - Solute transport without decay

   - Solute transport with biodegradation modeled as a first-order process

   - Solute transport with biodegradation modeled as an "instantaneous" reaction dependent on concentrations of available electron acceptors

By comparing these different scenarios with each other and with results of actual groundwater analytical results, the potential significance of biodegradation can be visualized. BIOSCREEN is a tool to evaluate groundwater data and estimate the significance of biodegradation in controlling plume migration. The results of this evaluation can provide strong support to a comprehensive demonstration of biodegradation, and often avoids the need for more extensive groundwater flow and fate/transport modeling.

BIOSCREEN requires chemical- and Site-specific information. Where possible, the input parameters for Site-specific information were obtained from geologic and hydrogeologic data from assessments conducted at the Site. For chemical-specific data, the BIOSCREEN model is primarily based on efforts to evaluate the behavior of groundwater plumes consisting of gasoline range organics by using benzene as a primary constituent. Therefore, to model groundwater impacts within the Fuel Area, where diesel fuel is the petroleum hydrocarbon impacting groundwater, either chemical-specific data representative of a worse case scenario, or chemical-specific data of individual constituents detected at the Site was used in the model (assuming that individual constituents detected within the Fuel Area comprise the majority of the dissolved organic mass in equilibrium with groundwater).

The following sections present the natural attenuation and BIOSCREEN evaluation following the procedures outlined above.

Assessment Results

Data Assessment

The following evaluation includes a description of ORP, ferrous iron, sulfate, and methane data for wells located at the Fuel Area. These natural attenuation parameters are included in the AOC-specific evaluation because they provide a distinct pattern indicative of increased biological activity or are present at a level that either supports or provides evidence of biodegradation. For reference, natural attenuation data is summarized in Table F-4 of Appendix F. Based on available petroleum hydrocarbon data presented in Tables F-2 and F-3, wells where petroleum hydrocarbons have been detected (e.g., MW-11, MW-12, and MW-13) are considered to be present in impacted areas while other wells within the Fuel Area (e.g., upgradient well MW-21 and downgradient wells MW-14, MW-15, MW-16, and MW-19) are considered to be present in non-impacted areas.

- ORP – Decreased ORP values in impacted areas compared to non-impacted areas is not evident. However, the presence of relatively low ORP values provide supporting evidence of microbiological activity

- Sulfate – Sulfate concentrations were generally lower in those wells located within the plume, providing evidence that sulfate is being used as an electron acceptor in support of anaerobic biodegradation. In addition, ORP values and the production of methane (discussed below) correspond well with sulfate reducing conditions

- Methane - Since methane is almost exclusively produced through biogenic processes, its presence in groundwater (38 to 3,000 ug/L) provides a strong indication of naturally occurring microbiological activity. Highly reducing conditions required for methanogenesis to occur are represented by measured ORP values and indicates that groundwater conditions supportive of methanogenesis are present

Other natural attenuation parameters (e.g., DO, ferrous iron, nitrate, and nitrite) do not provide clear or conclusive evidence of biological activity at this time and are not discussed further. In general, detections of nitrogen, phosphorous, BOD, and TOC indicate that nutrients required to support microbiological metabolism are present in groundwater.

BIOSCREEN

Input parameters used for the BIOSCREEN model of benzene and phenanthrene for this AOC are summarized in Tables 5-3 and 5-4, respectively. The source of all input parameters is also presented in Tables 5-3 and 5-4. Relevant assumptions used to model natural attenuation and transport of benzene and phenanthrene in groundwater are presented in Table 5-5. Evaluations for benzene and phenanthrene were conducted because they exhibited exceedances of the applicable Iowa standards.

Figures A-10 and A-11 show the model input screen and output for the evaluation of benzene within the Fuel Area, respectively. Figures A-12 and A-13 show the model input screen and output for the evaluation of phenanthrene within the Fuel Area, respectively. The model results indicate the following:

- Dissolved phase benzene would not migrate beyond a distance of 50 feet downgradient of the source area if biodegradation was not involved in natural attenuation processes. When first order biodegradation kinetics are considered as an attenuating mechanism, results indicate that benzene concentrations do not migrate downgradient of the source area at all.

- Dissolved phase phenanthrene would not migrate beyond a distance of 50 feet downgradient of the source area if biodegradation was not involved in natural attenuation processes. When first order biodegradation kinetics were considered as an attenuating mechanism, results indicate that phenanthrene concentrations do not migrate downgradient of the source area at all.

- When biodegradation is modeled as an instantaneous reaction, results indicate that concentrations do not migrate downgradient of the source area at all for either benzene or phenanthrene. Model predictions also indicate that sulfate reduction would account for 95% of the biodegradation of petroleum hydrocarbons. Although this percentage is based on utilization factors for BTEX compounds (see assumption 8 in Table 5-5), the preliminary evaluation of available natural attenuation data also indicates that groundwater conditions are suitable for sulfate reduction.

- Although there are detections of both benzene and phenanthrene at monitoring wells located downgradient of the source area, predicted concentrations are generally consistent with empirical field measurements when biodegradation is considered as a natural attenuation mechanism. This indicates that petroleum hydrocarbon transport within the Fuel Area is significantly influenced by biodegradation and that the dissolved plume is most likely stable or shrinking.

5.2 AOC-3 Former Roundhouse

5.2.1 Magnitude of Impacts Detected

Magnitude of Soil Exceedances

Soil samples were not collected during the Phase IIIA ESA.

Magnitude of Groundwater Exceedances

During the Phase II ESA, selenium was detected in the groundwater sample collected from MW-3 at a concentration that exceeded the applicable IDNR standard. The groundwater sample collected from MW-3 during the Phase IIIA ESA was analyzed for selenium. Selenium was detected at a concentration of 21.6 ug/L which did not exceed the IDNR standard of 50 ug/L.

5.2.2 Suitability of Groundwater Monitoring Network

The AOC-3 monitoring well network consists of monitoring well MW-3. Based upon the hydraulic characteristics of this AOC, and the associated laboratory analytical data, the existing well network is suitable to monitor groundwater quality at AOC-3.

5.2.3 Migration of Free-Phase Hydrocarbons

Based on the data collected during the Phase IIIA ESA, free-phase hydrocarbons do not exist in MW-3. The migration of free-phase hydrocarbons at AOC-3 is not an issue of concern.

5.2.4 Migration of Dissolved Groundwater Impacts

AOC-specific data indicate that selenium is below the IDNR standard, and therefore, does not exhibit the potential to migrate.

5.3 AOC-11 UPRR Stockpiles

5.3.1 Magnitude of Impacts Detected

Magnitude of Soil Exceedances

During the Phase IIIA ESA, one soil sample was collected. There were no regulatory exceedances noted in soil sample collected from the AOC-11 area.

Magnitude of Groundwater Exceedances

During the Phase IIIA ESA, one groundwater sample was collected. There were no regulatory exceedances noted in groundwater sample collected from the AOC-11 area.

5.3.2 Suitability of Groundwater Monitoring Network

One temporary monitoring well, Temp Well-2, was installed at AOC-11 during the Phase IIIA ESA. The temporary well was placed at the property boundary between UPRR and CCPR. Based upon the hydraulic characteristics of this AOC, and the associated laboratory analytical data, the existing well network is suitable to monitor groundwater quality at AOC-11.

5.3.3 Migration of Free-Phase Hydrocarbons

Based on the data collected during the Phase IIIA ESA, free-phase hydrocarbons do not exist in Temp Well-2. The migration of free-phase hydrocarbons at AOC-11 is not an issue of concern.

5.3.4 Migration of Dissolved Groundwater Impacts

Since no regulatory exceedances were noted in the groundwater sample collected from the AOC-11 area, there is no apparent potential for dissolved groundwater impacts to migrate.

5.4 AOC-12 American Recycling

5.4.1 Magnitude of Impacts Detected

Magnitude of Soil Exceedances

During the Phase IIIA ESA, one soil sample was collected. There were no regulatory exceedances noted in soil sample collected from the AOC-12 area.

Magnitude of Groundwater Exceedances

During the Phase III ESA, one groundwater sample was collected. There were no regulatory exceedances noted in groundwater sample collected from the AOC-12 area.

5.4.2 Suitability of Groundwater Monitoring Network

One temporary monitoring well, Temp Well-1, was installed at AOC-12 during the Phase IIIA ESA. The temporary well was placed at the property boundary between American Recycling and CCPR. Based upon the hydraulic characteristics of this AOC, and the associated laboratory analytical data, the existing well network is suitable to monitor groundwater quality at AOC-12.

5.4.3 Migration of Free-Phase Hydrocarbons

Based on the data collected during the Phase IIIA ESA, free-phase hydrocarbons do not exist in Temp Well-1. The migration of free-phase hydrocarbons at AOC-12 is not an issue of concern.

5.4.4 Migration of Dissolved Groundwater Impacts

Since no regulatory exceedances were noted in the groundwater sample collected from the AOC-12 area, there is no apparent potential for dissolved groundwater impacts to migrate.

5.5 Regulatory Framework

5.5.1 Application of Iowa Regulations

The IAC 135.7(5) requires that free-phase petroleum hydrocarbons measuring 0.01 feet or more be assessed and removed. The Code indicates that free phase hydrocarbons be removed "at a frequency determined by the recharge rate of the product and in a manner than minimizes the spread of contamination into previously uncontaminated zones by using recovery and disposal techniques appropriate to the hydrogeologic conditions at the site and that properly treats, discharges, or disposes of recovery by-products in compliance with applicable local, state, and federal regulations." This regulatory framework was considered during the screening and selection of remedial options for the Site (Section 6).

For impacts to soil and groundwater at the Site, RETEC used applicable regulatory standards promulgated by the IDNR. The SSNGW is the applicable regulatory standards for groundwater and was developed by the ILRP. The SSS is the applicable regulatory standards for soil and was also developed by the ILRP. Because no standard exists for total extractable hydrocarbons in the SSNGW or SSS regulations, LUST Tier 1 values were used to evaluate total extractable hydrocarbons in groundwater and soil analyses. The applicable standards for soil and groundwater are provided in the data tables provided in Appendix F.

6 Conceptual Design

This section presents a remedial options screening and selection process for the Fuel Area (i.e., AOCs 1, 2, and 8) evaluated as part of the Phase IIIA ESA.

For the Fuel Area, remedial options are presented which vary in their relative cost, aggressiveness, and implementability. A set of options is evaluated against a set of preliminary screening criteria. Based upon the results of the preliminary screening task, several options have been retained for a detailed discussion and cost analysis. The CCPR ESIS sheets for the Site have been included as Appendix M.

6.1 Regulatory Framework

As summarized in Section 5.5 of this document, the existence of free-phase hydrocarbons within the Fuel Area results in a conflict with the IAC. Chapter 135.7(a) of the IAC requires the assessment and removal of free-phase hydrocarbons when 0.01 feet or more of free-phase hydrocarbons exist at a monitoring point.

The above regulatory framework, along with CCPR management considerations, have provided the framework for which the conceptual design task has been completed.

6.2 Remedial Option Screening Criteria

The following is a description of the screening criteria applied to the various remedial options.

Option Aggressiveness

This criteria considers how aggressive the technology is in terms of meeting the AOC-specific remedial objectives. A high rating represents the highest ability to meet the remedial objectives.

Relative Coverage of Plume

This criteria considers how much of the free-phase and/or dissolved phase hydrocarbon plumes can be addressed by each technology presented. A high rating represents the best plume coverage.

Relative Control of Plume Migration

This criteria considers the ability of each option to stop or limit the migration of free-phase hydrocarbons and dissolved groundwater impacts to areas that are not currently impacted. A high rating represents a technology which has a high level of control over the migration of free-phase hydrocarbons or impacted groundwater.

Compliance with Regulations

This criteria considers the ability of the option to meet regulatory requirements of the State of Iowa. A high rating indicates compliance with regulations with limited interpretation necessary.

Relative Effectiveness

This criteria considers the ability of the option to meet AOC-specific remedial objectives. A high rating represents the best effectiveness.

Relative Cost

This criteria is related to costs associated with capital investment, operation and maintenance costs, and length of time operation must be maintained. A rating of high represents the most expensive or longest anticipated operating time.

Relative Technical Implementability

This criteria considers each option based on any implementability issues related to the technology itself or interference with CCPR railroad operations. A high rating represents the least amount of implementability issues and the least amount of disruptions to local CCPR railroad operations.

6.3 Basis of Design - Fuel Area

6.3.1 Assumptions

The following assumptions have been considered during the remedial options screening process:

- Free-phase hydrocarbons have been detected in wells MW-6, MW-10R, MW-11, MW-12, MW-13, MW-17, MW-18, and MW-20
- Free-phase hydrocarbons have not been detected in downgradient perimeter monitoring wells
- The volume of recoverable free-phase hydrocarbons in the subsurface is estimated to be approximately 150,000 gallons
- Laboratory testing has revealed that the free-phase hydrocarbon release within the Fuel Area is greater than 10 years old
- The water table is typically between 15 and 20 feet below ground surface.

- Low levels of dissolved hydrocarbons (i.e., not exceeding regulatory standards) exist in downgradient wells (i.e., wells MW-14, MW-15, MW-16, and MW-19)

- Low-level dissolved hydrocarbon impacts (i.e., not exceeding regulatory standards) exist at well MW-15 which is located in close proximity to a downgradient CCPR property line

- BIOSCREEN groundwater contaminant fate and transport modeling has demonstrated that biodegradation processes are on-going in groundwater and have aided in limiting the extent of dissolved groundwater impacts within the Fuel Area

- Because free-phase hydrocarbons exist within the Fuel Area, the remedial option selected to address dissolved groundwater impacts would be implemented only after recoverable hydrocarbons have been substantially removed from the subsurface

- The primary remedial objectives for the Fuel Area are to contain and remove free-phase hydrocarbons from the subsurface and minimize the potential for dissolved hydrocarbons to migrate off of CCPR property

- The remedial options considered for this AOC have been grouped by their associated target media (i.e., free-phase hydrocarbons and dissolved groundwater impacts)

- The estimated costs developed for options which have been retained for detailed discussion are presented as conceptual design level estimates, with an expected accuracy of -30%/+50%

6.3.2 Remedial Action Objectives for the Fuel Area

The remedial action objectives (RAOs) for the Fuel Area are as follows:

- Comply with Iowa regulations, specifically with IAC Chapter 135.7 that discusses requirements for removing free-phase hydrocarbons from the subsurface

- Monitor for petroleum constituents in order to assess potential of free-phase hydrocarbons and dissolved groundwater impacts to migrate off of CCPR property

6.3.3 Specific Technology Descriptions

Because both free-phase and dissolved phase hydrocarbons exist within the Fuel Area, two sets of potentially applicable remedial options are presented below. To meet the RAOs for the Fuel Area, the following remedial options are evaluated to address free-phase hydrocarbons:

- Well-based free-phase hydrocarbon recovery skimming system
- Vacuum-enhanced well-based free-phase hydrocarbon recovery skimming system (Vacuum-enhanced hydrocarbon skimming)
- Vacuum-enhanced free-phase hydrocarbon recovery with bioventing (Bioslurping)
- Dual-pump free-phase hydrocarbon recovery

The following remedial options are evaluated to address dissolved groundwater impacts:

- Monitored natural attenuation
- Enhanced bioremediation
- In-situ chemical oxidation
- Air sparging

Because free-phase hydrocarbons exist at this AOC, the remedial options for addressing dissolved groundwater impacts, with the exception of groundwater monitoring, would only be implemented after recoverable free-phase hydrocarbons have been removed from the subsurface.

The following subsections present the results of the preliminary remedial option screening process. Table 6-1 summarizes the preliminary remedial option screening results for the Fuel Area.

Free-Phase Hydrocarbon Impacts

Remedial Option 1 - Well-Based Free-Phase Hydrocarbon Recovery Skimming System

The well-based free-phase hydrocarbon recovery skimming system (skimming system) consists of pneumatic free-phase hydrocarbon skimming pumps installed in monitoring/recovery wells. Presently there are several wells containing free-phase hydrocarbons. According to recoverability calculations in Section 4.4, 96 additional wells (4-inch diameter) would be installed within the Fuel Area for necessary plume coverage. Pneumatic hydrophobic hydrocarbon recovery pumps would be installed in each well that contained free-phase hydrocarbons. The pumps at each well will pump recovered free-phase hydrocarbons to a central recovered oil tank. Air supply tubing and recovered product tubing would be installed below ground in PVC conduits. The recovered oil tank would be evacuated intermittently with the frequency determined by actual free-phase hydrocarbon recovery rates for the wells. Oil removed from the recovered oil tank would be transported off of the Site for disposal. This option would result in the placement of semi-permanent mechanical systems at the Site, including well pumps, oil transfer and compressed air tubing, and a system control building.

Option Aggressiveness

This option receives a medium-high aggressiveness rating because it is a continuous hydrocarbon collection method.

Relative Coverage of Plume

This option receives a medium-high rating for plume coverage if multiple wells are used. Proper well placement will also affect plume coverage.

Relative Control of Plume Migration

This option receives a medium rating for plume control because it has localized influence on hydrocarbon movement. Effectiveness is dependent on well placement and well density.

Compliance with Regulations

This option receives a high rating for compliance because free-phase hydrocarbons are effectively removed on a continuous basis. Continuous removal will reduce hydrocarbon thicknesses at monitoring points.

Relative Effectiveness

The effectiveness of this option is rated medium-high because it will result in the continuous removal of hydrocarbons which, over time, will reduce the volume of mobile free-phase hydrocarbons.

Relative Cost

The cost rating for this option is high due to high up-front costs associated with installation of additional wells and system installation, and high costs associated with long term operation and maintenance.

Relative Technical Implementability

The implementability rating for this option is medium-low due to the high density of wells needed to achieve effective plume coverage and the interference with railroad operations during installation of the required number of wells.

Screening Results

This option was not retained for detailed evaluation because of its high cost and its medium-low implementability rating (i.e., many wells necessary to achieve plume coverage and interference with local railroad operations during system installation).

Remedial Option 2 – Vacuum-Enhanced Well-Based Free-Phase Hydrocarbon Recovery Skimming System

The vacuum-enhanced well-based free-phase hydrocarbon skimming system (VEHS) consists of pneumatic product skimming pumps installed in monitoring/recovery wells with the introduction of vacuum to enhance the migration of free-phase hydrocarbons to the well. Presently there are several wells containing free-phase hydrocarbons. According to recoverability calculations in Section 4.4, 12 additional wells (4-inch diameter) would be installed within the Fuel Area. Pneumatic hydrophobic hydrocarbon recovery pumps would be installed in each well that contained oil. Each well would also be subjected to a vacuum in order to enhance product movement to the well. The pumps at each well will pump recovered free-phase hydrocarbons to a central recovered oil tank. Vacuum piping, air supply tubing, and recovered product tubing would be installed below ground. The recovered oil tank would be evacuated intermittently with the frequency determined by actual hydrocarbon recovery rates for the wells. Oil removed from the recovered oil tank would be transported off of the Site for disposal. This option would result in the placement of semi-permanent mechanical systems at the Site, including well pumps, vacuum pump, vacuum piping, oil transfer and compressed air tubing, and a system control building.

Option Aggressiveness

This option receives a high aggressiveness rating because it is a continuous hydrocarbon collection method.

Relative Coverage of Plume

This option receives a medium-high rating for plume coverage if multiple wells are used or if the radius of influence from vacuum enhancement is significant. Proper well placement will also affect plume coverage.

Relative Control of Plume Migration

This option receives a medium-high rating for plume control because of the influence on hydrocarbon movement due to the applied vacuum. Effectiveness is limited by well placement, well density, and vacuum radius of influence.

Compliance with Regulations

This option receives a high rating for compliance because free-phase hydrocarbons are effectively removed on a continuous basis. Continuous removal will reduce hydrocarbon thicknesses at monitoring points.

Relative Effectiveness

The effectiveness of this option is rated medium-high because it will result in the continuous removal of hydrocarbons and have significant influence on hydrocarbon migration.

Relative Cost

The cost rating for this option is medium-high due to medium-high up-front costs associated with installation of additional wells and system installation and medium costs associated with long term operation and maintenance.

Relative Technical Implementability

The implementability rating for this option is medium due to associated mechanical systems required, interference with railroad operations during system installation, and the necessary operation and maintenance activities.

Screening Results

This option is retained for detailed discussion due to its medium-high rating for the control of plume migration criteria.

Remedial Option 3 – Vacuum-Enhanced Free-Phase Hydrocarbon Recovery with Bioventing (Bioslurping)

Vacuum-enhanced free-phase hydrocarbon recovery with bioventing (bioslurping) involves applying a high vacuum to the recovery well to enhance the effective gradient to the well and thus increase the yield for the well. Presently there are several wells containing free-phase hydrocarbons. According to recoverability calculations in Section 4.4, 12 additional wells (2-inch diameter) would be installed within the Fuel Area. Both water and free-phase hydrocarbons are recovered in the process (via a stinger pipe). Recovered liquid is transferred through underground piping to a central collection area for oil/water separation. Recovered oil is stored in a holding tank and periodically emptied depending on free-phase hydrocarbon recovery rates. Recovered water must be treated to a hydrocarbon concentration acceptable for discharge to the local municipality's sanitary sewer system. Equipment required to implement bioslurping include a vacuum pump, fluids removal and oil/water separation system, controls, and control building.

Option Aggressiveness

This option receives a high aggressiveness rating because it is a continuous hydrocarbon collection method.

Relative Coverage of Plume

This option receives a high rating for plume coverage if multiple wells are used or if the radius of influence from vacuum enhancement is significant. Proper well placement will also affect plume coverage.

Relative Control of Plume Migration

This option receives a medium-high rating for plume control because of the influence on hydrocarbon movement due to the applied vacuum. Effectiveness is limited by well placement, well density, and vacuum radius of influence.

Compliance with Regulations

This option receives a high rating for compliance because free-phase hydrocarbons are effectively removed on a continuous basis. Continuous removal will quickly reduce hydrocarbon thicknesses at monitoring points.

Relative Effectiveness

The effectiveness of this option is rated high because it will result in the continuous removal of hydrocarbons and have significant influence on hydrocarbon migration.

Relative Cost

The cost rating for this option is medium-high due to medium-high up-front costs associated with installation of additional wells and system installation, and medium costs associated with long term operation and maintenance.

Relative Technical Implementability

The implementability rating for this option is medium-high because of this recovery techniques effectiveness in removing free-phase hydrocarbons from varying stratigraphy (i.e., silt, sand and clay stringers). This recovery technique calls for mechanical systems and interference with railroad operations during system installation.

Screening Results

This option is retained for detailed discussion due to its many high and medium-high ratings for the applied screening criteria.

Remedial Option 4 – Dual-Pump Free-Phase Hydrocarbon Recovery

Dual-pump free-phase hydrocarbon recovery (dual-pump recovery) consists of a water pump installed with the intake near the bottom of a well, combined with a free-phase hydrocarbon skimmer placed just below the oil/water interface. An additional 19 larger diameter wells would be installed to support this option. Water is withdrawn at a controlled rate to depress the potentiometric surface near the recovery well. Controls and sensors are required to control the free-phase hydrocarbon and groundwater recovery pumps as free-phase hydrocarbon and water accumulate in the well and are subsequently removed. Recovered liquid is transferred through underground piping to a central collection area for water treatment and free-phase hydrocarbon storage. Recovered oil is stored in a holding tank and periodically emptied depending on free-phase hydrocarbon recovery rates. Recovered water must be treated to a hydrocarbon concentration acceptable for discharge to the local municipality's sanitary sewer system. Equipment required to implement dual pump recovery include down-well pumps and controls, water treatment system, controls, and control building.

Option Aggressiveness

This option receives a high aggressiveness rating because it is a continuous hydrocarbon collection method.

Relative Coverage of Plume

This option receives a medium-high rating for plume coverage if multiple wells are used or if the radius of influence is sufficient to capture the plume. Proper well placement will also affect plume coverage.

Relative Control of Plume Migration

This option receives a medium-high rating for plume control because of the influence on hydrocarbon movement due to the depressed water table. Effectiveness is limited by well placement, well density, and hydraulic radius of influence.

Compliance with Regulations

This option receives a high rating for compliance because free-phase hydrocarbons are effectively removed on a continuous basis. Continuous removal will quickly reduce hydrocarbon thicknesses at monitoring points.

Relative Effectiveness

The effectiveness of this option is rated medium-low due to potential ineffectiveness in removing free-phase hydrocarbons from varying stratigraphy (i.e., sand and clay stringers) found at the Site.

Relative Cost

The cost rating for this option is medium-high due to medium-high up-front costs associated with installation of additional wells and system installation, and medium costs associated with long term operation and maintenance.

Relative Technical Implementability

The implementability rating for this option is medium due to associated complex pump control system and other mechanical systems required, and medium-low effectiveness at Sites with varying stratigraphy.

Screening Results

This option is not retained due to medium-low and medium ratings for effectiveness and implementability, respectively.

Dissolved Groundwater Impacts

Remedial Option 5 - Monitored Natural Attenuation

Natural attenuation is the cumulative result of a variety of physical, chemical and biological processes that affect the transport and fate of chemicals in the environment. These processes include sorption, dissolution, volatilization, physical/chemical decomposition, and biodegradation. The biological component of natural attenuation is typically the most important mechanism of natural attenuation since it can result in the actual destruction and removal of the chemicals from the environment. It is therefore especially effective in limiting the migration of dissolved contaminant plumes. As indicated in Section 5, biodegradation processes have been demonstrated to be occurring within the Fuel Area.

To implement a formal monitored natural attenuation (MNA) remedy for dissolved hydrocarbon impacts, a routine groundwater sampling and reporting program would be implemented at the Site. It is anticipated that the existing monitoring well network, and an additional two monitoring wells, would be sampled on a quarterly basis for a set of natural attenuation parameters. It is estimated that the sampling program would continue for two years. After the two-year monitoring period, a comprehensive MNA report would be prepared to document in-situ natural attenuation processes.

Option Aggressiveness

This option is rated as low in aggressiveness because the primary remedial component of the option is groundwater sampling and data evaluation.

Relative Coverage of Plume

Plume coverage criteria is rated as high because natural attenuation processes affect the entire area of impacted groundwater.

Relative Control of Plume Migration

The control criteria is rated medium-high because natural attenuation processes affect the entire area of impacted groundwater, however, the plume is affected at a level commensurate with in-situ conditions within the Fuel Area.

Compliance with Regulations

This criteria is rated as medium-high because in-situ biodegradation processes are limiting the spread of impacts at the Fuel Area.

Relative Effectiveness

This criteria is rated as medium-high because in-situ biodegradation processes are limiting the spread of impacts at the AOC. The rate of the degradation of chemicals of interest is controlled by in-situ conditions.

Relative Cost

Relative cost is rated low because this option requires no mechanical systems and only intermittent groundwater sampling activities are required.

Relative Technical Implementability

This criteria is rated high because no mechanical systems are needed and only intermittent groundwater sampling activities are required.

Screening Results

This option was retained for detailed discussion due to its medium-high effectiveness rating, high implementability rating, and its low cost rating.

Remedial Option 6 - Enhanced Bioremediation

This option consists of accelerating the natural attenuation of dissolved hydrocarbons by enriching the in-situ environment such that the biodegradation rates of the contaminants of interest increase. Biodegradation rates can be accelerated through the addition of oxygen, nutrients, electron acceptors, or degrading microorganisms. During enhanced natural attenuation, the amendments are injected directly into the source zone and in the upgradient portion of the plume. Microorganisms in the vicinity of, and downgradient of, the injection site utilize the amendments to reduce or oxidize hydrocarbons to innocuous end products.

Bioremediation of diesel fuel constituents, such as those found at the Fuel Area, is most readily accomplished through the addition of oxygen. For this option, oxygen will be added to the subsurface through the addition of oxygen releasing compounds to the subsurface environment. Oxygen releasing compounds would be placed in the subsurface in a slurry-form via a set of push-probe injection points.

A single application of oxygen enhancing material is planned. However, if groundwater concentrations of chemicals of interest warrant further treatment, supplemental oxygen releasing compounds can be easily applied to the area. A groundwater monitoring program similar to Option 5 would be implemented to document effectiveness of this option.

Option Aggressiveness

This option is rated medium-high due to the addition of oxygen enhancing compounds to the groundwater environment already affected by natural attenuation processes.

Relative Coverage of Plume

This option is rated high for coverage of plume because oxygen amendment can positively affect much of the plume if application is appropriate.

Relative Control of Plume Migration

Plume migration control is rated high because oxygen enhancement will positively affect groundwater already being affected by natural attenuation processes.

Compliance with Regulations

This option rates high for compliance with regulations because the Site would be undergoing active remediation and oxygen enhancement will aid ongoing biodegradation processes.

Relative Effectiveness

This option rates high as oxygen enhancement will aid ongoing in-situ biodegradation processes already taking place at the Site.

Relative Cost

This option rates high due to costs associated with the large volume of oxygen releasing compounds required. Increased costs would be experienced if more then one application of oxygen releasing compounds is needed.

Relative Technical Implementability

This option rates high for implementability due to lack of on-site mechanical systems and negligible interference with local railroad operations.

Screening Results

This option is retained for detailed discussion due to its high effectiveness.

Remedial Option 7 – In-Situ Chemical Oxidation

In-situ chemical oxidation (ISCO) is a technology whereby oxidants and other amendments are injected directly into the subsurface to chemically oxidize constituents of interest. ISCO has been found effective in reducing the concentration of petroleum-related compounds. Several new wells would be required as a means to deliver oxidizing material.

Option Aggressiveness

This option is rated high because the process is continuous in nature. Semi-permanent mechanical systems would be required to store and distribute chemicals to be injected to subsurface.

Relative Coverage of Plume

This option is rated high due to continuous introduction of oxidizer into subsurface.

Relative Control of Plume Migration

This option is rated high due to continuous introduction of oxidizer into subsurface.

Compliance with Regulations

This option is rated high for compliance with regulations due to its positive affect on an environment already subjected to natural attenuation processes.

Relative Effectiveness

Effectiveness is rated high as technology is proven to aid in destruction of dissolved hydrocarbon plumes.

Relative Cost

Relative cost is rated high due to semi-permanent on-site mechanical systems, and associated operation and maintenance costs, required for implementation.

Relative Technical Implementability

This option is rated as medium due to the presence of mechanical systems which will require upkeep.

Screening Results

This option was not retained due to high relative cost.

Remedial Option 8 - Air Sparging

This option consists of injecting air or air enriched with oxygen below the water table. Air sparging is generally used to target dissolved volatile compounds. A secondary effect of air sparging is the introduction of oxygen into the groundwater which can increase the microbial degradation rates of constituents of interest.

Option Aggressiveness

This option is rated high because the process is continuous in nature.

Relative Coverage of Plume

This option is rated high due to continuous introduction of oxygen into subsurface. If sparge well placement is correct, the entire plume will be affected.

Relative Control of Plume Migration

This option is rated high due to continuous introduction of oxygen into subsurface.

Compliance with Regulations

This option is rated high for compliance with regulations due to its high aggressiveness rating.

Relative Effectiveness

Effectiveness is rated high as technology is proven to aid in the degradation of dissolved hydrocarbon plumes.

Relative Cost

Relative cost is rated high due to semi-permanent on-site mechanical systems required for implementation.

Relative Technical Implementability

Implementability is rated medium due to need for mechanical systems and the associated operation and maintenance issues.

Screening Results

This option was not retained for detailed discussion due to its relatively high cost.

6.3.4 Detailed Analyses of Remedial Options

This section presents a detailed discussion of the remedial options retained during the preliminary screening process. A total of four remedial options have been retained for discussion. The two options selected to potentially address the free-phase hydrocarbon impacts at this AOC are as follows:

- Vacuum-enhanced well-based free-phase hydrocarbon recovery skimming system (Vacuum-enhanced hydrocarbon skimming)

- Vacuum-enhanced free-phase hydrocarbon recovery with bioventing (Bioslurping)

The two remedial options selected to address the dissolved groundwater impacts at this AOC are as follows:

- Monitored natural attenuation
- Enhanced bioremediation

Appendix N contains detailed cost tables associated with remedial options retained for detailed analyses.

Remedial Option 2 - Vacuum-Enhanced Well-Based Free-Phase Hydrocarbon Recovery Skimming System (Vacuum-Enhanced Hydrocarbon Skimming)

VEHS is a technique that simultaneously removes hydrocarbons and enhances the natural biodegradation of hydrocarbons in the vadose zone. The technique employs two remediation techniques: hydrocarbon-only, pneumatic skimming pumps and soil vapor extraction. Hydrocarbons are recovered by installing pneumatic hydrocarbon-only skimming pumps in recovery wells, while hydrocarbon movement to the recovery wells is enhanced by an applied vacuum. In addition, biodegradation within impacted soils is enhanced by the air drawn through the vadose zone from the applied vacuum. A pilot-scale demonstration of the remedial option would be conducted.

System Components

The VEHS system will consist of 14, 4-inch diameter recovery wells, and seven existing 2-inch diameter wells. The radius of influence for each well will be determined through pilot testing on the existing wells in the area. The exact number of recovery wells will be based on the radius of influence determined during the pilot test.

The proposed well and piping layout are shown on Figure A-14. The vacuum line connection is installed below ground and is not exposed. Air supply and recovered hydrocarbon tubing are connected to the pump and enter the well through the wellhead. All piping and tubing conduits will be installed in trenches below the frost line. Where necessary, vacuum piping and tubing conduits may pass beneath railroad tracks. If feasible, one carrier pipe may be installed to carry multiple vacuum pipes and tubing conduits beneath the railroad tracks. Heat-trace may be required for short portions of the tubing that are located above the frost line (i.e., at the wellhead and at the recovered oil tank).

Recovered hydrocarbons are transferred back to a control building where a 500-gallon recovered hydrocarbon tank is located nearby. The control building will house the vacuum pump(s), air compressor(s), pneumatic pump controls, and other processing equipment. Air treatment equipment may also be required based on the emissions concentration. Based on experience with VEHS systems used for diesel fuel recovery, air from the system will likely not need treatment prior to discharge. Confirmatory air samples will be collected during the pilot study.

Capital, O&M, and NPV Costs

This option has medium capital costs including pneumatic pumps and controls, recovery well installation, trenching, vacuum pump(s), air compressors, and control building. A breakdown of the capital costs associated with this option is provided in Table N-1.

The O&M costs include electric supply; periodic system inspections; equipment maintenance, repair, and replacement; and recovered fluids management. Typical inspection frequency for a VEHS system is monthly. A breakdown of the O&M costs associated with this option is provided in Table N-1.

The NPV is estimated assuming this option will require 20 years of operation. A summary of the NPV estimate is provided in Table N-1.

Advantages and Disadvantages

The advantages of the VEHS system are its relatively-high level of aggressiveness and medium-high level of effectiveness. Hydrocarbon collection rates are many times greater with a VEHS system than those obtained using passive systems. In addition, the recovery wells have relatively large radii of influence due to the applied vacuum. The VEHS system can accommodate expansion if more vacuum pump capacity than originally installed is required.

Disadvantages of the VEHS system are its medium O&M costs, high-maintenance pneumatic pumps, and interruption of railroad operations during installation.

Regulatory Approvals

Since the volume of hydrocarbons in the subsurface is relatively large, an aggressive recovery technique such as described above should gain approval from the IDNR. Based on experience with VEHS systems used for recovering diesel fuel, air emissions levels will likely be below thresholds requiring permitting and emission controls. However, air samples will be collected and analyzed as part of a pilot study.

Remedial Option 3 – Vacuum-Enhanced Free-Phase Hydrocarbon Recovery with Bioventing (Bioslurping)

Bioslurping is a technique that simultaneously removes free-phase hydrocarbons and water and enhances the natural biodegradation of hydrocarbons in the vadose zone. The technique employs two remediation techniques: hydrocarbon and water removal via applied vacuum and soil vapor extraction. Free-phase hydrocarbons and water are recovered by applying vacuum to vertical recovery wells. In addition, biodegradation within impacted soils is enhanced by the air drawn through the vadose zone from the applied vacuum. A pilot-scale demonstration of the remedial option would be conducted.

System Components

The bioslurping system will consist of 19, 2-inch diameter recovery wells, seven of which will be modified existing monitoring wells. The radius of influence for each well will be determined through pilot testing on the existing wells in the area. The exact number of recovery wells will be based on the radius of influence determined during the pilot test.

The well and piping layout are shown on Figure A-15. The vacuum line connection is installed below ground and is not exposed. A stinger pipe will extend down to the free-phase hydrocarbon layer for optimal recovery. The applied vacuum will be directed down the stinger pipe, and recovered liquids will travel up through the stinger pipe to the vacuum line. All vacuum line conduits will be installed in trenches below the frost line. Where necessary, vacuum lines may pass beneath railroad tracks. If feasible, one carrier pipe may be installed to carry multiple vacuum lines beneath the railroad tracks.

Recovered liquids are transferred back to a control building where liquids will enter a air-liquid separation tank. Liquids will be pumped to an oil/water separator for separation. Free-phase hydrocarbons will be transferred to a 500-gallon recovered hydrocarbons tank located nearby. Treated water will be discharged to the municipal sanitary sewer system. The control building will house the vacuum pump, oil/water separator, controls, and other processing equipment. Air treatment equipment may also be required based on the emissions concentration. Based on experience with bioslurping systems used for diesel fuel recovery, air from the system will likely not need treatment prior to discharge. Confirmatory air samples will be collected during the pilot study.

Capital, O&M, and NPV Costs

This option has medium capital costs including controls, recovery well installation, trenching, vacuum pump, telemetry, control building, and water treatment equipment. A breakdown of the capital costs associated with this option is provided in Table N-3.

The O&M costs include electric supply; periodic system inspections; equipment maintenance, repair, and replacement; and recovered fluids management. Typical inspection frequency for a bioslurping system is monthly. Telemetry equipment will be installed to monitor system performance and operation. A breakdown of the O&M costs associated with this option is provided in Table N-3.

The NPV is estimated assuming this option will require seven years of operation. A summary of the NPV estimate is provided in Table N-4.

Advantages and Disadvantages

The advantages of the bioslurping system are its relatively-high level of aggressiveness and high level of effectiveness. Hydrocarbon collection rates are many times greater with a bioslurping system than those obtained with passive systems. In addition, the recovery wells have relatively large radii of influence due to the applied vacuum. Given the appropriate placement of recovery wells, plume coverage should be good. The bioslurping system can accommodate expansion if more plume coverage than originally planned is required. Low-level maintenance requirements of down-well equipment is an advantage.

Disadvantages of the bioslurping system are its medium-high O&M cost, water treatment and discharge requirements, and interruption of railroad operations during installation.

Regulatory Approvals

Since the volume of hydrocarbons in the subsurface is relatively large, an aggressive recovery technique like bioslurping should gain approval from the IDNR. Water discharge limits (i.e., water discharge concentrations and volume) set by the city of Council Bluffs will determine the size and complexity of the water treatment system. Based on experience with bioslurping systems used for recovering diesel fuel, air emissions levels will likely be below thresholds requiring permitting and emission controls. However, air samples will be collected and analyzed as part of a pilot study.

Remedial Option 5 - Monitored Natural Attenuation

The MNA option would be initiated after free-phase hydrocarbon recovery efforts are substantially completed. Natural attenuation is the cumulative result of a variety of physical, chemical and biological processes that affect the transport and fate of chemicals in the environment. These processes include sorption, dissolution, volatilization, physical/chemical decomposition, and biodegradation. The biological component of natural attenuation is typically the most important mechanism of natural attenuation since it can result in the actual destruction and removal of the chemicals from the environment. It is therefore especially effective in limiting the migration of dissolved contaminant plumes. As indicated in Section 5, biodegradation processes have been demonstrated to be occurring at the Fuel Area.

To implement a formal MNA remedy for dissolved hydrocarbon impacts, a routine groundwater sampling and reporting program would be implemented at the Site. The reporting program would follow applicable IDNR guidance. It is anticipated that the existing monitoring well network, and an additional two monitoring wells, would be sampled on a quarterly basis for a set of natural attenuation parameters. Figure A-16 shows the locations of monitoring wells to be used for this option. It is estimated that the sampling program would continue for two years. After the two-year monitoring period, a comprehensive MNA report would be prepared to document in-situ natural attenuation processes.

System Components

System components would consist of the existing monitoring well network plus the additional monitoring wells listed above. No mechanical systems are required for this option.

To document the effectiveness of natural attenuation, groundwater will be sampled for laboratory analyses and field parameter measurements. Required laboratory analysis include:

- OA-1
- OA-2
- BTEX

- PAHs
- Methane
- Sulfate
- Nitrite/Nitrate
- COD
- BOD
- Nutrients
- TOC

Typically, the following field parameters are measured to aid in tracking natural attenuation effectiveness:

- Dissolved oxygen
- Dissolved ferrous iron
- Oxidation/reduction potential

Groundwater monitoring activities will be conducted on a quarterly basis for two years so that trends in site hydraulics and the concentrations of the parameters of interest can be established.

Capital, O&M, and NPV Costs

Capital costs include the installation of three additional monitoring wells. A breakdown of the capital costs associated with this option is provided in Table N-5.

O&M costs include quarterly groundwater monitoring for two years and two years of annual groundwater monitoring thereafter. A breakdown of the O&M costs associated with this option is provided in Table N-5

The NPV is estimated assuming the option will require two years to demonstrate on-going natural attenuation in a comprehensive manner. A summary of the NPV estimate is provided in Table N-6

Advantages and Disadvantages

Advantages include the low level of O&M effort and low overall costs required for this option. In addition, interruption of railroad operations will be minimal and will be limited to a short duration during installation of the monitoring wells.

The primary disadvantage associated with this option includes no hydraulic containment of the dissolved hydrocarbon plume.

Regulatory Approval

Natural attenuation, including biodegradation, is commonly approved for sites considered low risk by the IDNR. There are no air or water discharges which would require regulatory approval.

Remedial Option 6 - Enhanced Bioremediation

This remediation technique consists of accelerating the natural biodegradation of dissolved hydrocarbons by enriching the in-situ environment with the addition of oxygen, nutrients, electron acceptors, or degrading microorganisms. The addition of oxygen is the most common amendment used to enhance natural biodegradation. These amendments are typically injected directly into the subsurface environment using a push-probe type rig. Effectiveness is tracked by measuring dissolved hydrocarbon concentrations in groundwater over time, in addition to the dissolved oxygen concentrations in groundwater.

System Components

Oxygen Release Compound (ORC) is a formulation of magnesium peroxide that releases oxygen slowly when hydrated. The ORC would be installed using a push-probe rig during a single event. Additional installations may be necessary based on the effectiveness of the ORC as evaluated during the groundwater monitoring activities. Groundwater monitoring activities and frequency will be identical to those outlined in the Natural Attenuation option above. Figure A-17 shows the anticipated ORC injection area and locations of those wells to be sampled for monitoring the effectiveness of this option. No mechanical components are required for this option. No additional monitoring wells would be required to adequately track effectiveness of the enhanced biodegradation.

Capital, O&M, and NPV Costs

Capital costs include purchase of the ORC and installation of the ORC with the push-probe rig. A breakdown of the capital costs associated with this option is provided in Table N-7.

O&M costs include groundwater monitoring to track the effectiveness of the enhanced biodegradation. A breakdown of the O&M costs associated with this option is provided in Table N-7.

The net present value (NPV) is estimated assuming the cleanup will require two years. A summary of the NPV estimate is provided in Table N-8

Advantages and Disadvantages

Advantages include the low level of O&M effort required for this option. In addition, the natural biodegradation already taking place at the Site will be enhanced. Interruption of railroad operations will be minimal and will be limited to a short duration during installation of the ORC.

Disadvantages include no hydraulic containment of the dissolved plume and the relativly high cost of the oxygen releasing compound.

Regulatory Approval

Natural attenuation, including enhanced biodegradation, is commonly approved for sites considered low risk by the IDNR. There are no air or water discharges associated with this option that would require regulatory approval.

Recommendations

Table 6-2 summarizes selected information related to each of the remedial options discussed for the Fuel Area. Based on the options presented for detailed discussion, RETEC recommends implementing the Bioslurping system (Option 3) because of its high effectiveness. At a point when hydrocarbon recovery is substantially completed, RETEC recommends that monitored natural attenuation (MNA) be employed (Option 5) to remediate the dissolved groundwater impacts. The combination of these two options will be effective in meeting the RAOs for Fuel Area.

6.4 AOC-3 – Former Roundhouse

Because no regulatory exceedances were identified during the Phase IIIA ESA in groundwater samples collected from monitoring well MW-3 located at AOC-3, RETEC recommends that no further activities be conducted. RETEC also recommends retaining MW-3 to be used as a downgradient monitoring point for the Fuel Area.

6.5 AOC-11 - UPRR Stockpiles

Because no regulatory exceedances were identified during the Phase IIIA ESA in soil or groundwater samples collected from temporary monitoring well Temp Well-2 at AOC-11, RETEC recommends that no further activities be conducted.

6.6 AOC-12 - American Recycling

Because no regulatory exceedances were identified during the Phase IIIA ESA in soil or groundwater samples collected from temporary monitoring well Temp Well-1 at AOC-12, RETEC recommends that no further activities be conducted.

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