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Summary Remedial Investigation Report Union Pacific Railroad Company Eugene Railyard

July 2005

Prepared for

Union Pacific Railroad Company
221 Hodgeman
Laramie, Wyoming 82072

K/J Project No. 022777.08

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Section 1: Introduction

On behalf of the Union Pacific Railroad Company (Union Pacific), Kennedy/Jenks Consultants (Kennedy/Jenks) is submitting this *Summary Remedial Investigation (Summary RI) report* summarizing several field investigations at the Eugene Railyard (Yard). The Summary RI presents data collected at the Yard from 1993 to present and includes data collected during a Preliminary Groundwater Assessment, the Phase I, Phase II, Phase III, and Phase IV remedial investigations (RI). The Summary RI describes operational history at the Yard, operable units investigated, and the nature and extent of impacted soil, groundwater, and soil gas at the Yard and surrounding neighborhoods based on data collected during these investigations. Sample collection methods, quality assurance/quality control (QA/QC) sampling protocol, laboratory analytical data sheets, findings, and recommendations for additional work are detailed in each of the four RI phases and are referenced in this Summary RI, but are not presented in this document.

1.1 Summary RI Objectives

Several investigations at the Yard have been conducted by various Union Pacific contractors since 1993. The objectives of this document include the following:

- Consolidate the data collected throughout the various investigations into one comprehensive document
- Present description of the previous investigations conducted at the Yard, including summary data tables and figures showing historical operation areas and sample locations
- Present an understanding of nature and extent of soil and groundwater impacts at the Yard
- Presents an understanding of offsite migration of impacted groundwater into the River Road and Trainsong neighborhoods.

Section 2.3 describes previous investigations conducted at the Yard.

1.2 Document Organization

The summary RI presents an Introduction (Section 1), Operational History and Background (Section 2), Site Setting (Section 3), Nature and Extent of Contamination (Section 4), Fate and Transport (Section 5), Risk Assessment (Section 6), Summary (Section 7), and References (Section 8). Summary data tables and figures are presented at the end of Section 8 in separately tabbed sections.

Section 2: Operational History and Background

2.1 Yard Operable Units

The Yard is in located Lane County, Oregon, in the city of Eugene (City) (Figure 1). The legal address of the Yard is 341 Bethel Drive, which is located in Township 17 South, Range 4 West, Sections 10, 15, 23, 25, and 26 of the Willamette Basin and Meridian System. Land use in the area is mixed industrial, commercial, and residential. Residential areas exist adjacent to the Yard, both on the northeast (River Road neighborhood) and the southwest (Trainsong neighborhood). Numerous commercial enterprises are also located near the Yard.

Currently, industrial activities and operations conducted by Union Pacific at the Yard are limited to railcar switching and remote fueling of locomotives. Central Oregon and Pacific Railroad currently leases and operates the diesel shop. Historical operations at the Yard were more extensive and included locomotive maintenance and fueling, railcar repair, and wood treatment. In addition, the site had a wastewater treatment and disposal system, which is no longer active.

The Yard is a long narrow property that has had a wide variety of historical and current operations conducted at different locations within the Yard. To simplify operations and site investigations conducted, the Yard has been divided into five geographical operable units based on the general type of railroad operations performed in each area. The five geographic areas, as shown on Figure 2, include:

- The Blair Street Yard (BSY)
- The North Departure Yard (NDY)
- The Central Industrial Area (CIA)
- The Classification Yard (CY)
- The South Departure Yard (SDY)

In the early 1870s, the Oregon and California Railroad Company (O&CRCo) acquired a small portion of the land currently occupied by the Yard. Additional land was purchased in 1925 and 1926 by the O&CRCo. Southern Pacific Transportation Company (SPTCo) acquired the Yard in 1927 through the purchase of the O&CRCo. SPTCo was acquired by Union Pacific in 1996. Yard operations are maintained by Union Pacific with the exception of the diesel shop, which is operated by the Central Oregon and Pacific Railroad under a lease agreement with Union Pacific.

The historical activities within each operable unit are detailed in *Phase I Remedial Investigation Proposal* (IC 1994a) and *Remedial Investigation/Feasibility Study Workplan* (IC 1994b). Because industrial activities have been conducted primarily within the CIA, most of the RI activities have focused on this area. The following is a description of the geographic location of each operable unit and their operational history.

2.1.1 Blair Street Yard

The BSY is the southernmost area of the Yard. It is a triangular parcel bounded by businesses facing 1st Street to the southwest, River Road to the northeast, and the Chambers Street overpass to the northwest. Figure 3 shows the configuration of the BSY. The BSY historically was used for timber storage and milling, and as a livestock holding area. Petroleum-impacted soil generated from derailment sites, underground storage tank (UST) removals, and the service track lead cleanup activities have been stockpiled in the BSY.

2.1.2 North Departure Yard

The southern edge of the NDY begins at the narrow mid-point of the Yard at the north end of the CY and SDY, and extends northward along the Northwest Expressway to Irving Road. Trains are staged in the NDY prior to departure from the Yard. No industrial operations have been performed in the NDY. Figure 4 shows the configuration of the NDY.

The former borrow pit, also referred to as Maxwell Pond, is located on the west side of the NDY on the south side of the Maxwell road overcrossing (Figure 2). The borrow pit was utilized as a source for aggregate materials from 1936 to at least 1950 and was used as a waste management unit from 1963 to at least 1972.

According to a preliminary assessment (PA) conducted by the Oregon Department of Environmental Quality (DEQ), wastes generated from cleaning old boxcars were dumped into the Borrow Pit from 1945 to 1975. The pit was reported to have collected refuse such as sugar, grain, soybean meal, and broken plasterboard. DEQ also reported that from the early 1980s to 1983, general refuse disposal was allowed in the borrow pit, and that no dumping within the pit has occurred since that time. Railroad ties were observed on the north and east boundaries of the pit as recently as December 2003.

2.1.3 Central Industrial Area

The CIA is bordered by the Chambers Street overpass to the south, the SDY to the east, the CY to the north, and Bethel Drive to the west. The CIA historically has been the center of locomotive and railcar service and maintenance operations in the Yard. Figure 5 shows the layout of the CIA and surrounding areas. The CIA was subdivided into the following areas based on site operations:

- Locomotive maintenance and fueling facility
- The railcar repair shed
- The wood treatment facility
- Wastewater treatment facilities
- The diesel shop
- Roundhouse

- One Spot
- Auto and work equipment (A&WE) shop

A significant number of the structures, including the roundhouse and turntable, the car repair shed, the locomotive fueling facility, the wood treatment facility, and the oil/water separator, were constructed by SPTCo in the late 1920s and early 1930s. The wastewater impoundments were constructed in 1941 and modified several times during their use. Additional locomotive fueling facilities were constructed in the late 1950s during the conversion from oil-fired to diesel-fueled locomotives. The holding ponds and associated equipment that handled wastewater from the locomotive wash and the A&WE shop were constructed in 1958. The wood treatment facility and the car repair shed were retired or converted to different uses in 1962 and 1963. A car repair shop, which replaced the car repair shed, was constructed in 1963 north of the roundhouse.

The operation of each facility within the CIA is discussed in the following sections.

<u>Locomotive Maintenance and Fueling Facility</u>

The roundhouse and turntable were constructed in 1927. A machine shop (diesel shop) was constructed in 1928 adjacent to the roundhouse on the south side. These facilities were used for locomotive maintenance and operations. Other structures located within this area associated with locomotive maintenance and operations included a locomotive inspection pit immediately north of the turntable.

The steam locomotive fueling facility was constructed in 1927 north of the turntable (Figure 5). Bunker C fuel oil was supplied to the facility by rail tankers, which emptied into concrete track unloading sumps located west of the primary oil/water separator. The oil flowed to a concrete oil sump and was then pumped through a pump house to a 55,000-barrel above ground storage tank (AST). The unloading sumps, primary oil/water separator, and pump house were located to the northwest of the turntable area. The 55,000-barrel AST was located northwest of the former wastewater impoundment ponds. Locomotive fueling was performed on the tracks that lead to the turntable from the north.

Other structures associated with the fueling facility included a 55-gallon drum Bunker C storage area, oil and water columns, engine pit, and inspection pit (located north of the turntable area). By 1962, the Bunker C fuel oil tank and 55-gallon drum storage area were removed and the oil unloading and Bunker C fueling facilities were retired.

<u>Railcar Maintenance</u>

The car repair shed and support structures were constructed in 1927 and 1928 east of the roundhouse. Railcar maintenance operations were performed at this facility.

In 1963, a new car repair shop, One Spot, was constructed north of the roundhouse, and the old car repair shed and all of the associated buildings were removed.

Wood Treatment

In 1927, a wood treatment facility was constructed along the west boundary of the CIA (Figure 5). This facility was used to treat ties, piles, piers, and poles with creosote. Creosote was delivered to the facility by rail tankers, which unloaded into track sumps located north of the Bunker C unloading area. These track sumps drained to a 12,500-gallon holding tank. The creosote was pumped from this tank to the 15,000-barrel AST located in a containment berm at the north end of the wood treatment facility. Wood apparently was treated with creosote in a retort building south of the creosote tank. Poles were treated in two vertical aboveground tanks located northeast of the creosote tank. Treated wood was stored primarily in a storage area north of the creosote tank.

A 90,000-gallon fuel oil tank adjacent to the creosote tank in the containment berm supplied fuel to a boiler used to generate steam for the retort. Two aboveground 12,500-gallon tanks, one for fuel oil storage and the other for boiler blowoff, also were constructed in the containment berm. A 6,500-gallon fuel oil UST was located south of the boiler building. A spray pond, possibly used for retort cooling, was located between the boiler building and the creosote tank. In 1941, two aboveground tanks (tank cars) used for fuel oil storage were installed within the creosote tank containment berm.

The wood treatment facility was retired in 1962, and shortly thereafter, the creosote tank, water towers, and other aboveground tanks in the containment area were removed. Between 1963 and 1972, the creosote tank containment berm and spray pond areas were graded, and an asphalt automobile transfer area was constructed at the north end of the north wood storage area.

Wastewater Treatment

In 1927, an oil/water separator and pump house for a pressurized sewer discharge pipeline were constructed. Between 1941 and 1950, three wastewater impoundments were constructed immediately north of the southern Bunker C tank in the general location of the now closed wastewater impoundment ponds (WWIPs A and B). By 1983, the WWIPs were constructed to the final configuration (Figure 5). The WWIPs were used until 2001. In late 2002, the WWIP sediments were stabilized and the ponds were backfilled (see Section 2.3.9).

In 1958, holding pond B and former holding pond A were constructed south of the diesel shop (Figure 5). Holding ponds A and B received wastewater from the locomotive wash and the A&WE shop. Other structures historically associated with these ponds include a concrete oil/water separator, an in-ground steel settling tank, and ASTs for waste oil generated from the oil/water separator. Former holding pond A was decommissioned sometime before 1983. Treated industrial wastewater and stormwater from the Yard was discharged to the municipal sanitary sewer system. In general, stormwater and wastewater generated at the Yard received primary and secondary treatment prior to discharge to the sanitary sewer system.

Stormwater and wastewater from the A&WE shop area and the locomotive wash rack area, both located in the southeastern portion of the CIA, was collected in a sump and pumped directly to the treatment center and processed through the oil/water separator. The separated oil was pumped to a holding tank and the water was discharged into WWIP B. Stormwater collected in catch basins and washdown water from the diesel shop, roundhouse, and service track areas was processed through the oil/water separator and collected in WWIP B as well. WWIP A, located next to WWIP B, collected stormwater and washdown water generated from the northwest end of the Yard, which includes the car repair shop, also known as One Spot.

After the stormwater and washdown water was discharged into the WWIPs, belt skimmers removed oil that floated to the top of the water column in each pond. The collected oil was pumped to the oil recycling holding tank and the water was discharged back into WWIP B.

Following removal of floating oil by the belt skimmers, water samples were collected from WWIP A and analyzed for oil and grease. If the oil and grease detections were below 100 milligrams per liter (mg/l), the water was discharged directly to the sanitary sewer system per the discharge permit. If oil and grease was detected above 100 mg/l, the water from WWIP A was pumped to an air floatation oil/water separator (Tricellorator™) for additional treatment prior to discharging to the sanitary sewer. Sludge generated from the Tricellorator™ process was collected in a holding tank.

<u>Waste Management Units</u>

Areas at the Yard known to have received refuse generated from Union Pacific operations include two areas within the CIA identified as the “burn pit” and “pit” on SPTCo maps. The burn pit consisted of a former gravel pit located east of the car repair shed (Figure 5). This former gravel pit has been defined as a "burn area" on SPTCo maps. The burn pit area was graded by 1993 and is currently used as a material storage area. The pit area was defined as a "pit" on SPTCo maps.

2.1.4 Classification Yard

The CY (see Figure 2), also known as the Hump Yard, is situated between the CIA to the south, the SDY to the east, the NDY to the north, and Bethel Drive to the west. The CY is used for assembly of freight trains bound for other destinations. No industrial operations have been performed in the CY.

2.1.5 South Departure Yard

The SDY (see Figure 2) is bounded by the BSY to the south, the Northwest Expressway to the east, the CIA and the CY to the west, and the NDY to the north. Trains are staged in the SDY prior to entering the CY or prior to departing from the Yard. No industrial operations have been performed in the SDY.

2.1.6 Off-Property Investigation Areas

2.1.6.1 River Road Neighborhood

The River Road neighborhood (formerly referred to as the Mayfair/Park residential area) as defined by the Yard investigation is bounded by Hatten Avenue (not a through-street) on the north, a line approximately parallel to and approximately 1/5 mile west of River Road beginning at Hatten Avenue extending south to Hansen Avenue on the west, a line extending from Hansen

Avenue southwest to the Northwest Expressway on the south, and the Northwest Expressway on the west (Figure 2).

2.1.6.2 Trainsong Neighborhood

The Trainsong neighborhood as defined by the Yard investigation is bounded by Morse Street on the north, Bethel Drive on the east, Roosevelt Boulevard on the south, and the Burlington Northern Santa Fe Railroad tracks on the west (Figure 2).

2.2 Chemical Use and Handling

This section presents a brief summary of chemical usage and handling at the Yard based on the records and site information collected to date. The following types of chemicals have been historically used or are currently used at the Yard:

- Bunker C fuel oil
- Diesel fuel
- Lube oil
- Creosote
- Gasoline
- Paints containing lead oxides, enamel paints, thinners, and acrylic lacquers
- SP235, carbonate and phosphate-containing floor cleaners
- SP237 and SP312, caustic cleaners used in wash racks for parts cleaning
- SP234 and SP250, solvents used as degreasers in the diesel shop
- Miscellaneous chemicals.

The historic and current use and handling of each type of chemical are described below.

<u>Bunker C Fuel Oil</u>

Bunker C fuel oil (Bunker C) was used to fuel steam engines at the Yard from 1927 through the early 1960s. Fueling of the steam engines occurred along the tracks that lead to the turntable from the north. The Bunker C fueling system was removed in the late 1950s and early 1960s as diesel electric locomotives were phased into service.

<u>Diesel Fuel</u>

Diesel fuel has been used at the Yard to fuel automotive vehicles and locomotives from the early 1960s to present. Currently, locomotives are fueled remotely using fuel tank trucks. Prior to 1999, diesel fuel for locomotive use was supplied to the Yard via the Santa Fe Pacific/Kinder

Morgan underground pipeline that runs along Bethel Drive and enters the Yard north of the former retort building. Diesel was stored in a 5,000-barrel AST located north of the turntable. Diesel was transported to the fueling area via above ground and underground lines. The 5,000-barrel AST and many of the aboveground and underground lines have been removed.

Diesel was also delivered to the Yard via tanker cars or trucks and stored onsite in various ASTs, USTs, and tanker cars.

Lube Oil

Lube oil has been used at the Yard from the late 1920s to present. Lube oil was stored in ASTs northeast of the fueling tracks. The lube oil was pumped from the ASTs to the fueling track, roundhouse, and diesel shop lube oil lines. Lube oil was also stored in 55-gallon drums within the roundhouse or diesel shop and oil racks throughout the Yard.

Creosote

Creosote was used at the Yard from 1927 to 1962 to treat ties, poles, piers, and piles. Creosote was delivered to the Yard by tank car and was unloaded into track sumps west of the oil/water separator. These sumps drained to a 12,500-barrel holding tank that was located near the oil/water separator. The creosote was pumped to a 15,000-barrel AST within the bermed former wood treatment area (FWT) former AST area, then transferred to the retort building via underground pipelines.

Gasoline

Gasoline has been used historically at the Yard to fuel automotive vehicles from 1927 to approximately 2000. Gasoline has been stored in USTs and ASTs throughout the Yard. The USTs and ASTs have been removed.

Paints, Paint Thinners, and Acrylic Lacquers

Paint, paint thinner, and acrylic lacquers have been used at the Yard from 1927 through 1999. These chemicals were historically stored in the paint shop (which was located within the diesel shop) and One Spot and were used in the diesel shop area (DSA), car repair sheds, and One Spot.

SP235

SP235, a powdered floor cleaner, was used through the late 1980s to remove grease and oil from the floors in the diesel shop and the roundhouse. SP235 contains carbonates, phosphates, solvents [aromatic solvents were used until 1987, short-chain parrafinic hydrocarbons (which break down more readily than aromatic solvents) were used after 1987], and nonionic and ionic surfactants (as a wetting agent).

SP234, SP237, and SP312

These alkaline, nonsolvent parts cleaners were used through the early 1990s to wash locomotive parts and exteriors. These detergents were used at the wash racks southeast of the diesel shop and northwest of the turntable tracks, and at the One Spot. They were stored in ASTs near the wash racks. The detergents were replaced by a similar Quaker brand detergent, which may still be in use.

SP250

Chlorinated solvents with various formulations have been historically used for degreasing and cleaning electrical components of diesel engines within the roundhouse and the diesel shop. Until the 1950s, carbon tetrachloride was widely used for degreasing. In 1951 and 1952, SP250 was adopted as a substitute for carbon tetrachloride. From 1952 through 1954, SP250 had become SP250A, composed of 25 to 30 percent chlorinated solvents and 70 to 75 percent naphtha, a petroleum-based solvent. From 1954 through 1967, changes to the percentages of chlorinated solvents in the degreaser continued to vary. By 1967, SP250E (formerly known as SP250A) was 67 to 75 percent 1,1,1-trichloroethane (1,1,1-TCA) and 25 to 33 percent tetrachloroethene (PCE). From 1981 through 1983, SP250F (formerly SP250E) contained 70 percent aliphatic petroleum hydrocarbons, 25 percent methylene chloride, and 5 percent ethyl cellosolve. The SP250 series was only used within the diesel shop.

Miscellaneous Chemicals

Miscellaneous household cleaners, disinfectants, insecticides, and vehicle maintenance chemicals have been used locally at the Yard.

2.3 Regulatory History

In August 1990, DEQ completed a preliminary assessment (PA) of the Yard. The PA was limited to reconnaissance of the Yard to assess whether remedial investigations, removal or remedial actions, or long-term controls were needed to protect human health and the environment. DEQ concluded that further work was warranted, which included characterization for the nature and extent of soil and groundwater impacts on the Yard based on site operation practices. DEQ placed the Yard on the Confirmed Release List (CRL) and the inventory of sites needing further investigation.

On 19 March 1992, DEQ's Hazardous Waste Division performed a hazardous waste facility inspection of the Yard. Subsequent to the inspection, DEQ issued a Notice of Noncompliance (NON) to SPTCo for failure to perform complete waste determinations and failure to submit quarterly reports. Based on responses to the NON provided by SPTCo, DEQ acknowledged in a 12 October 1993 letter that SPTCo had corrected the violations.

In March 1993, the United States Environmental Protection Agency (USEPA) contracted URS Consultants to conduct a Level I site inspection prioritization (SIP) of the Yard. The SIP focused on the Maxwell Pond area and was intended to determine whether past waste handling activities at the borrow pit posed a threat to human health and the environment. Based on the results of the SIP, the EPA concluded that past waste handling procedures at the borrow pit did not warrant Superfund listing or investigation. On 10 October 1993, the USEPA delegated to DEQ responsibility for further investigation and cleanup at the Yard.

The following section summarizes several site investigations that have been completed at the Yard from 1993 to the present under DEQ oversight.

2.4 Summary of Investigation and Remediation Activities

This section provides a brief summary of historic site investigations completed at the Yard. Specific details of these investigations are presented in individual reports referenced throughout and listed in Section 8. Section 4 presents an evaluation of the nature and extent of impacts from the Yard based on all historic data collected at the Yard. Figure 5 shows sampling and monitoring well locations for investigations that were conducted prior to 1998. Figure 6 shows sampling and monitoring well locations for investigations conducted from 1998 to the present.

2.4.1 Preliminary Groundwater Assessment

In 1993, a preliminary groundwater assessment was completed by Industrial Compliance (IC). The investigation included the installation and sampling of eight shallow monitoring wells. The results of the preliminary groundwater assessment indicated that various priority pollutant metals were detected in each of the eight monitoring wells and are summarized in the *Phase I Remedial Investigation/Feasibility Study Workplan, Southern Pacific Transportation Company, Eugene Yard, Eugene, Oregon* (IC 1994).

2.4.2 Phase I Remedial Investigation

The Phase I RI activities were conducted by IC and were initiated in 1994. The Phase I RI included the following:

- Collection of 96 shallow soil samples at 33 locations from the CIA
- Collection of 8 surface water and 12 sediment samples from onsite ponds (WWIPs and Holding Pond B) and an offsite drainage ditch (adjacent to the Northwest Exressway)
- Installation and sampling of 66 shallow temporary well points throughout the Yard
- Installation and sampling of nine shallow monitoring wells throughout the Yard
- Collection of groundwater samples from eight existing monitoring wells throughout the Yard
- Slug testing at nine shallow monitoring well locations in the CIA
- Residential irrigation well survey and sampling in the River Road area
- Installation of three monitoring wells within the River Road area
- Review of federal and state database records for potential offsite environmental concerns.

The results of the Phase I RI concluded that soil and groundwater had been impacted. The RI listed several data gaps and recommendations for data collection for the Phase II RI. The results of the Phase I RI are summarized in *Phase I Remedial Investigation Report* (IC 1995).

2.4.3 Phase II Remedial Investigation

The Phase II RI was conducted by IC during 1996. The Phase II RI report was submitted to DEQ by Terranext in 1997. The purpose of the Phase II RI was to assess data gaps identified during the Phase I RI. The Phase II RI included the following:

- Collection of 38 shallow soil samples at 18 discrete locations throughout the Yard and in the Trainsong neighborhood along the boundary with the Yard
- Collection of 3 sediment samples from an offsite drainage ditch (adjacent to the Northwest Expressway)
- Collection of reconnaissance groundwater samples from 16 shallow and 5 deep temporary well points throughout the Yard and in the Trainsong neighborhood along the boundary with the Yard
- Installation and sampling of 2 shallow and 3 deep monitoring wells within the Yard and in the Trainsong neighborhood
- Collection of groundwater samples from 20 existing monitoring wells throughout the Yard and off property locations (River Road and Trainsong neighborhoods)
- Slug testing at 3 deep monitoring well locations in the CIA
- Residential irrigation well survey and sampling in the Bethel Drive area
- Geophysical survey in the area of the former wood treatment facility to assess for potential USTs
- Investigation of the onsite Santa Fe Pacific/Kinder Morgan diesel pipeline
- Review of literature and records review regarding potential upgradient offsite source areas.

In the Phase II RI, Terranext concluded that soil and groundwater impacts from operations at the Yard warranted further investigation. The results of the Phase II RI are summarized in *Phase II Remedial Investigation Report* (Terranext 1997).

2.4.4 Phase III Remedial Investigation

Phase III RI activities were conducted by Environmental Resources Management (ERM) in 1998 to assess data gaps identified during the Phase II RI and included the following:

- A Bethel Drive area investigation, which included the collection of 19 soil samples from 9 locations, collection of 33 screening-level groundwater samples from 13 locations, collection of groundwater samples from 6 residential irrigation wells, and the installation and sampling of 5 monitoring wells
- Potential source areas soil investigation, which included the collection of 343 soil samples from 108 locations throughout the Yard (primarily in the CIA)
- Other areas soil investigation, which included the collection of 88 soil samples from 33 locations including the CIA and CY
- Reconnaissance groundwater investigation, which included non-aqueous phase liquid (NAPL) screening and the collection of screening-level groundwater samples at 62 locations throughout the Yard (primarily in the CIA)
- An intrinsic bioremediation (IBR) study
- Evaluation of ASTs and USTs, which included the collection of 23 soil samples from 10 locations and the collection of screening-level groundwater samples from 3 locations.

The results of the Phase III RI concluded that impacts in groundwater had migrated offsite into the Trainsong Neighborhood and presented recommendations for future data collection. The results of the Phase III RI are summarized in *Phase III Remedial Investigation Summary Report* (ERM 1999a).

2.4.5 Inactive Areas Investigation

The Inactive Areas investigation was completed in 1999. The investigation focused on the NDY (including the borrow pit) and the BSY, (Figure 2), and included the following:

- Review of eight aerial photographs of the Yard dated from 1936 to 1993
- Area reconnaissance surveys to look for evidence of hazardous substance releases (e.g., stained soil, distressed vegetation, etc.)
- Collection of 31 soil samples from 12 locations from the NDY and BSY
- Collection of reconnaissance groundwater samples from 3 locations in the NDY (borrow pit area) and BSY.

The results of the Inactive Areas investigation are summarized in *Inactive Areas Investigation Letter Report and Request for No Further Action* (ERM 2000). ERM concluded that the soil and groundwater have not been impacted in these areas and recommended no further action (NFA) for the NDY and BSY. DEQ has not issued a formal NFA determination for the NDY and BSY. However, groundwater samples are not collected from these areas during routine semi annual groundwater monitoring events.

2.4.6 Phase IV Remedial Investigation

Phase IV RI activities were completed by ERM from 1999 through 2001 to address data gaps identified after the Phase III RI was completed. The objectives of the Phase IV RI included:

- Characterizing the vertical extent of volatile organic compounds (VOCs) in groundwater in the suspected source area (the area between the FWT and DSA)
- Characterizing the vertical and lateral extent of VOCs in groundwater in the River Road area
- Characterizing the nature and extent of NAPL in the CIA
- Evaluating aquifer properties that influence the fate and transport of constituents of concern (COCs) in groundwater
- Evaluating the relationship between potential groundwater mounding and fluctuations in groundwater flow direction near the WWIPs
- Characterizing the nature and extent of COCs in the WWIPs sediments.

To accomplish these objectives, ERM conducted the following activities:

- Installed four shallow zone monitoring wells, three intermediate zone monitoring wells, one deep zone monitoring well, and two shallow zone piezometers in the CIA
- Installed eight shallow zone monitoring wells, four intermediate zone monitoring wells, and four deep zone monitoring wells in the River Road neighborhood
- Installed one shallow zone monitoring well in the Trainsong neighborhood
- Collected 37 sediment samples from the WWIPs
- Installed four temporary well points to evaluate for the presence of NAPL
- Conducting a Land and Beneficial Water Use Determination (BUD) report
- Analyzed groundwater samples for intrinsic bioremediation indicator parameters.

In the Phase IV RI, ERM concluded that:

- Soil in localized areas of the CIA were impacted with elevated levels of total petroleum hydrocarbons (TPH), polynuclear aromatic hydrocarbons (PAHs), and metals. A source of VOCs in soil that corresponds to VOC concentrations in groundwater has not been identified.
- Groundwater in the CIA has been impacted with dissolved TPH, VOCs, and PAHs.

- Dissolved VOCs are the most widely distributed COC at the site, extending north into the River Road neighborhood and to the west into the Trainsong neighborhood. Sample results and risk evaluations conducted indicated that the concentrations of VOCs in groundwater beneath the River Road and Trainsong neighborhoods do not pose an unacceptable risk to human health based on the current uses (irrigation, wading pools, car washing, and other outdoor uses).

- NAPL occurs locally and sporadically in the central portion of the CIA.

- No evidence of liquid-phase chlorinated hydrocarbons was observed.

The results of the Phase IV RI are summarized in *Phase IV Remedial Investigation Summary Report* (ERM 2002).

2.4.7 OffSite Risk Evaluations

Several site-related VOCs have been detected in offsite groundwater. Preliminary evaluations of the potential human health risk associated with these VOC impacts have been completed as part of the overall RI at the Yard. In general, these risk evaluations have been conducted separately from the Phase I, II, III, and IV field investigations, and have included residential irrigation well sampling and isolation flux chamber (ground level soil vapor) sampling within the River Road and Trainsong neighborhood areas. Flux chamber sampling was conducted during both the wet season (March 1999) and the dry season (September 1999) by ERM.

ERM concluded that the preliminary risk evaluations indicated that potential exposures to site-related VOCs in offsite groundwater do not pose an unacceptable risk (as defined by DEQ and the USEPA) to residents living adjacent to the Yard. The results of the risk evaluation for potential exposures during the wet season are presented in *Preliminary Risk Evaluation/Off-Property Ground Water* (ERM 1999b). The results of the risk evaluation for potential exposures during the dry season are presented in *Preliminary Risk Evaluation/Supplemental Analysis, Off-Property Ground Water* (ERM 2000e). In addition, preliminary risk-based screening levels (RBSLs) for potential residential exposures to the VOCs detected in offsite groundwater were derived in *Preliminary Risk Evaluation/Supplemental Analysis* (ERM 2000e). The evaluation of potential risks associated with irrigating home gardens with offsite groundwater is presented in *Evaluation of Potential Risks Associated with Eating Homegrown Produce* (ERM 2001a).

2.4.8 Preliminary Risk Assessment

A preliminary risk assessment (PRA) was completed by ERM in April 2000 to streamline the overall risk assessment process and to focus future RI/FS activities. The purpose of the PRA was three-fold:

1. The PRA presented the methodologies and assumptions proposed for use in the baseline risk assessment.

2. The PRA presented preliminary risk-based screening levels (RBSLs) for hazardous substances detected in soil.

3. The PRA assessed the presence of data gaps related to the characterization of soil at the Yard. No data gaps were identified for soil.

ERM concluded based on the results of the PRA that hot spots, as defined in *Final Guidance for the Identification of Hot Spots* (DEQ 1998a), are not present in soil at the Yard. The results of the PRA are summarized in *Preliminary Risk Assessment* (ERM 2000f).

2.4.9 Wastewater Impoundment Pond Closure

In late 2002, WWIPs A and B were closed. The WWIPs were used until 2001 to treat wastewater and stormwater from the CIA prior to discharge to the City's sanitary sewer system. The locations of the impoundments are shown on Figures 5 and 6. The eastern impoundment is referred to as Impoundment A and the western impoundment as Impoundment B. The WWIPs were closed in accordance with a work plan that was approved by DEQ. WWIP closure activities included applying for wastewater discharge and grading permits, removing and discharging water from the WWIPs to the City's sanitary sewer, stabilizing impoundment sediments, placing and compacting backfill, and grading to facilitate drainage. Wastewater was discharged to the sanitary sewer under a temporary discharge authorization issued by the City Industrial Source Control. Sediment stabilization was accomplished by mixing diatomaceous earth and lime with backfill material and sediment and then compacting. Two samples of the stabilized sediment were collected from each WWIP for analysis. The WWIPs were backfilled using material borrowed from the Yard "hump" and an alternate soil stockpile located along the southwest boundary of the CIA along Bethel Drive, with the approval of DEQ. Resident engineering services were provided by Kennedy/Jenks during the WWIP closure activities. The WWIP closure activities were summarized in *Wastewater Impoundments Closure Report* (Kennedy/Jenks, 19 August 2003).

2.4.10 20-Acre Parcel, North Departure Yard Operable Unit

In anticipation of a possible property transfer of section of land adjacent to the NDY, Union Pacific conducted a baseline environmental study of a 20-acre parcel located at the northwest end of the Yard in December 2003. In addition, to support the possible property transfer, Union Pacific requested that DEQ remove the parcel from DEQ's Voluntary Cleanup Program (VCP) boundaries, established when Union Pacific entered the Yard into the VCP in 1993, and issue a No Further Action (NFA) determination for this parcel. The location of the 20-acre parcel is shown on Figure 4. The parcel consists primarily of a paved access road parallel to the railroad tracks. The parcel is bordered by the Yard tracks to the east, Irving Road to the north, various industrial properties (including the Kinder Morgan bulk fuel terminal, Lane Forest Products, a pallet recycling facility, and Golden Temple Foods) to the west, and Maxwell Road to the south. The Santa Fe Pacific Pipeline traverses the south and north ends of the parcel. The pipeline runs parallel to the parcel north of the Kinder Morgan bulk fuel terminal. The parcel and surrounding properties are zoned industrial and it is likely that the zoning will remain unchanged in the foreseeable future.

Petroleum-related constituents were detected in a soil and a reconnaissance groundwater sample obtained from explorations completed in the vicinity of the Kinder Morgan bulk fuel terminal and its associated underground pipeline. It was concluded that the hydrocarbon impacts at this boring location are related to historical activities at the fuel terminal. Heavy oil-range hydrocarbons detected in the northern portion of the parcel are likely related to activities associated with the storage of vehicles at this location.

The results of the baseline environmental study of the 20-acre parcel are summarized in the *Summary of Investigation Activities, 20-Acre* Parcel (Kennedy/Jenks, 31 March 2004). Based on the results of the baseline environmental study and laboratory analyses of soil and groundwater samples collected from the 20-acre parcel, Kennedy/Jenks, on behalf of Union Pacific, requested removal of the parcel from the VCP boundaries and an NFA determination for the parcel. An NFA determination was issued for the parcel by DEQ and the parcel was removed from the VCP by DEQ in 2004.

2.4.11 Soil Vapor and Air Sampling

Soil vapor sampling has been conducted in the CIA, and Trainsong and River Road neighborhoods to assess the vapor intrusion pathway. The assessment was conducted to evaluate the potential for exposure of residents in the Trainsong neighborhood to VOCs volatilized from groundwater.

In 1999, isolation flux chamber sampling was conducted along Bethel Drive and within the Trainsong neighborhood by ERM. Based on the results of this sampling, the DEQ stated they could not make a final decision regarding concentrations of VOC in air based on the limited sampling data and recommended additional sampling.

Additional sampling was conducted in February, May June, July and August 2004, primarily in the Trainsong neighborhood. The 2004 assessment consisted of collection of soil gas (collected using hand operated and mechanical equipment), crawlspace and ambient air, isolation flux chamber, soil, and groundwater samples to evaluate whether there may be a positive correlation between emissions of VOCs [specifically trichloroethene (TCE), tetrachloroethene (PCE), and vinyl chloride (VC)] from the existing groundwater plume beneath the Trainsong neighborhood into soil gas and then into ambient air.

A summary of the sampling activities and results are presented in the *Assessment of the Vapor Intrusion Pathway* (Kennedy/Jenks, December 2004). Based on the results of the groundwater, soil gas and ambient air sampling conducted in the Trainsong neighborhood and the Yard, Kennedy/Jenks made the following conclusions:

- Volatilization of PCE, TCE, and VC from groundwater into subsurface soil gas is a complete pathway.
- Concentrations of PCE, TCE, and VC in groundwater and soil gas do indicate a complete pathway but do not support the concentrations of PCE and TCE detected in the crawlspace samples.
- Concentrations of PCE, TCE, and VC in ambient air data collected away from the Trainsong neighborhood and the Yard and outside of the existing VOC groundwater plume suggests that PCE, TCE, and VC detected in ambient air in the Trainsong neighborhood may be from sources other than impacted groundwater.

- Background ambient air data and indoor air concentrations predicted from soil gas data indicate that the contribution from volatilization from groundwater migrating from the Yard to indoor air concentrations may be minor relative to the other sources.

Section 3: Site Setting

3.1 Topography

The Yard is located on the northwest side of the City approximately ½ mile west of the Willamette River. The topography of the Yard is relatively flat, sloping at a gradient of approximately 0.002 foot per foot (ft/ft) to the north. The ground surface elevation of the yard is approximately 400 feet above mean sea level.

3.1.1 Locality of the Facility

A BUD report was prepared as part of the Phase IV RI. The purpose of the BUD was to provide information for the evaluation of potential receptors and exposure pathways in the risk assessment, and for the development of remedial action objectives (RAOs) and remedial alternatives in the FS. The BUD described the current and reasonably likely future land and beneficial water uses within the "locality of the facility" (LOF). The LOF is defined by DEQ as any point where a human or an ecological receptor contacts or is reasonably likely to come into contact with facility-related COCs. The LOF considers the current nature and extent of COCs and their potential to migrate.

Figure 7 shows the estimated extent of the Yard LOF. The Yard LOF includes the CIA and portions of the River Road and Trainsong residential areas affected by past or potential future migration of site-related VOCs in groundwater.

3.2 Land/Water Use and Zoning

The current and most likely future land use within the LOF is heavy industrial for the Yard, and primarily residential with some general commercial for the adjacent River Road and Trainsong areas. The Yard property is zoned for heavy industrial use (I-3). Figure 8 shows the zoning for the Yard and surrounding area.

Based on the information reviewed for the BUD, the following beneficial water uses were identified by ERM within the LOF:

- Groundwater is not currently used at the Yard. Groundwater obtained from private residential wells within the River Road and Trainsong areas is currently used for irrigating lawns and gardens, washing cars, filling swimming pools, and other outdoor/recreational uses. The drinking water supply for the Yard and adjacent residential areas is provided by the City.

- Reasonably likely future beneficial uses of groundwater within the Trainsong and River Road areas include drinking water for residents. Groundwater within the Yard boundary is not currently and is not likely to be used in the future.

- The current and most likely future surface water use within the LOF is aquatic life.

3.3 Regional Geology and Hydrogeology

Regional geology of the Eugene area is based on well log information and United States Geologic Survey (USGS) maps. In general, the youngest consolidated sedimentary rock that underlies the Eugene area is the Oligocene-age (24 to 38 million years old) marine sandstone of the Eugene Formation. The Eugene Formation is approximately 15,000 feet thick and forms much of the foothill area in the vicinity of Eugene. Unconsolidated quaternary deposits overlie the Eugene Formation and are grouped as younger and older alluvium. The Yard is underlain by older alluvium, which ranges from 20 to 250 feet thick in the Eugene area and is comprised mainly of sand and gravel with silt and clay. The younger alluvium is primarily found along the banks of the Willamette and McKenzie Rivers.

The regional groundwater flow direction in the vicinity of the Yard is to the northwest. The younger and older alluvial deposits comprise the principal aquifer in the Eugene area. Production water supply wells in the Eugene area are predominantly screened in the older alluvium. Constant rate discharge tests have indicated that the older alluvium is highly transmissive (62,000 square feet per day) with average horizontal hydraulic conductivities approximately 3,000 feet per day (ft/day).

3.3.1 Site–Specific Geology and Hydrogeology

Results of investigations at the Yard indicate that two water-bearing zones of interest (Gravel 1 [subdivided into Gravel 1A and Gravel 1B] and Gravel 2) exist beneath the Yard and adjacent residential areas. The two water-bearing zones are referred to as the shallow zone and the deep zone. The water-bearing zones consist predominantly of gravel with varying amounts of sand and silt. A detailed description of the site geology is included in *Phase III Remedial Investigation Workplan* (ERM 1998).

The shallow zone is an unconfined or semiconfined aquifer that extends from the water table (encountered approximately 6 to 16 feet below ground surface [bgs]) to the base of the Gravel 1B Unit (approximately 50 feet bgs). A semicontinuous silt/clay unit (Silt/Clay 1B Unit) separates the shallow zone into an upper (Gravel 1A) and a lower (Gravel 1B) portion. The upper portion extends from the water table to the base of the Gravel 1A unit (approximately 10 to 25 feet bgs). The lower portion extends from the base of the Silt/Clay 1B unit to the base of the Gravel 1B unit (approximately 35 to 50 feet bgs). Monitoring wells and peizometers completed within the Gravel 1A portion are referred to as shallow zone monitoring wells (or piezometers). Monitoring wells or peizometers completed in the Gravel 1B portion of the shallow zone are referred to as intermediate zone monitoring wells (or peizometers).

The deep water-bearing zone is a semiconfined aquifer typically encountered between 60 and 75 feet bgs. This zone corresponds to the Gravel 2 unit, which ranges from 10 to 18 feet thick across the Yard and adjacent neighborhoods. The semicontinuous Silt/Clay 2 unit separates the shallow and deep water-bearing zones. Monitoring wells completed within the deep water bearing zone are referred to as deep zone monitoring wells.

Figure 9 shows the surface representation of geologic cross-sections A-A' and B-B'. The cross-sections are shown on Figures 10 and 11. As shown on the cross-sections, the stratigraphy is relatively consistent throughout the CIA. However, there is considerable variability in the depth and thickness of the hydrogeologic units. Examples include the northern portion of cross-section A-A' (River Road neighborhood) where the silt/clay units were not observed, and the eastern portion of the River Road neighborhood, where the dominant lithology consists of silt and clay.

Of the 58 monitoring wells and piezometers installed on or near the Yard, 42 are completed within the upper portion of the shallow zone, 8 are completed within the lower portion of the shallow zone, and 8 are completed within the deep zone. Table 1 summarizes the monitoring well and piezometer construction details.

3.3.2 Groundwater Gradients and Flow Direction

A historical summary of depth to groundwater measurements and groundwater elevation data, which includes NAPL thickness and depth, is presented in Table 2. The groundwater flow direction in the shallow, intermediate, and deep zones during the second semiannual 2004 monitoring and sampling event was generally to the north-northwest onsite and in the River Road area as shown on Figures 12, 13, and 14. The groundwater flow direction is generally to the north-northwest during the wet and dry seasons. A westerly groundwater flow component is apparent on the west side of the Yard (in the Trainsong neighborhood) throughout the year. This flow direction is consistent with historical monitoring events and is parallel to or away from the Willamette River, located approximately 1/2 mile east of the Site. The average horizontal hydraulic gradient in the shallow zone is approximately 0.002 to 0.003 feet per foot (ft/ft). The average horizontal hydraulic gradient in the deep zone is approximately 0.001 ft/ft.

Vertical gradients between the shallow and deep zones have historically been downward at most well cluster locations. The vertical gradients have ranged from 0.032 ft/ft upward (well cluster RR-DMW-001/RR-MW-007, March 2001) to 0.045 ft/ft downward (well cluster CIA-DMW-004/CIA-MW-019, September 2001).

In March 2001, slug tests were performed in six monitoring wells in the CIA and River Road areas. Additionally, slug tests were performed in 12 monitoring wells during the Phase I and II RI. The slug test data indicate that the hydraulic conductivity in the shallow zone proximal to the test wells ranges from approximately 2 feet per day (ft/day) to 250 ft/day. For an aquifer-effective porosity of 0.32 and a hydraulic gradient of 0.003 ft/ft, these conductivity values correspond to groundwater seepage (pore) velocities of 0.02 ft/day to 2.3 ft/day. The geometric mean of the conductivity estimates for the upper portion of the shallow zone (based on slug test data from five representative shallow monitoring wells) is 52 ft/day. The arithmetic mean of the conductivity estimates for the lower portion of the shallow zone (based on slug test data from two intermediate monitoring wells) is 13 ft/day.

Estimates for the hydraulic conductivity in the deep zone range from approximately 0.61 ft/day to 34 ft/day. For an aquifer-effective porosity of 0.32 and a hydraulic gradient of 0.001 ft/ft, these conductivity values correspond to groundwater seepage velocities of 0.002 ft/day to 0.11 ft/day. The geometric mean of the conductivity estimates for the deep zone (based on slug test data from five deep monitoring wells) is 6.2 ft/day.

Laboratory permeability tests performed on two soil samples collected from the silt/clay units between the zones indicate that the hydraulic conductivity of the silt/clay is on the order of 5×10^{-5} to 8×10^{-4} ft/day.

3.3.3 Site Surface Soil Types and Distribution

Surface soil type identification is based on information obtained from the Natural Resources Conservation Service (NRCS). In the northern portion of the Yard (north of the former WWIPs), the surface soil is comprised of gravelly sandy loam to a depth of approximately 14 inches and gravelly sand below the loam to about 60 inches. South of the former WWIPs, the surface soil is comprised of loam to clay loam to a depth of approximately 16 inches overlying gravelly sandy loam to a depth of approximately 60 inches (approximately the top of the Gravel 1A water-bearing zone).

Section 4: Nature and Extent of Impacts

Soil, groundwater, surface water, sediment, soil gas, ambient air, and isolation flux chamber samples have been collected for analysis during previous RI phases at the Yard and the Trainsong and River Road neighborhoods. The selection of analytes for the RI was based on knowledge of chemicals used in industrial processes at the Yard. The COCs, based on *Draft Baseline Human Health Risk Assessment* (ERM, 2000) for all of the media sampled include at least one of the following:

- VOCs
- TPH
- PAHs
- Metals
- NAPL.

Samples have been collected for analysis of these constituents throughout the Yard and off-property locations. The majority of the samples have been collected in the CIA operable unit because most of the chemical use occurred there. For the purposes of this Summary RI, those constituents listed above are the primary COCs for the Yard. Constituents other than those listed above may have been analyzed for during the RI, but are not discussed in detail in this document.

This section presents a summary of analytical results by medium for each operable unit during the RI process.

4.1 Soil

The criteria listed below were used for comparison purposes only, to identify areas of soil that may have required further action during the RI process. These criteria were not intended to be used as cleanup levels for the Yard during the RI. Site-specific risk-based remedial goals for constituents detected in soil have not been established for the Yard. A revised baseline human health risk assessment (HHRA) will be developed in 2005 that will address risk-based remedial goals. RAOs for soil will be developed during development of the feasibility study in 2006.

The criteria used to identify COCs in soil are as follows:

- **VOCs:** Identification as a COC is based on detections above USEPA Region 9 industrial preliminary remediation goals (PRGs) (USEPA 2004) and the DEQ risk-based concentrations (RBCs) (Risk-Based Decision Making [RBDM] for the Remediation of Petroleum Contaminated Sites, DEQ, September 2003)

- **TPH:** Identification as a COC is based on detections above the DEQ RBCs for diesel for the soil ingestion, dermal contact, and inhalation pathway for the residential and construction worker scenario's as appropriate

- **PAHs:** Identification as a COC is based on detections above USEPA Region 9 industrial PRGs and DEQ's RBCs

- **Metals:** Identification as a COC is based on detections above site background concentrations, or USEPA Region 9 industrial PRGs where background levels are below PRGs.

Table 3A summarizes the potentially applicable regulatory criteria described above for each group of chemicals. Tables 4 through 8 summarize the analytical results of soil and sediment samples collected during previous investigations at the Yard.

Using the above criteria, the following COCs in soil have been identified:

- Total petroleum hydrocarbons (TPHd) (diesel-range)

- Carcinogenic PAHs

- Metals.

VOCs have been detected only sporadically in soil and no VOC source areas in soil have been identified. Therefore, VOCs are not considered COCs in soil.

The following sections summarize the nature and extent of impacted soil at the Yard and offsite properties.

4.1.1 Central Industrial Area

This section summarizes the results of soil sampling conducted in the CIA. The following sections summarize the extent of the COCs identified in soil. Figures 5 and 6 show the sampling and monitoring well locations.

4.1.1.1 Locomotive Fueling Facility Area

Soil samples were collected during the RI from approximately 43 locations. During the Phase III RI, 38 boreholes were advanced (LFF-01 through LFF-38). The highest TPHd and total petroleum hydrocarbons (TPHho) (heavy-oil) concentrations in the locomotive fueling facility (LFF) were detected in soil samples obtained near the former drying slab (LFF-22), near the former diesel pump house (LFF-23), between the former diesel AST (also the location of the former Bunker C AST) and the former WWIPs (LFF-24), and northwest of the former WWIPs (LFF-33). The diesel-range TPH concentration in samples collected from these locations exceeded the DEQ RBC for the construction worker receptor scenario. None of the other soil samples collected in the LFF contained TPHd at concentrations that exceed the DEQ RBC for the construction worker scenario. Figures 15 and 16 show TPHd and TPHho isoconcentration contours for various depth intervals (0.5 to 3 feet, 3.5 to 6 feet, and 6.5 to 15 feet bgs). Table 5 summarizes the TPH analytical results for soil in the CIA.

Carcinogenic PAHs including benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene, were detected in soil samples obtained from the LFF at concentrations that exceed the industrial PRGs. Figure 17 shows carcinogenic PAH isoconcentration contours for various depth intervals. The highest PAH concentrations in the LFF area were identified in soil samples obtained in the former Bunker C unloading track sumps (LFF-33). With the exception of the former Bunker C unloading track sumps, pump house, and former diesel pump house area (LFF-28, through LFF-31), the PAH concentrations that exceed the PRG were identified at depths of 5 feet bgs or less. In the former Bunker C unloading track sumps, pump house, and former diesel pump house area, PAH concentrations that exceed the PRG were identified as deep as 13.5 feet bgs. Table 6 summarizes the PAH analytical results for soil in the CIA.

Metals concentrations in soil samples collected from the LFF area that exceeded the industrial PRGs include lead, arsenic, and chromium. As in the former wood treatment area (FWT) and DSA, the arsenic concentration in the majority of the soil samples collected from the LFF area exceeded the industrial PRG. However, the PRG for arsenic is significantly lower than the site-specific background concentration. The concentration of barium in three soil samples exceeded the site-specific background level, but are below the PRG. Figures 18, 19, and 20 show the arsenic, chromium, and lead concentrations for soil samples collected at the Yard. Table 7 summarizes the metals analytical results for soil in the CIA.

Lead was detected below background concentrations in all but 14 (LFF-1, LFF-2, LFF-3, LFF-5, LFF-8, LFF-15, LFF-22, LFF-23, LFF-25, LFF-26, LFF-28, LFF-32, LFF-35, and LFF-38) of the soil sample locations within the LFF area. The samples that contained lead in excess of the background concentration were obtained from depths of 5 feet or less. The lead concentration in only one sample in the LFF (2.5 feet bgs in LFF-23) exceeded the industrial PRG.

Arsenic was detected below background concentrations in all but 12 (LFF-3, LFF-15, LFF16, LFF-24 through 28, LFF-30 through 32, and LFF-38) of the soil sample locations within the LFF area. The samples that contained arsenic in excess of the background concentration were obtained from depths of 5 feet or less.

None of the samples obtained from the LFF contained chromium concentrations that exceed the industrial PRG. The site-specific background concentration was slightly exceeded in 20 of the sampling locations in the LFF area.

4.1.1.2 Former Wood Treatment Area

To evaluate soil impacts within the FWT area, soil samples from approximately 45 locations were collected during the RI. The Phase III RI included sampling at 33 of those locations (FWT-01 through FWT-28 and FWT-31 through FWT-35).

The highest TPHd and TPHho concentrations detected in the FWT were detected in samples obtained from depths of 0.5 to 3 feet bgs in the former AST location (Table 5). Diesel-range TPH concentrations exceeded the DEQ RBC for the construction worker receptor scenario in one location (FWT-08). Figures 15 and 16 show TPHd and TPHho isoconcentration contours for various depth intervals (0.5 to 3 feet, 3.5 to 6 feet, and 6.5 to 15 feet bgs) in the CIA.

Carcinogenic PAHs including benzo(a)anthracene, benzo(a)pyrene, and benzo(b)fluoranthene were detected in soil samples collected from the FWT at concentrations that exceed the PRGs

(Table 6). Figure 17 shows carcinogenic PAH isoconcentration contours for various depth intervals. As with TPH, the highest PAH concentrations in the FWT area were identified in the former AST location.

Metals concentrations in soil samples collected from the FWT area that exceeded the industrial PRGs include lead, arsenic, and chromium (Table 7). The arsenic concentration in the majority of the soil samples collected from the FWT area exceeded the industrial PRG. However, the PRGs for arsenic were significantly lower than the site-specific background concentrations established during the HHRA. Concentrations of barium in several soil samples exceeded the site-specific background, but were below the PRG. Figures 18, 19, and 20 show the arsenic, chromium, and lead concentrations for soil samples collected at the Yard.

Lead was detected below background concentrations in all but six (FWT-04, FWT-26, FWT-28, CIA-05, CIA-06, and CIA-07) of the soil sample locations within the FWT area. The samples that contained lead in excess of the background concentration were collected from shallow soil (0-3 feet bgs) except for CIA-06, which was obtained from 5 feet bgs. None of the soil samples collected in the FWT contained lead at concentrations exceeding the industrial PRG.

Arsenic was detected below background concentrations in all but nine (FWT-03, FWT-04, FWT-06, FWT-08, FWT-09, CIA-05, CIA-06, CIA-07, and CIA-08) of the soil sample locations within the FWT Area. The samples that contained arsenic in excess of the background concentration were obtained from shallow soil (0-3 feet bgs) except for the area where the "CIA" samples were collected where the exceedences were identified in samples collected as deep as 5 feet bgs.

None of the samples obtained from the FWT contained chromium concentrations that exceed the industrial PRG. The site-specific background concentration was slightly exceeded in 21 of the sampling locations in the FWT area.

4.1.1.2.1 Diesel Shop and Roundhouse Area and Wastewater Conveyance System

Soil samples from 38 locations were collected from within the DSA during the RI. During the Phase III RI, 37 boreholes were advanced (DSA-01 through DSA-37).

The highest TPHd and TPHho concentrations in the DSA were detected in soil samples obtained from the northwest portion of the former turntable (DSA-24, Table 5). The diesel-range TPH concentration in the sample collected from 5 feet bgs at this location exceeded the DEQ RBC for the construction worker receptor scenario and was the only location in the DSA where the DEQ RBC was exceeded. Figures 15 and 16 show TPHd and TPHho isoconcentration contours for various depth intervals (0.5 to 3 feet, 3.5 to 6 feet, and 6.5 to 15 feet bgs).

Benzo(a)pyrene was detected in the sample collected from 5 feet bgs in location DSA-24 at a concentration that exceeds the PRG (Table 6). This is the only sample collected in the DSA that contained any of the PAHs that exceeded the PRG. Figure 17 shows carcinogenic PAH isoconcentration contours for various depth intervals.

Metals concentrations in soil samples collected from the DSA area that exceeded the industrial PRGs include lead, arsenic, and chromium (Table 7. As in the FWT, the arsenic concentration in the majority of the soil samples collected from the DSA area exceeded the industrial PRG.

The PRG for arsenic is significantly lower (approximately one order of magnitude) than the site-specific background concentration. The concentration of barium in one soil sample exceeded the site-specific background, but was well below the PRG. Figures 18, 19, and 20 show the arsenic, chromium, and lead concentrations for soil samples collected at the Yard.

Lead was detected below background concentrations in all but five (DSA-6, DSA-11, DSA-21, DSA-23, and DSA-33) of the soil sample locations within the DSA area. The samples that contained lead in excess of the background concentration were obtained from 5 feet or less except for DSA-11, where the background concentrations was exceeded in each of the three samples collected (3, 5.5, and 12 feet bgs). The lead concentration in only one sample in the DSA (5.5 feet bgs in DSA-11) exceeded the industrial PRG.

Arsenic was detected below background concentrations in all but five (DSA-8, DSA-11, DSA-19, DSA-31, DSA-33) of the soil sample locations within the DSA Area. The samples that contained arsenic in excess of the background concentration were obtained from depths of 5 feet or less except for location DSA-19 (7 feet bgs).

None of the samples obtained from the DSA contained chromium concentrations that exceeded the industrial PRG. The site-specific background concentration was slightly exceeded in 10 of the sampling locations in the DSA area.

4.1.1.2.2 Former Burn Pit and Disposal Pit

Soil samples were collected at six locations during the Phase I and Phase III RIs to evaluate soil impacts within the former burn pit and disposal pit areas. Following collection of soil samples at 0.5, 2.5, 5, and 9 feet bgs at BP-02, refusal was encountered. The borehole location was moved approximately 1 to 2 feet to the northwest and was identified as BP-02A. Soil samples were collected at depths of 0.5, 3, 5.5, and 13 feet bgs in location BP-02A.

The diesel-range TPH concentrations in the samples collected from locations BP-01 and BP-02A at depths of 0.5 and 3 feet respectively, exceeded the DEQ RBC for the residential receptor scenario (Table 5). None of the other soil samples collected in the LFF contained TPHd at concentrations that exceed the DEQ RBC for either the residential or construction worker scenarios. Figures 15 and 16 show TPHd and TPHho isoconcentration contours for various depth intervals (0.5 to 3 feet, 3.5 to 6 feet, and 6.5 to 15 feet bgs).

Benzo(a)pyrene was detected in the samples collected from 3 and 5.5 feet bgs in location BP-02A at a concentration that exceeds the PRG (Table 6). These are the only samples collected in this area that contained any of the PAHs that exceed the PRG. Figure 17 shows carcinogenic PAH isoconcentration contours for various depth intervals.

As in other areas of the Yard, the arsenic concentration in the majority of the soil samples collected from the former burn pit and former disposal pit area exceeded the industrial PRG (Table 7). However, the PRG for arsenic is significantly lower than the site-specific background concentration. The concentration of barium in one soil sample exceeded the site-specific background, but is well below the PRG. Figures 18, 19, and 20 show the arsenic, chromium, and lead concentrations for soil samples collected at the Yard. The lead concentration in two samples (BP-02 at 5 feet bgs and BP-02 at 9 feet bgs) exceeded the site-specific background concentration. The chromium concentration in three samples (BP-02A at 0.5 feet and

WP-N010.5 at 5 and 10 feet bgs) exceeded the site-specific background concentration. None of the samples contained lead or chromium concentrations that exceed the industrial PRG.

4.1.1.2.3 Auto and Work Equipment Shop (AW&E)

To evaluate soil impacts within the A&WE repair shop area, five boreholes were advanced (AWE-01 through AWE-05, Figure 6). The soil sampling in the A&WE area was conducted during the Phase III RI.

In addition to VOC, TPH, and metals analysis, a fibrous material found in the soil from AWE-03 at approximately 4 to 5 feet bgs was submitted for asbestos analysis by polarized light microscopy (PLM) using USEPA Methods 600/M4-82-020 and 600/R-93/116. Asbestos-containing material (ACM) was identified in this sample. This was the only location and depth where ACM was observed.

None of the soil samples collected in the A&WE area contained TPHd in concentrations that exceed the DEQ RBC for the construction worker receptor scenario (Table 5). Soil samples were not analyzed for PAHs in the vicinity of the A&WE Shop because TPH was not detected above 500 mg/kg.

Total lead was detected below the industrial PRG in all 15 samples analyzed (Table 7). Total lead was detected above the background concentrations in two samples (AWE-01-0.5 and AWE-04-5.0). Total chromium was detected above the industrial PRG in one of the 15 samples analyzed (AWE-03-5.0) and above the background concentration in one other sample (AWE-3.0-13.5). Arsenic was detected above the industrial PRG in seven of the 15 soil samples analyzed, but below the background concentration in all 15 samples.

4.1.1.2.4 Former Holding Ponds A and B

Soil samples were collected from 11 locations during various investigation events to evaluate soil impacts within the Former Holding Ponds A and B (Table 5). The highest TPHd concentrations in the former holding pond area were detected in soil samples obtained from the base of pond B. Diesel-range TPH concentrations in samples collected from locations HPB-S001 and HPB-S003 exceed the DEQ RBC for the construction worker receptor scenario. None of the other soil samples collected in the former holding ponds area contained TPHd at concentrations that exceed the DEQ RBC for the construction worker scenario. Figures 15 and 16 show TPHd and TPHho isoconcentration contours for various depth intervals (0.5 to 3 feet, 3.5 to 6 feet, and 6.5 to 15 feet bgs).

None of the soil samples collected in the former holding pond area contained PAHs in concentrations that exceed the DEQ RBC for the construction worker scenario (Table 6).

Metals concentrations in soil samples collected from the former holding pond A and B area that exceeded the industrial PRGs include lead and arsenic (Table 7). As in other areas of the site, the arsenic concentration in the majority of the soil samples obtained from the former holding pond area exceeded the industrial PRG. The PRG for arsenic is significantly lower than the site-specific background concentration. The concentration of barium detected in three soil samples exceeded the site-specific background, but are below the PRG. Figures 16, 17, and 18 show the arsenic, chromium, and lead concentrations for soil samples collected at the Yard.

Lead was detected above background concentrations in eight locations within the former holding pond area. None of the samples collected along the perimeter of the former holding pond area (HP-01 through HP-04) contained lead concentrations that exceed the site specific background concentrations. The lead concentration in two samples collected in the same general area at the base of former holding pond B (HPB-HA-01 at 2.5 feet bgs and A2.5 at 2.5 feet bgs) exceeded the industrial PRG.

Arsenic was detected below background concentrations in all but six sample locations in the former holding pond area. The arsenic concentration in only one sample collected from the perimeter of the former holding ponds (HP-01 at 2.5 feet bgs) exceeded the site specific background concentration.

None of the samples obtained from the former holding pond area contained chromium concentrations that exceed the industrial PRG. The site-specific background concentration was exceeded in seven of the sampling locations in the former holding pond area.

4.1.1.2.5 Underground and Aboveground Storage Tanks

A total of 20 USTs and 28 ASTs have been identified through records review and/or site reconnaissance. All of these storage tanks have been evaluated during various investigation events. The approximate storage tank locations (identified by structure number) are shown on Figure 6. Table 9 presents a summary of investigation activities and status for each storage tank. The results of sampling, if conducted during the RI, are presented in the analytical data tables [Tables 4 through 8 (soil) and 10 through 15 (water)].

4.1.1.2.6 Former Car Repair Shed/Shop Soil Investigation

Soil samples were collected from nine locations during various investigation events to evaluate soil impacts within the former car repair shed/shop area (CRS). During the Phase III RI, a total seven boreholes were advanced (CRS-01 through CRS-07). Soil samples were also obtained from monitoring wells CIA-MW-008 and CIA-MW-009 which are also located in the vicinity of the CRS area.

None of the soil samples collected in the CRS contained TPHd in concentrations that exceed the DEQ RBC for the construction worker receptor scenario (Table 5).

Soil samples obtained from locations CRS-01 through CRS-07 were not analyzed for PAHs because TPHd was not detected above 500 millagrams per kilogram (mg/kg).

Arsenic was the only metal to exceed the industrial PRG in soil samples collected from the CRS (Table 7). As in other areas of the site, the arsenic concentration in the majority of the soil samples obtained from the CRS exceeded the industrial PRG. However, the PRG for arsenic is significantly lower than the site-specific background concentration. Figures 18, 19, and 20 show the arsenic, chromium, and lead concentrations for soil samples collected at the Yard.

Lead was detected above the site specific background concentration in two locations (CRS-04 at 0.5 feet bgs and CRS-06 at 0.5 feet bgs). None of the soil samples obtained from the CRS contained lead at concentrations exceeding the industrial PRG. Arsenic was not detected above the background concentration in any of the soil samples obtained in the CRS.

None of the samples obtained from the CRS contained chromium concentrations that exceed the industrial PRG. The site-specific background concentration for chromium was exceeded in three of the four sampling locations in CRS.

4.1.2 Classification Yard

Investigated areas within the Classification Yard include the car repair shed (One-Spot) and three USTs. The USTs were evaluated as described in Section 4.1.1.2.5 and the investigation of the One-Spot is described below. The Yard hump was also located within the Classification Yard. Soil from the hump was used as backfill material for the former WWIPs.

4.1.2.1 Car Repair Shed (One Spot) Area

A total of four boreholes were advanced (OSA-01 through OSA-04) during the Phase III RI to evaluate soil impacts within the Car Repair (OSA) Area (Figure 6). None of the soil samples collected in the OSA contained TPHd in concentrations that exceed the DEQ RBC for the construction worker receptor scenario (Table 5).

The benzo (a) anthracene and benzo (a) pyrene concentration in one of the soil samples (OSA-04 at 0.5 feet bgs) exceeded the industrial PRG (Table 6). None of the soil samples collected in the former holding pond area contained PAHs in concentrations that exceed the DEQ RBC for the construction worker scenario.

Metals concentrations in soil samples collected from the OSA that exceeded the industrial PRGs include lead and arsenic (Table 7). As in other areas of the site, the arsenic concentration in the majority of the soil samples obtained from the OSA exceeded the industrial PRG. However, the PRG for arsenic is significantly lower than the site-specific background concentration. Figures 18, 19, and 20 show the arsenic, chromium, and lead concentrations for soil samples collected at the Yard.

Lead was detected above the industrial PRG in the surface soil sample (0.5 feet bgs) at location OSA-04. The sample collected at a depth of 2.5 feet at this same location slightly exceeded the site-specific background concentration.

Arsenic was detected below background concentrations in all but one sample (OSA-04 at 0.5 feet bgs) in the OSA.

None of the samples obtained from the OSA contained chromium concentrations that exceed the industrial PRG. The site-specific background concentration was exceeded in three of the four sampling locations in OSA.

4.1.2.2 Yard Hump

The borrowed material in the Yard hump was characterized through collection and analysis of soil samples from 12 locations (KJB-1 through KJB-12) along the axis of the southern half of the hump (Figure 6). In their 11 November 2002 letter, DEQ approved the use of the hump soil as fill material for the WWIPs based on this characterization. The analytical results of the hump sampling are summarized in Tables 5, 6, and 7.

4.1.3 South Departure Yard

Based on the operational history of the SDY, collection of soil samples was not performed in this area of the Yard.

4.1.4 Blair Street Yard

To evaluate soil impacts within the BSY area a total of six boreholes were advanced (BSY-01 through BSY-06, Figure 3) during the Phase III RI. None of the soil samples obtained in the BSY contained TPHd in concentrations that exceed the DEQ RBC for the construction worker receptor scenario (Table 5).

The benzo (a) pyrene concentration in one of the soil samples (BSY-03 at 2 feet bgs) exceeded the industrial PRG (Table 6). None of the soil samples collected in the BSY area contained PAHs in concentrations that exceed the DEQ RBC for the construction worker scenario.The benzo (b) pyrene concentration in two other samples collected from the BSY sample locations exceeded the DEQ RBC for the residential scenario.

Arsenic was the only metal to exceed the industrial PRG in soil samples collected from the BSY (Table 7). As in other areas of the site, the arsenic concentration in the majority of the soil samples obtained from the BSY exceeded the industrial PRG. The PRG for arsenic is significantly lower than the site-specific background concentration.

Lead was detected above the site specific background concentration in two locations (BSY-03 at 1 and 2 feet bgs and BSY-04 at 1 foot bgs). None of the soil samples obtained from the BSY contained lead at concentrations exceeding the industrial PRG. Arsenic was detected above the background concentration in only one (BSY-02 at 1 foot bgs) of the soil samples obtained in the BSY.

None of the samples obtained from the BSY contained chromium concentrations that exceed the industrial PRG. The site-specific background concentration for chromium was exceeded in each of the sampling locations in BSY.

4.1.5 North Departure Yard

Soil samples were collected from eleven locations during two separate site investigations within the NDY area (Figure 4). During the Phase III RI, three soil boreholes were advanced (NDY-01 through NDY-03). During an investigation of a 20-acre parcel along the west side of the NDY (see Section 2.4.10) in 2003, eight soil boreholes were advanced (B-1 through B-8) and one surface soil sample (B-9) was collected. None of the soil samples obtained in the NDY contained TPHd in concentrations that exceed the DEQ RBC for the construction worker receptor scenario (Table 5).

The benzo (a) pyrene concentration in one of the soil samples (NDY-02 at 5.5 feet bgs) exceeded the industrial PRG (Table 6). None of the soil samples collected in the NDY area contained PAHs in concentrations that exceed the DEQ RBC for the construction worker scenario.

Arsenic was the only metal to exceed the industrial PRG in soil samples collected from the NDY (Table 7). As in other areas of the site, the arsenic concentration in the majority of the soil samples obtained from the NDY exceeded the industrial PRG. The PRG for arsenic is significantly lower than the site-specific background concentration.

None of the soil samples obtained from the NDY contained lead at concentrations exceeding the site-specific background concentration. Arsenic was detected above the background concentration in only one (NDY-02 at 5.5 feet bgs) of the soil samples obtained in the NDY.

None of the samples obtained from the BSY contained chromium concentrations that exceed the industrial PRG. The site-specific background concentration for chromium was exceeded in two of the sampling locations in NDY.

4.2 Sediment

Sediment samples have been collected from the former WWIPs, and off property locations at the Maxwell Pond and the culvert drainage area on the east side of the Northwest Expressway.

4.2.1 Central Industrial Area

4.2.1.1 Wastewater Impoundment Ponds

Sediment samples were collected from the WWIPs during the RI phase on two occasions during 1994 and 2001. The WWIP sediment was stabilized prior to backfilling and samples of the stabilized sediment were collected as described in Section 2.2.9. The sampling locations are shown on Figures 5 and 6. Sediment sample analysis included:

- VOCs
- TPH
- PAHs
- Metals

A summary of analytical results for sediment samples are presented in Table 4 through Table 8.

The DEQ RBC for TPHd for the construction worker receptor scenario was exceeded in approximately half of the sediment samples collected from the WWIPs prior to stabilization (Table 5). None of the remaining sediment samples contained TPHd in concentrations that exceed the DEQ RBC for the construction worker receptor scenario.

As described in Section 2.4.9, the WWIPs were closed in late 2002. Two samples of the stabilized sediment were collected from each of the WWIPs for analysis of PAHs and metals using the toxicity characteristic leaching procedure (TCLP) prior to backfilling. Based on the TCLP results, no PAHs or metals were detected in the samples at concentrations that exceed industrial PRGs.

4.2.2 Off Property and Other Investigation Areas

4.2.2.1 River Road Neighborhood (Northwest Expressway Culvert)

Ten sediment samples have been collected from the northeast end of the culvert that conveys stormwater from the yard under the Northwest Expressway to characterize potential impacts from stormwater runoff in this area. Four of the sediment samples (RR-S-001 through RR-S-004) were collected in 1996 and the other six samples (NWEX-1 through NWEX-6) were collected in August 2004. The samples were analyzed for TPH, PAHs, and metals. The locations of the sediment samples are shown on Figure 21.

Based on the analytical results, the TPHd concentration exceeded the DEQ RBC for the residential receptor scenario in 3 of the samples (RR-S-001, NWEX-1 and NWEX-3, Table 5). None of the sediment samples contained TPHd concentrations that exceeded the DEQ RBC for the construction worker scenario. None of the samples contained PAHs at concentrations that exceeded DEQ RBCs for the residential receptor scenario with the exception of benzo (a) pyrene (Table 6). The arsenic concentration in all of the samples except one (NWEX-2) exceeded the industrial PRG (Table 7). The arsenic concentration did not exceed the site-specific background concentration in any of the samples.

4.2.2.2 Maxwell Pond

Three sediment samples (BP-S001, BP-S002, and BP-S003) were collected from the Maxwell Pond (also referred to as the Borrow Pit) in 1994 during the Phase I RI for analysis of VOCs, TPH, PAHs, and metals. No VOCs or PAHs were detected in any of the three sediment samples (Tables 4 and 6). None of the TPHd concentrations in the samples collected from the Maxwell Pond exceeded the DEQ RBC for the construction worker receptor scenario (Table 5). The arsenic concentrations exceed the industrial PRG but not the site specific background concentration (Table 7). No other metals concentrations detected exceeded their respective industrial PRG.

4.3 Groundwater

The criteria listed below were used for comparison purposes only. These criteria were not intended to be used as cleanup levels for the Yard. Risk-based remedial goals for constituents detected in groundwater at the Yard have not been established, but will be established when the revised baseline HHRA is completed in 2005. RAOs for groundwater will be developed in the Feasibility Study.

The criteria used to identify COCs in groundwater are as follows:

- **VOCs:** Identification as a COC is based on USEPA's maximum contaminant levels (MCLs) and USEPA Region IX Tap Water PRGs
- **TPH:** Identification of TPH as a COC is based on the DEQ RBC for groundwater in excavations and the residential receptor scenario, as appropriate
- **PAHs:** Identification as a COC is based on USEPA's MCLs and USEPA Region IX Tap Water PRGs

- **Metals:** Identification as a COC is based on USEPA's MCLs and USEPA Region IX Tap Water PRGs

- **NAPL:** where present, is considered a COC.

Table 3B summarizes the potentially applicable regulatory criteria described above for each group of chemicals.

Groundwater samples are collected from the shallow, intermediate, and deep monitoring wells at the Yard and off property locations on a semiannual basis for analysis of VOCs, PAHs, and metals. The results of the groundwater sampling are submitted to the DEQ in semiannual groundwater monitoring reports. Historically, groundwater samples collected from the Yard have been analyzed for TPH and semivolatile organic compounds (SVOCs). In addition, reconnaissance-level groundwater samples have been collected during various investigation events. Tables 10 through 15 summarize the analytical data for groundwater samples collected at the Yard and off-property locations.

The following COCs have been identified in groundwater:

- VOCs

- TPHd

- PAHs

- Metals

- NAPL

4.3.1 Central Industrial Area Operable Unit

This section summarizes groundwater analytical data collected from monitoring wells screened in the shallow, intermediate, and deep portions of the water-bearing zones beneath the CIA. Detailed discussion of groundwater monitoring results can be found in quarterly and semiannual groundwater reports prepared by ERM and Kennedy/Jenks from 1996 through 2004. The groundwater monitoring network in the CIA consists of 16 shallow zone monitoring wells (CIA-MW-001 through CIA-MW-011, CIA-MW-017, CIA-MW-018, CIA-MW-019, CIA-MW-021, and CIA-MW-024) two intermediate zone monitoring wells (CIA-MW-020 and CIA-MW-022), three deep zone monitoring wells (CIA-DMW-001, CIA-DMW-002, and CIA-DMW-004), three shallow zone piezometers (CIA-PZ-001 through CIA-PZ-003), and one intermediate zone piezometer (CIA-PZ-004).

4.3.1.1 VOCs in the Shallow Zone:

Based on groundwater monitoring and sampling events over the past 4 years (2000 through 2004), VOCs are not detected above the USEPA MCLs in groundwater samples collected from nine of the 16 CIA OU shallow zone monitoring wells (Table 10). One or more VOCs are consistently detected at concentrations that exceed the MCLs in groundwater samples collected from the other seven CIA monitoring wells screened in the shallow zone. The VOCs that are detected at concentrations exceeding the MCLs include 1,1,1-trichloroethane (1,1,1-TCA), 1,1-dichloroethene (1,1-DCE), benzene, cis-1,2-dichloroethene, tetrachloroethene (PCE), trichloroethene (TCE), and vinyl chloride. The highest VOC detections are generally detected in the former turntable area and locomotive fueling area (monitoring wells CIA-MW-19 and CIA-MW-21).

The compound 1,4-dioxane was added to the list of VOC analytes in selected monitoring wells in the first 2004 semiannual monitoring event at the request of DEQ. The compound 1,4-dioxane was detected in the groundwater sample from onsite shallow zone monitoring well CIA-MW-021 at a concentration that exceeds the USEPA PRG (an MCL for 1,4-dioxane has not been established). The compound 1,1,1-TCA was also detected in the groundwater sample from CIA-MW-021 at a concentration that exceeds the MCL.

Isoconcentration maps for 1,1-DCE, PCE, and TCE within the shallow zone for the September 2004 monitoring event are presented in Figures 22, 23, and 24, respectively, to show the current VOC plume geometry. In general, the isoconcentration maps indicate the plume geometry for 1,1-DCE, TCE, and PCE are similar to previous sampling events and have not changed significantly during the past year. The maps also indicate that groundwater flow in the shallow zone has directly influenced VOC migration to the west of the CIA.

As previously discussed, Figure 10 presents a geologic cross-section through the River Road neighborhood, Yard, and Trainsong neighborhood that shows the vertical distribution of selected VOCs in groundwater observed during the September 2004 monitoring and sampling event.

Concentration and groundwater elevation versus time plots were generated for 1,1-DCE, PCE, and TCE in shallow zone monitoring wells CIA-MW-005, CIA-MW-012 (Trainsong neighborhood), CIA-MW-021, and RR-MW-009 (River Road neighborhood) to show the variation of constituent concentrations with groundwater fluctuations. The plots are included in Appendix A.

The concentration plot for shallow monitoring well CIA-MW-005 shows some correlation between groundwater elevations and concentrations of 1,1-DCE and TCE. As groundwater elevations decrease in the fall, TCE concentrations increase, and as groundwater elevations increase in the spring, TCE concentrations decline. Concentrations of PCE appear to increase as the groundwater elevation increases in monitoring well CIA-MW-005.

The concentration versus time plot for shallow monitoring well CIA-MW-012 shows an inverse relationship between groundwater elevations and VOC concentrations. Groundwater elevations generally decline during the spring while VOC concentrations increase. As the groundwater elevations decrease in the fall, VOC concentrations increase. The concentration versus time plot for shallow monitoring well CIA-MW-021 does not show as strong a correlation between groundwater elevations and VOC concentrations because of the lack of groundwater level data. Correlation of groundwater levels and VOC data for this well has been difficult because of the presence of NAPL. The concentration of VOCs in monitoring well RR-MW-009 has been declining or not detectable since 2001 and a direct correlation with groundwater levels cannot be determined.

4.3.1.2 VOCs in the Intermediate and Deep Zone

Based on groundwater monitoring and sampling events over the past four years (2000 through 2004), VOCs have not been detected in groundwater samples collected from the two intermediate zone and three deep zone monitoring wells in the CIA with the exception of a low concentration of 1,3-dichlorobenzene in a sample collected from deep monitoring well CIA-DMW-004 in March 2004.

4.3.1.3 TPHd in the Shallow Zone

Analysis for TPH was conducted on groundwater samples collected from 14 shallow zone monitoring wells in the CIA generally from 1994 through 1997 (Table 11). Figure 25 shows TPHd and TPHho isoconcentration contours in groundwater. Measurable NAPL is typically observed in monitoring wells CIA-MW-007, CIA-MW-019, and CIA-MW-021 during the semiannual monitoring events.

4.3.1.4 TPHd in the Intermediate and Deep Zone

TPH has not been detected in the groundwater samples collected from the two intermediate monitoring wells CIA-MW-20 or CIA-MW-22 (located adjacent to shallow zone monitoring well CIA-MW-021). No NAPL has been observed in any of the intermediate or deep monitoring wells.

4.3.1.5 PAHs in the Shallow Zone

Based on historical analytical results of groundwater samples collected from the CIA, PAH concentrations are detected above the PRGs in only three of the 16 shallow zone monitoring wells (CIA-MW-003, CIA-MW-007, and CIA-MW-018). Figure 25 shows carcinogenic PAH isoconcentration contours in groundwater. The highest PAH concentrations are detected in the samples collected from monitoring well CIA-MW-003. Concentrations of PAHs that exceed PRGs were also detected in reconnaissance groundwater samples [FWT-10, FWT-12 (former creosote AST), FWT-19, FWT-20, and FWT-24 (former retort building)] in the vicinity of monitoring wells CIA-MW-003 and CIA-MW-018. Reconnaissance groundwater samples collected from well points WP-B009 and WP-C010, located on the west side of Bethel Drive in this area did not contain PAH concentrations that exceed the PRGs (Table 12).

4.3.1.6 PAHs in the Intermediate and Deep Zones

Based on the historical analytical results of groundwater samples collected from intermediate and deep zone monitoring wells in the CIA, no PAHs are detected in these zones.

4.3.1.7 Metals in the Shallow Zone

Total metals concentrations of arsenic, chromium, and lead in groundwater samples collected from some shallow zone monitoring wells in the CIA have exceeded the USEPA MCL in one or more historical sampling event (Table 13). However, where analysis for dissolved metals was performed, the concentrations of these metals were below the MCL or only slightly exceeded the MCL. The monitoring wells where total metals concentrations exceed the MCL include CIA-MW-005 (Pb), CIA-MW-007 (As, Cr, and Pb), CIA-MW-008 (Cr), CIA-MW-009 (As), CIA-MW-10 (Pb), CIA-MW-012 (As, Cr, and Pb), CIA-MW-018 (As), CIA-MW-019 (As), CIA-MW-021 (As), and CIA-PZ-002 (As). With the exception of arsenic in the reconnaissance groundwater sample collected from locations DSA-37 (former turntable area) and LFF-03 (north of the WWIPs), the concentrations of dissolved metals detected in reconnaissance groundwater samples was less than the MCL. The dissolved arsenic concentration in the reconnaissance groundwater sample collected from location LFF-03 slightly exceeded the MCL and the dissolved arsenic concentration in the sample collected from location DSA-37 was similar to the total arsenic concentration.

4.3.1.8 Metals in the Intermediate and Deep Zones

Metals concentrations (total or dissolved) have not been detected in intermediate zone monitoring wells in the CIA. The total cadmium concentration detected in deep monitoring well CIA-DMW-001 in one or more historical sampling event exceeded the MCL. The dissolved cadmium concentrations were less than the MCL in these same sampling events.

4.3.1.9 Nonaqueous Phase Liquid

During the Phase III RI, an evaluation of the extent of NAPL was conducted within the CIA. Based on this evaluation, NAPL (Bunker C and diesel) were observed in the turntable area, and throughout the FWT and LFF Areas. Observed NAPL thickness ranged from a sheen (throughout the FWT and LFF areas and the turntable area), to 1.77 feet near the soil drying slab (LFF-27).

Monitoring for the presence and thickness of NAPL is conducted during the semiannual groundwater monitoring events. Typically NAPL is detected in monitoring wells CIA-MW-007, CIA-MW-018, CIA-MW-019, and CIA-MW-021, and in piezometer CIA-PZ-002. Table 2 summarizes the NAPL measurements. The NAPL observed in monitoring well CIA-MW-021 has a higher viscosity relative to the other monitoring wells where NAPL is typically observed.

4.3.2 Classification Yard

Two monitoring wells are located within the Classification Yard (shallow zone monitoring well T3-MW-001 and deep zone monitoring well CIA-DMW-002). Historically, VOCs, PAHs, and TPHd are not detected in groundwater samples collected from these monitoring wells. Total arsenic, cadmium, and lead were detected in groundwater samples collected from monitoring well T3-MW-001 in four sampling events in 1997. However, total metals concentrations did not exceed the MCL in groundwater samples collected from this well in more recent sampling events. The dissolved metals concentrations were below the MCL in the groundwater samples in which the total metals concentration exceeded the MCL.

The total cadmium concentration detected in deep monitoring well CIA-DMW-002 in one or more historical sampling events exceeded the MCL. The dissolved cadmium concentrations were similar to the total cadmium concentrations in these same sampling events.

4.3.3 South Departure Yard

South Departure Yard monitoring wells include shallow zone monitoring wells SDY-MW-001 SDY-MW-002 and SDY-MW-003 (Figures 5 and 6). Constituents of concern in the SDY include VOCs and TPHd.

Based on historical results of groundwater samples collected in the SDY monitoring wells, PCE has been detected at concentrations that exceed the MCL in groundwater samples collected from monitoring well SDY-MW-001. The PCE concentration detected in groundwater samples collected from this well in recent sampling events has been below the MCL.

Analysis for TPH was conducted on groundwater samples collected from monitoring wells in the SDY generally from 1994 through 1997. No NAPL has been observed in any of the SDY monitoring wells.

4.3.4 Blair Street Yard

Two groundwater monitoring wells are located in the BSY (BSY-MW-001 and BSY-MW-002, Figure 3). Historically, VOCs, PAHs and metals have not been detected in groundwater samples collected within the BSY. As with other areas of the Yard, analysis for TPH was conducted on groundwater samples in the BSY from 1993 through 1997. No NAPL has been observed in either of the BSY monitoring wells.

Total arsenic was detected in reconnaissance sample location BSY-07 at a concentration that exceeds the MCL. The dissolved arsenic concentration in this sample was less than the MCL.

4.3.5 North Departure Yard

One groundwater monitoring well (NDY-MW-001) is located in the NDY (Figure 4). Historically, VOCs, PAHs, and metals were not detected above reporting limits in groundwater samples collected in the NDY. As with other areas of the Yard, analysis for TPH was conducted on groundwater samples in the NDY from 1993 through 1997. TPHd has been detected in groundwater samples collected from monitoring well NDY-MW-001. However, no NAPL has been observed.

4.3.6 Off Property and Other Investigation Areas

Groundwater investigations are ongoing in off property areas including the River Road and Trainsong neighborhoods. The investigations include monitoring and sampling shallow, intermediate, and deep monitoring wells on a semiannual basis. The COCs in the off property areas include VOCs. Analysis for TPHd, PAHs, and metals has also been conducted on groundwater samples collected from these areas.

4.3.6.1 River Road Neighborhood

The monitoring well network in the River Road neighborhood consists of 11 shallow zone monitoring wells (RR-MW-001 through RR-MW-6 and RR-MW-008 through RR-MW-012), four intermediate zone monitoring wells (RR-MW-007, RR-MW-013, RR-MW-014, and RR-MW-015), and four deep zone monitoring wells (RR-DMW-001 through RR-DMW-004). In addition, groundwater samples were collected for VOC analysis from 41 domestic irrigation wells in the River Road neighborhood in 1999 and 2000. Analytical results of groundwater samples collected from the domestic irrigation wells were used to evaluate the placement of monitoring wells in the River Road neighborhood. Table 10 summarizes the groundwater VOC data for samples collected from monitoring wells and domestic irrigation wells.

4.3.6.1.1 VOCs in the Shallow Zone

Based on groundwater monitoring and sampling events over the past four years (2000 through 2004), VOCs are not detected above the USEPA MCLs in groundwater samples collected from River Road neighborhood shallow zone monitoring wells. One or more VOCs are consistently detected at concentrations that are less than the MCLs in monitoring well RR-MW-001. The VOCs that are typically detected in groundwater samples collected from monitoring well RR-MW-001 include 1,1,1-TCA, 1,1-dichloroethane (1,1-DCA), chloroform, cis-1,2-dichloroethene, PCE, and TCE. The VOC concentrations detected in groundwater samples collected from monitoring wells are generally consistent with the VOC concentrations detected in samples collected from the domestic irrigation wells.

4.3.6.1.2 VOCs in the Intermediate and Deep Zones

Based on the historical results of the groundwater samples collected from River Road neighborhood intermediate zone monitoring wells, VOCs [1,1,1-TCA, 1,1-dichloroethane (1,1-DCA), 1,1-DCE, cis-1,2-DCE, PCE, and TCE] are consistently detected at low concentrations (below MCLs) in monitoring wells RR-MW-007, RR-MW-013, and RR-MW-015. The highest VOC concentrations in the intermediate zone in the River Road neighborhood are typically detected in groundwater samples collected from monitoring well RR-MW-013. VOCs have not been detected in the shallow zone (monitoring well RR-MW-003) at this same location. The silt/clay unit that appears to separate the shallow and intermediate zones (discussed in Section 3.3.1) was not encountered during the installation of monitoring well RR-MW-013, indicating that the Gravel 1A and Gravel 1B zones may be continuous in this area. VOCs have historically impacted the intermediate zone downgradient to RR-MW-015.

Groundwater samples collected from deep zone monitoring well RR-DMW-003 consistently contain VOCs (1,1-DCA and cis-1,2-DCE) at low concentrations. PCE was consistently detected at low concentrations in groundwater samples collected from deep monitoring well RR-DMW-001 prior to September 2003. PCE has not been detected in this well since September 2003. Volatile organic compounds have not been detected in groundwater samples collected from the other deep zone monitoring wells in the River Road neighborhood. In addition, the compound 1,4-dioxane was detected in groundwater samples collected from intermediate zone monitoring wells RR-MW-013 and RR-MW-015 in 2004 (this compound was added to the VOC list of analytes in 2004).

4.3.6.1.3 TPHd, PAHs, and Metals in the Shallow Zone

Analysis for TPH was conducted on groundwater samples collected from River Road shallow zone monitoring wells RR-MW-001, RR-MW-002, and RR-MW-003 in 1996 and 1997. The TPHd concentrations in the groundwater samples collected from monitoring wells RR-MW-001 and RR-MW-002 exceeded the DEQ RBC for the residential receptor scenario. The TPHd concentrations in samples collected from monitoring well RR-MW-003 were typically less than the DEQ RBC or were not detected. PAHs have not been detected in samples collected from River Road neighborhood monitoring wells. Total metals (including arsenic, chromium, and lead) were detected in some samples collected from River Road neighborhood monitoring wells RR-MW-002, RR-MW-003, RR-MW-005, and RR-MW-012 at concentrations that exceed the MCL. However, the dissolved concentrations of these metals are below MCLs or are not detected.

4.3.6.2 Trainsong Neighborhood

The monitoring well network in the Trainsong neighborhood consists of five shallow zone monitoring wells (CIA-MW-012, CIA-MW-014, CIA-MW-015, CIA-MW-016, and CIA-MW-023), one intermediate zone monitoring well (CIA-MW-013), and one deep zone monitoring well (CIA-DMW-003). In addition, groundwater samples were collected for VOC analysis from 12 domestic irrigation wells in the Trainsong neighborhood in 1999 and 2000 and reconnaissance groundwater samples were collected during various phases of investigation. Analytical results of groundwater samples collected from the domestic irrigation wells and some of the reconnaissance sampling locations were used to evaluate the placement of monitoring wells in the Trainsong neighborhood.

4.3.6.2.1 VOCs in the Shallow Zone

Based on groundwater monitoring and sampling events over the past four years (2000 through 2004), VOCs are not detected above the USEPA MCLs in groundwater samples collected from four of the five Trainsong shallow zone monitoring wells. Several VOCs are consistently detected at concentrations that exceed the MCLs in groundwater samples collected from monitoring well CIA-MW-012. The VOCs that are detected at concentrations exceeding the MCLs include 1,1,1-TCA, 1,1-DCA, 1,1-DCE, chloroform, cis-1,2-dichloroethene, PCE, TCE, and vinyl chloride. The compound 1,4-dioxane has been detected in samples collected from monitoring well CIA-MW-012 at a concentration that is less than the PRG (no MCL has been established for 1,4-dioxane). Figures 22, 23, and 24 show the distribution of 1,1-DCE, PCE, and TCE in September 2004 in the shallow groundwater zone at the Yard and including the Trainsong neighborhood. The VOC concentrations detected in groundwater samples collected from monitoring wells are generally consistent with the VOC concentrations detected in samples collected from the domestic irrigation wells.

4.3.6.2.2 VOCs in the Intermediate and Deep Zones

Based on historical results of groundwater samples collected from intermediate monitoring well CIA-MW-013 (co-located with shallow zone monitoring well CIA-MW-012), VOCs are present in the intermediate zone but at significantly lower concentrations than the shallow zone. No VOCs have been detected in groundwater samples collected from deep zone monitoring well CIA-DMW-003 (also co-located with shallow monitoring well CIA-MW-012). The compound 1,4-dioxane was detected (at a concentration less than the PRG) in one of the two groundwater samples collected from intermediate zone monitoring well CIA-MW-013.

4.3.6.2.3 TPHd, PAHs, and Metals in the Shallow Zone

Analysis for TPH was conducted on groundwater samples collected from Trainsong shallow zone monitoring well CIA-MW-012 in 1996 and 1997. The TPHd concentrations in samples collected from monitoring well CIA-MW-012 were typically less than the DEQ RBC or were not detected. No PAHs have been detected in samples collected from Trainsong monitoring wells. Total metals (including arsenic, chromium, and lead) were detected in some samples collected from Trainsong neighborhood monitoring well CIA-MW-012 at concentrations that exceed the MCL. The dissolved concentrations of these metals were below MCLs or were not detected.

4.4 Surface Water

The criteria used to identify COCs in surface water are the same as for groundwater and are used for comparison purposes only. Risk-based remedial goals for constituents detected in surface water at the Yard will be established, if necessary, in the revised baseline HHRA. In addition, RAOs for surface water will be developed in the Feasibility Study, if necessary.

Surface water samples have been collected from the WWIPs, the Borrow Pit, and the River Road Ponds. Surface water sample analysis included VOCs, TPH, PAHs, and metals. Tables 10 through 15 summarize the analytical data for surface water samples collected at the Yard and off property locations.

Based on the analytical results of surface water samples collected, the following COCs have been identified:

- TPHd
- PAHs
- Metals
- NAPL

4.4.1 Central Industrial Area

Surface water samples were collected from the WWIPs in 1994 for analysis of VOCs, TPH, PAHs, and metals. The results of these samples indicated that VOCs were not detected with the exception of a low concentration of xylenes. TPHd was detected in surface water samples collected from the WWIPs. In addition, several PAH compounds including benzo (a) anthracene, benzo (a) pyrene, benzo (b) fluoranthene, and indeno (1, 2, 3-cd) pyrene, and metals including arsenic, cadmium, chromium, and lead exceeded their respective PRGs.

During the WWIP closure activities, pond water samples were collected from the WWIPs prior to discharging to the City’s sanitary sewer to evaluate if the discharge met the City’s discharge limitations. None of the constituent concentrations exceeded the discharge limitations and the pond water was discharged to the sewer.

4.4.2 Off Property and Other Investigation Areas

Surface water samples have been collected at off property locations including the River Road Ponds and the Maxwell Ponds.

4.4.2.1 River Road Ponds

In August 2004, surface water samples were collected from the three River Road ponds to evaluate the risk from volatilization of VOCs from surface water. The locations of the surface water sample obtained from the River Road ponds are shown on Figure 26. Volatile organic compounds were not detected in any of the 11 surface water samples collected from the River Road ponds.

4.4.2.2 Maxwell Pond

To evaluate the water quality in the Maxwell Pond (also referred to as the Borrow Pit), surface water samples (BP-SW001 and BP-SW002) were obtained in 1994 for analysis of VOCs, TPH, PAHs, and total metals. Methylene chloride was detected in both samples at a concentration that exceeds the PRG and the MCL. No other VOCs were detected in either sample. Acenaphthene and pyrene were detected in one of the samples (BP-SW001) at a concentration below the regulatory criteria. No other PAHs were detected in either sample. Metals were not detected in either sample with the exception of low concentrations of zinc.

4.5 Soil Vapor and Air Sampling

As dicussed in Section 2.4.11, soil vapor sampling has been conducted in the CIA, and Trainsong and River Road neighborhoods to assess the vapor intrusion pathway. The assessment was conducted to evaluate the potential for exposure of residents in the Trainsong neighborhood to TCE, PCE, and vinyl chloride volatilized from groundwater.

In 1999, isolation flux chamber sampling was conducted along Bethel Drive and within the Trainsong neighborhood. Figure 27 shows the 1999 flux chamber sample locations. Table 16 presents a summary of the 1999 flux chamber sample results. Based on the results of this sampling, the DEQ stated they could not make a final decision regarding concentrations of VOC in air based on the limited sampling data and recommended additional sampling.

Additional sampling was conducted in February, May June, July and August 2004. Figures 28, 29 and 30 show the 2004 sample locations. Tables 16, 17, and 18 summarize the results of the 2004 sampling. The purpose of the 2004 assessment was to evaluate whether there may be a positive correlation between emissions of TCE, PCE and vinyl chloride from the existing groundwater plume beneath the Trainsong neighborhood into soil gas and then into ambient air. Figures 31 and 32 show TCE and PCE isoconcentration maps for soil gas and groundwater in the Trainsong neighborhood for the February 2004 sampling event. The soil gas plume correlates well with the existing VOC groundwater plume. Figures 33 and 34 show TCE and PCE isoconcentration maps for soil gas and groundwater in the Trainsong neighborhood for the August 2004 sampling event. Concentrations of TCE in soil gas do not correlate with the VOC groundwater plume as well as PCE in soil gas for the August sampling event.

A summary of the sampling activities and results are presented in the *Assessment of the Vapor Intrusion Pathway* (Kennedy/Jenks, December 2004). Based on the results of the groundwater, soil gas and ambient air sampling conducted in the Trainsong neighborhood and the Yard, the following conclusions were made:

- The groundwater, soil gas, and crawlspace data collected during this assessment indicate that volatilization of PCE, TCE, and vinyl chloride from groundwater to soil gas is occurring.
- Concentrations of TCE detected in soil gas do not show a positive correlation with concentrations of TCE detected in the crawlspace air samples at the four residences.
- Some positive correlation between PCE concentrations detected in soil gas and crawlspace air samples can be observed at three of the four residences.
- PCE, TCE, and vinyl chloride detected in groundwater migrating from the Yard may contribute to these VOCs detected in the crawlspace samples, but the data suggests that other sources are also contributing to the VOCs detected in the crawlspaces and ambient air
- An evaluation of the ambient air data collected outside of the inferred VOC groundwater plume compared to the crawlspace and ambient air data collected in the Trainsong neighborhood suggests that PCE, TCE, and vinyl chloride detected in ambient air in the Trainsong neighborhood may be from sources other than impacted groundwater.
- Background ambient air data and indoor air concentrations predicted from soil gas data indicates that the contribution from volatilization from groundwater migrating from the Yard to indoor air concentrations may be minor relative to the other sources.

Section 5: Fate and Transport and Intrinsic Bioremediation

Data collected during the Phase IV RI regarding site physical characteristics and contaminant characteristics were used to evaluate contaminant fate and transport and intrinsic bioremediation (IBR). The contaminant fate and transport evaluation provided by ERM described in general terms how various natural processes may be expected to influence COC fate and transport. The intrinsic Bioremediation evaluation was based on site specific physical and chemical soil and groundwater data.

5.1 Fate and Transport

The following items were presented by ERM in the Phase IV RI as part of the fate and transport evaluation:

- Potential routes of COC migration;
- COC fate in the environment; and
- COC transport.

Potential routes of impacted migration for COCs at the Yard include leaching via infiltration of rainwater through impacted soil, groundwater transport, surface water transport, vapor-phase transport, and fugitive dust transport.

The fate or persistence of COCs in soil and groundwater is influenced mainly by the physical and chemical properties in the COCs and by biological processes that can degrade the COCs in these media. The fate of organic chemicals is primarily determined by the tendency of these compounds to volatilize, dissolve in water, or adsorb to soil. Chlorinated VOCs have the greatest volatilization potential under atmospheric conditions. PAHs typically exhibit relatively lower vapor pressures and do not volatilize as readily as VOCs. The heavier hydrocarbons present in TPH, creosote, and Bunker C fuel oil exhibit relatively low vapor pressures and are not typically considered volatile. There is a wide range of solubilities for the COCs detected at the Yard, but in general, most organic COCs can potentially dissolve in water. The soils at the Yard appear to be relatively low in carbon content and sorption is probably not a dominant process. Table 19 summarizes physical parameters for soil samples collected at the Yard.

Metals are inorganic COCs detected at the Yard. Metals are considered relatively immobile because they have a tendency to adsorb to natural surfaces present in the vadose and saturated zones. Surface adsorption is one of the most important processes governing metals transport in the subsurface.

The transport of COCs in the vadose zone and groundwater is facilitated by the properties of the COCs as well as by geologic and hydrogeologic conditions. COCs in the vadose zone can migrate as free-phase liquids, as dissolved constituents in percolating rain/surface water, or as vapors if they are sufficiently volatile. COCs dissolved in groundwater are transported primarily by advection. Based on the current VOC plume geometry, the plume appears to be stable or decreasing in size. The plume geometry is being tracked through continued groundwater monitoring and sampling.

Based on slug tests completed in five shallow monitoring wells during the Phase I and Phase IV RI, hydraulic conductivities in the upper portion of the shallow zone range from 2.6 to 249 feet per day, with an average of approximately 52 feet per day. This range of hydraulic conductivities indicates that the shallow zone is heterogeneous in composition. Hydraulic conductivities of soil samples analyzed by the American Society of Testing and Materials Method D 5080 range from one to three orders of magnitude less than the values measured during the slug testing.

5.2 Intrinsic Bioremediation

ERM conducted an IBR data evaluation as part of the Phase IV RI. The objective of the study was to determine the effectiveness of natural attenuation as a remedial alternative for the Yard based on an evaluation of bioremediation parameters. Table 20 summarizes the bioremediation parameters for samples collected during the evaluation. Natural attenuation is defined as the reduction of contaminant mass through naturally occurring processes including biodegradation, dispersion, dilution, sorption, volatilization, and chemical or biochemical stabilization, transformation, or destruction, *Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies* (U.S. EPA 2002).

Findings of the IBR evaluation include:

- Groundwater monitoring indicates that the bulk of the dissolved COC mass exists in the shallow zone.
- IBR activity is evident in the areas of the shallow zone impacted by TPH and VOCs. Biodegradation of chlorinated VOCs and TPH is a major process in the natural attenuation of groundwater impacts in the CIA.
- Electron acceptors (required by microorganisms for reductive dechlorination of chlorinated VOCs) are depleted in the former roundhouse area of the CIA.
- Presence of daughter products associated with the reductive dechlorination of PCE, TCE and 1,1,1-trichloroethane (including cis-1,2-DCE, 1,1-DCE and VC) in the former roundhouse area of the CIA, provide evidence of IBR activity.
- Apparent first-order biodegradation rate constants were estimated for removal of TPH and VOCs in areas to the north and west of the former roundhouse area. Biodegradation rates are similar in magnitude for both areas.
- The biodegradation rates for TPH are low due to a lack of electron acceptors.

In addition, ERM conducted tests in December 2000 on soil samples from the former roundhouse area, to determine the number of diesel degrading microorganisms present among the native microbes in the subsurface. These tests confirmed the presence of natural diesel-degrading microorganisms.

Section 6: Risk Assessment

6.1 Baseline Human Health Risk Assessment

A *Baseline Human Health Risk Assessment* (BHHRA) was completed in 2002 by ERM. The results of the draft HHRA concluded that based on various scenarios considered in the HHRA, further action was deemed necessary of address PAHs and arsenic in onsite soil. In addition, further action was deemed necessary to address VOCs in offsite groundwater. Although VOCs did not pose an unacceptable risk under groundwater conditions (i.e., outdoor use only), VOCs have been detected at concentrations above PRGs for residential water supply.

An update to the 2002 draft HHRA will be completed in 2005.

6.2 Ecological Risk Assessment

A Level I (scoping) ecological risk assessment was conducted by ERM as part of the Phase IV RI (*Site Ecology Scoping Report*). Site visits for the Level I assessment were conducted in April and August 2001. The assessment was performed by a qualified ecologist in accordance with ODEQ guidance for ecological risk assessments. The *Site Ecology Scoping Report* was submitted to DEQ in 2002.

Based on the Level I assessment, ERM made the following recommendations:

- No ecological receptors or exposure pathways occur in the CIA and further ecological evaluation in the CIA is unwarranted

- A Level II (screening) ecological risk assessment is recommended for the Blair Street Yard (surficial soil impacts), the Borrow Pit (sediment and surface water impacts), and the River Road Ponds (sediment and surface water impacts).

The DEQ has not commented on the report.

Section 7: Summary

The Yard is an active railyard that has been in operation since the early 1870s. The yard is zoned I-3 for heavy industrial activity. Union Pacific plans to continue its industrial activity at the Yard for the foreseeable future.

A number of structures and operation areas, including the roundhouse and turntable, the car repair shed, the locomotive fueling facility, the wood treatment facility, and the oil/water separator, were constructed in the late 1920s and early 1930s. The wastewater impoundments were constructed in 1941 and modified several times during their use. Additional locomotive fueling facilities were constructed in the late 1950s during the conversion from oil-fired to diesel-fueled locomotives. The holding ponds and associated equipment that handled wastewater from the locomotive wash and the A&WE shop were constructed in 1958.

A preliminary groundwater investigation and four RI phases (Phase I, Phase II, Phase III, and Phase IV) have been completed at the Yard since 1993 with DEQ oversight. The CIA historically has been the center of locomotive and rail car maintenance operations in the Yard and, thus, has been the focus of the RI. As each phase of the RI was completed, additional phases were implemented based on data gaps identified from the previous phase of work. The focus of the four RI phases was characterization of soil, groundwater, sediment, and air on the Yard and surrounding neighborhoods. The following sections present an overall summary of nature and extent of soil, groundwater, sediment and soil gas impacts at the Yard and surrounding neighborhoods.

7.1 Soil

7.1.1 CIA

The COCs in soil identified during the RI include TPHd, carcinogenic PAHs, and metals (arsenic, lead, and chromium). Localized areas of TPH, PAH, and arsenic, lead, and chromium concentrations in soil that exceed regulatory criteria or background concentrations (metals) have been identified throughout the CIA. The impacted soils can be attributed to industrial activities at the locomotive fueling facilities, the wood treatment facility, diesel shop and roundhouse, burn pit and disposal pit, auto and work equipment shop, wastewater treatment facilities, storage tanks, and a car repair shed.

Surface and subsurface soil throughout the CIA have been impacted with COCs, with several areas in the CIA exceeding DEQ RBCs. Based on limited fate and transport evaluation conducted by ERM during the RI process it appears that impacted surface and subsurface soil source areas in the CIA, particularly near the roundhouse and fueling facility, may have contributed to impacted groundwater beneath the Yard.

7.1.2 Classification Yard

The primary COCs in soil detected in the CY include PAHs and lead in concentrations that exceed the PRG. The concentration of two carcinogenic PAH compounds in one of the soil samples collected in the OSA exceeded the industrial PRG. Soil impacts at the CY are predominantly from 0 to 3 feet bgs. Soil impacts in other areas of the Yard are minimal compared to the CIA.

7.2 Sediment

Sediment samples have been collected from the former WWIPs, and off property locations at the Maxwell Pond and the culvert drainage area on the east side of the Northwest Expressway.

The WWIPs were closed in late 2002. Based on the TCLP results from samples of the stabilized sediment from each of the WWIPs, no PAHs or metals were detected at concentrations that exceed the regulatory levels. The arsenic concentration in sediment samples collected from the Maxwell Pond and the Northwest Expressway culvert area exceed the industrial PRG, but not the site specific background concentration.

7.3 Groundwater

Groundwater samples are collected from the shallow, intermediate, and deep monitoring wells at the Yard and off property locations on a semiannual basis for analysis of VOCs, PAHs, and metals. The COCs in groundwater identified during the RI include VOCs, TPH (NAPL), carcinogenic PAHs, and metals. Based on the limited fate and transport evaluation conducted by ERM during the RI process, VOCs are the constituent at the Yard that are the most mobile. The source of groundwater impacts appears to be from the roundhouse and fueling facility located in the CIA. The VOC groundwater plume migrates beneath the Trainsong and River Road neighborhoods. The plume geometry has remained constant in the Trainsong neighborhood, but has decreased in the River Road neighborhood since 2001. Groundwater impacts at the Yard are most significant in the CIA.

7.4 Soil Gas and Ambient Air

Analytical data for soil gas and ambient outdoor air collected during the RI process and subsequent site investigations indicate that volatilization of PCE, TCE, and vinyl chloride from the VOC groundwater plume into soil gas is occurring. Some positive correlation between PCE concentrations detected in soil gas and crawlspace air samples were observed at several residences in the Trainsong neighborhood during 2004.

An evaluation of the ambient air data collected outside of the inferred VOC groundwater plume compared to the crawlspace and ambient air data collected in the Trainsong neighborhood suggests that PCE, TCE, and vinyl chloride detected in ambient air in the Trainsong neighborhood may be from sources other than impacted groundwater. Background ambient air data and indoor air concentrations predicted from soil gas data indicates that the contribution from volatilization from groundwater migrating from the Yard to indoor air concentrations may be minor relative to the other sources.

Section 8: References

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