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ENVIRONMENT

Case Closure Summary Report
Former BP Service Station #11133
2220 98th Avenue
Oakland, California
ACEH Case #RO0000403

"I declare that to the best of my knowledge at the present time, that the information and/or recommendations contained in the attached document are true and correct."

Date:
November 30, 2011

Submitted by:

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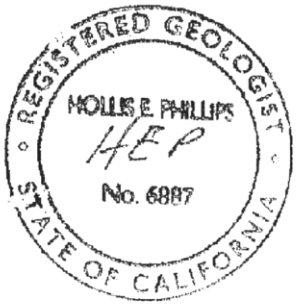

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Case Closure Summary Report

Former British Petroleum Station #11133
2220 98th Avenue
Oakland, California

November 30, 2011

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Case Closure Summary Report

Former British Petroleum Station #11133

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Acronyms and Abbreviations

1,2-DCA	1,2-dichloroethane
ACEH	Alameda County Department of Environmental Health
ASTM	American Society for Testing and Materials
bgs	below ground surface
BP	British Petroleum
BTEX	benzene, toluene, ethylbenzene, and xylenes
CAP	Corrective Action Plan
COC	constituent of concern
DIPE	di-isopropyl ether
DWR	California Department of Water Resources
EDB	1,2-dibromoethane
ESL	environmental screening level
ETBE	ethyl tert-butyl ether
FS	Feasibility Study
ft/ft	feet per feet
GWE	groundwater extraction
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
msl	mean sea level

MTBE	methyl tert-butyl ether
MWH	Montgomery Watson Harza
ppb	parts per billion
ppm	parts per million
ppmv	parts per million by volume
RBCA	Risk-Based Corrective Action
Report	Case Closure Summary Report
RWQCB	San Francisco Bay Regional Water Quality Control Board
SVE	soil vapor extraction
TAME	tert-amyl methyl ether
TBA	tert-butyl alcohol
TOSCO	TOSCO Marketing Company
TPHg	total petroleum hydrocarbons as gasoline
USEPA	United States Environmental Protection Agency
UST	underground storage tank
VET	vapor extraction test
µg/L	micrograms per liter

1. Introduction

ARCADIS has prepared this Case Closure Summary Report (Report) for the former British Petroleum (BP) Station #11133, located at 2220 98th Avenue in Oakland, California (the Site). Case closure is warranted for the Site based on the following:

- The Site has been adequately characterized;
- Petroleum hydrocarbon sources and residual hydrocarbons in site soil have been removed as evidenced by the most recent site analytical data;
- Concentrations of constituents of concern (COCs) in site groundwater have exhibited decreasing trends;
- Active remediation was conducted at the Site between 1994 and 1998;
- The plume is not migrating offsite;
- No sensitive receptors are likely to be impacted, including surface water bodies, municipal wells, and drinking water sources; and
- The Site presents no significant risk to human health and the environment.

The Report is organized as follows:

- Section 2 provides the site background;
- Section 3 provides a summary of previous investigations completed at the Site;
- Section 4 summarizes remedial activities completed at the Site;
- Section 5 describes the effectiveness of site remedial actions;
- Section 6 presents the beneficial uses; and
- Section 7 presents the conclusions with a request for case closure.

Appendix A shows historical sample locations; **Appendix B** includes groundwater sampling protocols; **Appendix C** includes geologic cross-sections; and **Appendix D**

presents concentration versus time charts for total petroleum hydrocarbons as gasoline (TPHg) and benzene.

2. Site Background

The Site currently consists of a vacant, flat lot covered with gravel, soil, concrete, and low-lying vegetation, and is located at the southeastern corner of 98th Avenue and Bancroft Avenue in Oakland, California (**Figure 1**). BP acquired the Site from Mobil Oil Corporation in 1989; and, in January 1994, BP transferred the Site to TOSCO Marketing Company (TOSCO; now known as ConocoPhillips) and has not operated the facility since. TOSCO ceased gasoline retail operations at the Site in 1999.

The land use in the immediate vicinity of the Site is mixed commercial and residential.

2.1 Site Geology and Hydrogeology

According to the East Bay Plain Groundwater Basin Beneficial Use Evaluation Report (Beneficial Use Report; California Regional Water Quality Control Board – San Francisco Bay Region [RWQCB] 1999), the Site is located within the Oakland Sub-Area of the East Bay Plain of the San Francisco Basin. The Oakland Sub-Area contains a sequence of alluvial fans; and the alluvial fill thickness ranges from 300 to 700 feet deep. There are no well-defined aquitards, such as estuarine muds. The largest and deepest wells in this sub-area historically pumped one to two million gallons per day at depths greater than 200 feet. Overall, sustainable yields are low due in part to low recharge potential. The Merritt sand in West Oakland was an important part of the early water supply for the City of Oakland, but before the turn of the last century, septic systems contaminated the water supply wells.

Throughout most of the Alameda County portion of the East Bay Plain, from Hayward north to Albany, water level contours show that the general direction of groundwater flow is from east to west (i.e., from the Hayward Fault to the San Francisco Bay). Groundwater flow direction generally correlates to topography. Flow direction and velocity are also influenced by buried stream channels that are typically oriented in an east to west direction. The site elevation is approximately 40 feet above mean sea level (msl), where regional topography slopes to the west (United States Geological Survey Topographic Map, Oakland East Quadrangle – 7.5 Minute Series). The topography of the surrounding area is characterized by valleys and gentle slopes. The regional surface and groundwater flow is generally to the southwest, towards San Francisco Bay. Historically, groundwater flow direction at the Site has been variable but is predominantly to the west or west-southwest (**Table 1**). The hydraulic gradient has ranged between 0.009 to 0.01 feet per feet (ft/ft) since 2006 (**Table 1**).

In general, the Site is underlain by clay, silty clay, and clayey silt to depths of approximately 18 to 20 feet below ground surface (bgs). Geologic cross-sections generated by URS Corporation (URS) (**Appendix C**) show a silty sand lens at approximately 3 to 4 feet bgs, and several silty sand and silty gravel lenses from approximately 13 to 17 feet bgs. Sandy clays, sandy silts, and silty sands are encountered at depths of approximately 19 to 40 feet bgs at the Site. The silty to clayey sand lens tapers to the south and is not encountered in well AW-4, which consists of silty clays to 35 feet bgs. The lens of sandy clays, sandy silts, and silty sands is underlain by silty clays, which extend to the total explored depth of all borings.

Based on the rising head slug test conducted in July 1990, by Alton Geoscience (Alton), the transmissivity, hydraulic conductivity, and linear velocity of aquifer material at the Site were calculated to be 9.0 $feet^2$/day, 0.6 feet/day (2.1×10^{-4} centimeters/second), and 6.0×10^{-3} feet/day, respectively. These values were reported to be representative of low permeability soil encountered at the Site and are within accepted values for clayey to silty sand. Results of the aquifer pump test conducted at the Site in April 1991, on recovery well RW-1 with nine observation wells located between 35 and 135 feet from the pumping well, indicated storativity and transmissivity values of 0.3493 and 0.1491 $feet^2$/minute, respectively. Assuming an aquifer thickness of 25 feet (based on the screen interval for recovery well RW-1), hydraulic conductivity at the Site was calculated to be 8.588 feet/day (3.029×10^{-3} centimeters/second). This hydraulic conductivity value corresponds to typical published values for silty sands (Fetter 1988).

3. Site Characterization Activities

The following is a summary of site characterization activities. Historical soil, groundwater from borings, and soil-gas data are summarized in **Tables 2a**, **2b**, and **2c**, respectively; and historical sample locations are presented in **Appendix A**.

3.1 Previous Investigations

3.1.1 1987 UST Excavation and Removal

In June 1987, Kaprealian Engineering, Inc. (Kaprealian) removed one 10,000-gallon, one 8,000-gallon, and one 5,000-gallon single-walled, steel gasoline underground storage tanks (USTs) from the southwestern portion of the Site (Broadbent & Associates, Inc. [Broadbent] 2009b). Soil samples (A1, A2, B1, B2, and C1) were then collected from the base of the tank cavity at depths of approximately 13.5 to 14 feet bgs. Laboratory analytical results indicated that TPHg was detected in the soil samples at concentrations ranging from 12 parts per million (ppm) (C1 at 13.5 feet bgs) to 420 ppm (A1 at 13.5 feet bgs). In addition, benzene was detected at concentrations between 0.74 ppm (C1 at 13.5 feet bgs) and 23 ppm (B1 at 13.5 feet bgs).

3.1.2 Groundwater Monitoring Well Installation and Early Site Investigations

In May 1988, three groundwater monitoring wells (MW-1 through MW-3) were installed onsite, and soil and groundwater analytical data were collected. TPHg was detected in two of the soil samples and one groundwater sample at concentrations of 2 ppm (MW-1 at 20 feet bgs), 210 ppm (MW-1 at 15 feet bgs), and 76,000 parts per billion (ppb; MW-1), respectively. Benzene and toluene were detected in soil samples from all three monitoring well locations at concentrations ranging from 0.0007 to 7.1 ppm (MW-1 at 15 feet bgs) and from 0.0007 to 20 ppm (MW-1 at 15 feet bgs), respectively. Ethylbenzene was detected in three of the soil samples at concentrations ranging from 0.0012 to 4.5 ppm (MW-1 at 15 feet bgs); and xylenes were detected in two of the soil samples at concentrations of 0.021 ppm (MW-1 at 20 feet bgs) and 23 ppm (MW-1 at 15 feet bgs). Benzene, toluene, ethylbenzene, and/or xylenes were detected in groundwater samples collected from MW-1 and MW-2 at maximum concentrations of 29,000 ppb, 23,000 ppb, 12,000 ppb, and 2,600 ppb (all at MW-1), respectively (Broadbent 2009b). **Table 2a** contains soil data and **Table 3** contains historical groundwater data.

In January 1990, Alton oversaw the advancement of eight soil borings to various depths ranging between 16 and 35 feet bgs, and the installation of eight temporary

wells (TW-1 through TW-8) at the Site. Temporary well locations are shown in **Appendix A**. The fieldwork was completed as part of a qualitative groundwater survey, and survey results were reported in the Supplemental Site Investigation Report (Alton 1990). A groundwater sample was not collected from TW-4 because free product was measured in the well. TPHg was detected in six of the seven temporary wells sampled at concentrations ranging from 66,000 ppb (TW-5) to 720,000 ppb (TW-8). Benzene, toluene, ethylbenzene, and xylenes were detected in all seven of the sampled wells at maximum concentrations of 32,000 ppb (TW-6), 41,000 ppb (TW-6), 12,000 ppb (TW-8), and 71,000 ppb (TW-8), respectively. Soil samples were not collected for laboratory analysis from the well borings.

In May and June of 1990, Alton oversaw the advancement of five soil borings and the installation of four additional groundwater monitoring wells (AW-1 through AW-4) and one recovery well (RW-1). Wells AW-1 and RW-1 were installed onsite, and the remaining wells were installed offsite. Laboratory analytical results indicated that TPHg was detected in three of the soil samples at concentrations of 1 ppm (AW-4 at 21 feet bgs), 1.2 ppm (AW-1 at 20 feet bgs), and 33 ppm (RW-1 at 25 feet bgs). Benzene was detected in soil at four of the five boring locations, with the exception of AW-2, at concentrations ranging from 0.006 ppm (RW-1 at 10 feet bgs) to 1 ppm (RW-1 at 25 feet bgs). Ethylbenzene, toluene, and xylenes were detected in soil samples collected from AW-3, AW-4, and RW-1 at maximum concentrations of 0.71 ppm (RW-1 at 25 feet bgs), 0.04 ppm (AW-4 at 21 feet bgs), and 2.3 ppm (RW-1 at 25 feet bgs), respectively. No groundwater sample was collected from RW-1 due to the presence of free product. TPHg and benzene were detected in three wells at concentrations ranging from 66 ppb (AW-1) to 38,000 ppb (AW-4) and from 1.0 ppb (AW-1) to 18,000 ppb (AW-4), respectively. Toluene and ethylbenzene were detected in one well, AW-4, at concentrations of 2,300 ppb and 1,500 ppb, respectively; and xylenes was detected in two wells at concentrations of 42 ppb (AW-3) and 2,000 ppb (AW-4).

In July 1990, pump and slug test activities were conducted during which approximately 100 gallons of product and groundwater were pumped from recovery well RW-1 to control the migration of free product at the Site. This product and groundwater were then appropriately disposed of offsite. Pump and slug test results are summarized in Section 2.1.

In February and March 1991, Alton oversaw the advancement of four soil borings (SBA-5 through SBA-8) that were converted into four groundwater monitoring wells (AW-5 through AW-8) at the Site. The fieldwork was completed as part of a Phase III site investigation, and investigation results were reported in the Phase III – Supplemental Site Investigation Study (Alton 1991). Laboratory analytical results

indicated that benzene, toluene, ethylbenzene, and xylenes were detected in soil samples collected from SBA-5 and SBA-6 at maximum concentrations of 0.091 ppm, 0.022 ppm, 0.008 ppm, and 0.04 ppm, respectively (all at SBA-6 at 10.5 to 11 feet bgs).

3.1.3 Supplemental Soil Boring and Groundwater Monitoring Well Installation

In 1994, EMCON collected supplemental soil boring samples at the Site; however, a report documenting the investigation results could not be found on file (Broadbent 2009b).

In December 1996, soil boring AW-9 was advanced to further delineate the extent of petroleum hydrocarbon contamination offsite (Alisto Engineering Group 1997). Soil boring AW-9 was converted to monitoring well AW-9, which was subsequently included in the ongoing groundwater monitoring program. Laboratory analytical results indicated that TPHg and benzene, toluene, ethylbenzene, and xylenes (BTEX) were non-detect in the soil samples collected from AW-9.

3.1.4 1998 UST Excavation and Removal

In October 1998, Gettler-Ryan, Inc., oversaw the removal of two 10,000-gallon USTs, one 12,000-gallon UST, and associated product piping (Gettler-Ryan, Inc. 1999). Approximately 655 tons of soil were excavated and disposed of offsite during this process; and no holes or cracks were observed in the tanks.

Following removal of the USTs and product piping, four tank pit sidewall soil samples (SW-1 through SW-4, from approximately 12.0 feet bgs), two tank pit groundwater samples (Water-1 and Water-2), and eight product piping soil samples (P1 through P8, from approximately 3.5 feet bgs) were collected and analyzed. TPHg and BTEX were not detected in the soil samples collected from the tank pit sidewalls; methyl tert-butyl ether (MTBE) was detected at concentrations of 0.099 ppm and 0.43 ppm in SW-3 and SW-2, respectively. TPHg was detected in one product piping soil sample, P7, at a concentration of 1.2 ppm. Benzene and toluene were detected in soil samples P5 and P7 at maximum concentrations of 0.067 ppm and 0.09 ppm, respectively. Ethylbenzene was detected at P5 at 0.0071 ppm; and xylenes and MTBE were each detected in three product piping soil samples at concentrations ranging from 0.029 ppm (P1) to 0.057 ppm (P5) and from 0.74 ppm (P5) to 4 ppm (P2), respectively. TPHg, benzene, toluene, ethylbenzene, xylenes, and MTBE were detected in both tank pit groundwater samples at maximum concentrations of 3,700 ppb, 98 ppb, 450 ppb, 56 ppb, 360 ppb, and 4,100 ppb (all at Water-2), respectively.

3.1.5 Previous Risk-Based Corrective Action Evaluations

In May 2000, Newfields, Inc. (Newfields) performed a risk-based corrective action (RBCA) evaluation for the Site using Oakland and American Society for Testing and Materials (ASTM) RBCA processes (Newfields 2000a). RBCA evaluations are used to categorize sites according to risk in order to select appropriate corrective action measures that are protective of human health and the environment. The residual gasoline and diesel constituent concentrations in onsite soil and groundwater were initially compared to the more conservative risk-based screening levels based on conservative, generic exposure and modeling parameters presented in the Oakland RBCA Tier 1 and Tier 2 look-up tables. When site conditions exceeded the Oakland RBCA Tier 1 and Tier 2 levels, further assessment was conducted using the Oakland RBCA Tier 3 analysis. The Tier 3 analysis utilized data that were representative of actual site conditions, and, thereby, provided a more accurate representation of existing and potential future risks. Results of the Oakland RBCA Tier 3 evaluation indicated that residual levels of petroleum hydrocarbons at the Site were below City of Oakland and United States Environmental Protection Agency (USEPA) acceptable cancer risk and non-cancer risk levels. It was thereby concluded that onsite soil and groundwater conditions should not pose a risk to current and future onsite workers or offsite residents.

In December 2000, Newfields submitted a revised RBCA evaluation for the Site to Alameda County Department of Environmental Health (ACEH) incorporating agency feedback and further detailing previously provided information (Newfields 2000b). However, the conclusions remained the same as in the May 2000 RBCA for the Site.

In October 2001, Cambria Environmental Technology, Inc. (Cambria) conducted a supplemental investigation to assess inhalation potential exposure risks, particularly to offsite residents, from residual subsurface hydrocarbon concentrations (Cambria 2002). As part of the supplemental investigation, soil, soil vapor, and groundwater samples were collected from six soil borings (B-1 through B-6) drilled in the eastern and southeastern property boundaries. TPHg was detected in three of the soil samples at concentrations ranging from 0.084 ppm (B-5-5.5) to 1.6 ppm (B-2-5); and xylenes were detected in one soil sample (B-6-5.5) at 0.013 ppm. Groundwater analytical data indicated that TPHg, benzene, ethylbenzene, and xylenes were detected at five out of six borings, with the exception of B-1, at maximum concentrations of 110,000 micrograms per liter (µg/l; B-6), 30,600 µg/l (B-6), 7,060 µg/l (B-4), and 36,600 µg/l (B-4), respectively. Toluene and MTBE were detected at all six boring locations at maximum concentrations of 42,100 µg/l (B-5) and 1,500 µg/l (B-2), respectively. Soil-vapor analytical data indicated that TPHg was detected in all soil-gas samples at

concentrations ranging from 1.3 to 11 parts per million by volume (ppmv; at B-2-V2); benzene was detected at concentrations ranging from 0.0033 to 0.34 ppmv (at B-6-V3); toluene was detected at concentrations ranging from 0.0033 to 0.23 ppmv (at B-6-V3); ethylbenzene was detected at concentrations ranging from 0.0027 to 0.15 ppmv (at B-6-V3); xylenes were detected at concentrations ranging from 0.0031 to 0.59 ppmv (at B-6-V3); and MTBE was detected at concentrations ranging from 0.0033 to 0.062 ppmv (at B-6-V3). Soil and soil vapor data are summarized in **Tables 2b and 2c**.

In May 2002, Montgomery Watson Harza (MWH) performed a revised RBCA evaluation for the Site using Oakland and ASTM Tier 1 through Tier 3 RBCA values (MWH 2002). The purpose of the evaluation was to assess whether petroleum hydrocarbon constituents detected in soil, soil vapor, and groundwater at the Site presented a potential health risk to current and future onsite workers, and offsite residents. This revised RBCA evaluation primarily incorporated the October 2001 Cambria supplemental investigation soil, soil vapor, and groundwater analytical results to adequately evaluate potential exposure risks to the residential properties adjacent to the Site.

Results of the MWH RBCA evaluation indicated that the theoretical upper-bound incremental lifetime cancer risks and non-cancer hazard indices associated with levels of TPH, BTEX, and MTBE in site soil and groundwater were below acceptable levels. Accordingly, it was concluded that no further action was necessary for the protection of human health at the Site.

3.1.6 URS Soil and Groundwater Investigation

In July and September 2005, URS conducted a soil and water investigation in order to further delineate the contaminant plume and perform a preferential pathway evaluation (URS 2005). Plume delineation activities included advancing two soil boring pairs (SB-1 and SB-2) consisting of one soil boring and one Hydropunch® boring at each location. Boring pair SB-1 was advanced to assess the extent of dissolved or free-phase hydrocarbons and to evaluate the potential for offsite contaminant migration to the southeast, in front of the neighboring residence. Boring pair SB-2 was advanced to assess the extent of dissolved hydrocarbons cross-gradient of wells AW-5 and AW-6.

Preferential pathway evaluation activities included advancing two soil borings (SB-3 and SB-4) along the sanitary sewer line—running beneath the north and northwestern section of the Site at approximately 6.5 to 7 feet bgs—to assess its potential to act as a preferential pathway for contaminant migration. In addition, three existing downgradient vapor extraction wells (VEW-4, VEW-5, and VEW-8) located in the vicinity of the

sanitary sewer line were sampled. A groundwater sample could not be collected from VEW-5 due to dry conditions.

A total of 22 soil samples and two groundwater samples were collected from borings SB-1 through SB-4. TPHg was detected in four soil samples collected from boring location SB-1 at concentrations ranging from 0.19 ppm (at 34.5 feet bgs) to 64 ppm (at 25 feet bgs). Ethylbenzene was detected in one soil sample (SB-1 at 25 feet bgs) at 0.2 ppm; MTBE was detected in three soil samples at concentrations of 0.0097 ppm (SB-1 at 37.5 feet bgs), 0.062 ppm (SB-2 at 30 feet bgs), and 0.068 ppm (SB-2 at 25 feet bgs); and tert-amyl methyl ether (TAME) was detected in two soil samples collected from boring location SB-2 at concentrations of 0.015 ppm (30 feet bgs) and 0.017 ppm (25 feet bgs). Groundwater analytical data indicated that TPHg, benzene, ethylbenzene, xylenes, and MTBE were detected at SB-1 at concentrations of 2,000 µg/l, 2.6 µg/l, 52 µg/l, 1.3 µg/l, and 6.5 µg/l, respectively. TPHg, ethylbenzene, xylenes, TAME, and MTBE were detected at SB-2 at concentrations of 260 µg/l, 2.3 µg/l, 0.69 µg/l, 15 µg/l, and 61 µg/l, respectively. Results of the investigation indicated that: (1) light non-aqueous phase liquid was not migrating to the east/southeast or to the northeast beneath the neighboring residences; and (2) the sanitary sewer did not appear to be acting as a preferential pathway even during seasons of high groundwater. Refer to **Appendix A** for sample locations.

3.1.7 Broadbent Soil and Groundwater Investigation

In July 2009, Broadbent conducted a soil and groundwater investigation to address the potential migration of contaminants downgradient of the Site based on elevated concentrations observed in offsite well AW-2 (Broadbent 2009a). Three soil borings (SB-1 through SB-3) were installed along the southwest side of Bancroft Avenue to the west of existing well AW-2; and soil and groundwater samples were collected from each boring and submitted to a California-certified laboratory, Calscience Environmental Laboratories, Inc., for chemical analyses. All soil and groundwater sample analytical results were below laboratory reporting limits. Accordingly, Broadbent concluded that: (1) the groundwater contaminant plume appeared to be delineated in the downgradient [southwest] direction; and (2) further offsite characterization was not warranted.

3.1.8 ARCADIS Well Installation

In September 2010, ARCADIS installed two injection wells (IW-1 and IW-2) and an observation well (OW-1) at the Site as part of a pilot study. Well installation and results are discussed in Section 4.2.4

3.2 Ongoing Groundwater Monitoring

To date, a total of 26 groundwater monitoring, extraction, and injection wells have been installed at the Site and in the site vicinity. These include 13 groundwater monitoring wells, seven of which are onsite (MW-1, MW-2, MW-3, AW-1, AW-5, AW-6, and RW-1) and six are offsite (AW-2, AW-3, AW-4, AW-7, AW-8, and AW-9). Well RW-1 was installed as a dual extraction and monitoring well. There are eight onsite vapor extraction wells (VW-1 through VW-3 and VEW-4 through VEW-8) and one offsite extraction well (VEW-9). Additionally three wells (IW-1, IW-2, and OW-1) were installed as part of a pilot study.

A quarterly groundwater monitoring program was initiated in April 1991 and is ongoing with a modified sampling schedule. Since the first quarter of 2001, the monitoring program at the Site has been conducted on a semiannual basis. Monitoring of offsite wells AW-7, AW-8, and AW-9 was discontinued in 1998; and monitoring of onsite well MW-2 and offsite well AW-3 was discontinued in 2000. Currently, wells MW-1, MW-3, AW-1, AW-4, AW-5, AW-6, and RW-1 are monitored semiannually (first and third quarters), and AW-2 is monitored annually (third quarter).

3.2.1 Investigation Methods

Soil and groundwater samples appear to have been collected appropriately for environmental investigation and data gathering purposes. During the 2005 soil and groundwater investigation, soil borings were continuously cored using direct push technology, and soil samples were collected in clear acetate sleeves for laboratory analysis. Groundwater samples were collected using Hydropunch® technology; the Hydropunch® sampler was advanced to the appropriate depth interval (i.e., where groundwater was observed in the initial lithologic soil boring), and samples were collected after approximately one hour once sufficient groundwater had accumulated in the Hydropunch® screen (URS 2005).

During the 2009 soil and groundwater investigation, soil borings were advanced using a direct push drilling technique, and soil samples were collected using split-spoon samplers and brass sleeves. For groundwater sampling, a temporary polyvinyl chloride casing with screened perforations between 20 and 30 feet bgs was installed within each borehole, and groundwater samples were collected using disposable polyethylene tubing with a check valve or peristaltic pump, or using factory decontaminated disposable bailers.

Groundwater samples have traditionally been withdrawn from monitoring wells at the Site using a peristaltic pump or disposable polyethylene bailers. Broadbent began completing the routine groundwater monitoring in the second quarter of 2006. Groundwater monitoring data prior to April 2006 were collected by Atlantic Richfield Company and their previous consultants. Groundwater sampling protocols are provided as **Appendix B.**

3.3 Soil and Groundwater Quality Evaluation

3.3.1 Soil

Impacted soil has been encountered historically during UST and product pipeline removal, soil boring sampling, and monitoring well installation sampling. The most recent soil samples (at locations SB-1 through SB-3) were collected in July 2009 as part of the soil and groundwater investigation completed by Broadbent. Laboratory analytical results indicated that TPHg, BTEX, and MTBE were not detected at levels above their respective laboratory reporting limits.

Historical soil data are summarized in **Table 2a**.

3.3.2 Groundwater

Historically, TPHg has been detected at concentrations above the laboratory reporting limits in groundwater samples collected from wells AW-1 through AW-8, IW-3, MW-1 through MW-3, RW-1, and VEW-4. The highest concentration reported was in well RW-1 (1,800,000 µg/L) in April 1997. However, in general, levels of TPHg have demonstrated a decreasing trend at this well (**Appendix D**). Based on third quarter 2011 groundwater monitoring data, concentrations of TPHg are currently below the laboratory reporting limit at all wells with the exceptions of AW-1 (1,600 µg/L), AW-4 (75 µg/L), MW-1 (330 µg/L), and RW-1 (310 µg/L). In general, TPHg concentrations have been declining steadily since maximum concentrations were detected in the 1990s.

Historically, BTEX has been reported at concentrations above the laboratory reporting limits in groundwater samples collected from wells AW-1 through AW-8, IW-3, MW-1 through MW-3, RW-1, and VEW-4. The maximum benzene concentration (57,000 µg/L) was detected at well AW-4 in April 1992. Currently (third quarter 2011), concentrations of benzene are below the laboratory reporting limit at all wells with the exceptions of AW-1 (35 µg/L), AW-4 (5.4 µg/L), and RW-1 (0.7 µg/L). The maximum concentrations of toluene (190,000 µg/L), ethylbenzene (48,000 µg/L), and xylenes

(281,000 µg/L) were detected at well RW-1 in April 1997. However, based on third quarter 2011 groundwater monitoring results, these constituents are currently non-detect in all wells with the following exceptions:

- Ethylbenzene was detected in wells AW-1 and AW-4 at concentrations of 92 µg/L and 1.7 µg/L, respectively; and

- Xylenes were detected in wells AW-1, AW-4, and RW-1 at concentrations of 6.8 µg/L, 2.2 µg/L, and 3.1 µg/L, respectively.

Historically, concentrations of MTBE have been detected above the laboratory reporting limits in groundwater samples collected from wells AW-1 through AW-8, IW-3, MW-1 through MW-3, and RW-1. The maximum concentration of MTBE was 37,000 µg/L in well AW-1 in July 2000. However, based on third quarter 2011 monitoring data, MTBE is currently below laboratory reporting limits at all wells except for AW-1, AW-4, AW-5, AW-6, and RW-1, which yielded concentrations of 26 µg/L, 4.2 µg/L, 0.87 µg/L, 47 µg/L, and 1.1 µg/L, respectively.

Analytical data for the fuel additives ethanol, tert-butyl alcohol (TBA), di-isopropyl ether (DIPE), ethyl tert-butyl ether (ETBE), TAME, 1,2-dichloroethane (1,2-DCA), and 1,2-dibromoethane (EDB) are available from July 2003. TBA, TAME, and/or 1,2-DCA have historically been detected in wells AW-1, AW-2, AW-4, AW-5, AW-6, MW-3, and/or RW-1 at concentrations above the laboratory reporting limits. However, based on third quarter 2011 groundwater monitoring results, these constituents are currently non-detect, with the following exceptions:

- TBA was detected in wells AW-1, AW-5, and RW-1 at concentrations of 20 µg/L , 4.1 µg/L, and 8.9 µg/L, respectively; and

- TAME was detected in wells AW-1, AW-4, and AW-6 at concentrations of 4.9 µg/L, 0.55 µg/L, and 9.8 µg/L, respectively.

A summary of groundwater analytical results is presented in **Table 3.**

3.3.3 Soil Vapor

In October 2001 Cambria conducted an investigation to assess inhalation potential exposure risks. As part of the investigation soil vapor was collected from six locations (B-1 through B-6) drilled in the eastern and southeastern property boundaries. Soil-

vapor analytical data indicated that TPHg was detected in all soil-gas samples at concentrations ranging from 1.3 to 11 parts per million by volume (ppmv; at B-2-V2); benzene was detected at concentrations ranging from 0.0033 to 0.34 ppmv (at B-6-V3); toluene was detected at concentrations ranging from 0.0033 to 0.23 ppmv (at B-6-V3); ethylbenzene was detected at concentrations ranging from 0.0027 to 0.15 ppmv (at B-6-V3); xylenes were detected at concentrations ranging from 0.0031 to 0.59 ppmv (at B-6-V3); and MTBE was detected at concentrations ranging from 0.0033 to 0.062 ppmv (at B-6-V3). Soil vapor sample locations are shown in **Appendix A** and data is summarized in **Table 2c**.

3.3.4 Separate-Phase Hydrocarbon Status

Historically, free product has been observed in onsite wells MW-1 and RW-1. Approximately 0.70 gallons of free product were removed from well MW-1 between 1993 and 1996, and measurable free product has not been observed at this well since 1998. Approximately 161 gallons of free product were removed from well RW-1 between 1993 and 2001, and measurable free product has not been observed at this well since 2001.

3.3.5 Hydraulic Gradient Trends

Groundwater elevation in the monitoring wells has ranged from 9.22 feet (RW-1 in October 1992) to 31.01 feet above msl (AW-9 in April 1998), fluctuating seasonally. Historically, the groundwater gradient has ranged from 0.006 to 0.09 ft/ft. The groundwater flow direction has been highly variable, but is predominantly from the east to west.

A summary of historical groundwater flow directions and gradients is provided in **Table 1**; and a potentiometric surface map for the third quarter 2011 monitoring event is provided as **Figure 2**.

4. Remedial Activities

This section summarizes remedial activities performed at the Site.

4.1 Former SVE and Groundwater Treatment System

4.1.1 Vapor Extraction Test

In March 1992, RESNA oversaw the advancement of three soil borings (B-9 through B-11) in which three vapor extraction wells (VW-1 through VW-3, respectively) were installed (Broadbent 2009b). In April 1992, RESNA installed a passive floating product removal system in RW-1 and initiated a program to manually remove any product collected by the system on a monthly basis (Broadbent 2009b). In addition, vapor extraction wells VW-1 through VW-3 were used in a vapor extraction test (VET) to evaluate the feasibility of using vapor extraction as a remedial alternative at the Site. Based on the estimated effective radius of influence calculated during the VET, soil vapor extraction (SVE) was identified as a feasible remedial option for the Site (Broadbent 2009b).

4.1.2 SVE and Groundwater Extraction System Installation and Operation

In 1994, an SVE treatment system, including five additional vapor extraction wells (VEW-4 through VEW-8), was installed at the Site; and operation of the system began in November 1994 (Broadbent 2009b). The SVE system—consisting of a blower, regenerative thermal oxidizer, and ancillary equipment—was initially connected to eight vapor extraction wells (VW-1 through VW-3, and VEW-4 through VEW-8) and recovery well RW-1. Vapor extraction well VEW-9 was installed and connected to the system in April 1996. Based on available records, the SVE system was operated intermittently until December 1998; and, as of December 27, 1995, a total of approximately 13,495 pounds of hydrocarbons had been removed from the subsurface.

A groundwater extraction (GWE) and treatment system, consisting of an air stripper, a series of four granular activated carbon canisters, and ancillary equipment, began operation in 1995. Based on available records, the system was operated intermittently until December 1998; and, as of December 14, 1998, a total of approximately 344 pounds of hydrocarbons had been removed from site groundwater.

The reason for shutdown of the SVE and GWE systems is unknown. Records show that the noise from system operation was a concern at the Site, which may have been one of the causes (URS 2005b).

4.2 Nitrate/Sulfate Injection Pilot Study

4.2.1 URS Nitrate/Sulfate Feasibility Study Work Plan

On July 8, 2005, URS submitted the Nitrate/Sulfate Feasibility Study Work Plan evaluating the effectiveness of nitrate/sulfate injections as a remedial approach at the Site (URS 2005a). This Work Plan was not approved by the ACEH until December 20, 2007; however, the remedial action was never initiated at the Site.

4.2.2 Broadbent Feasibility Study and Corrective Action Plan

On May 15, 2009, Broadbent submitted the Feasibility Study and Corrective Action Plan (FS/CAP) to evaluate possible cleanup alternatives for the Site (Broadbent 2009b). Based on the site conditions, remedial objectives, and their screening and evaluation of several remediation technologies, Broadbent concluded that enhanced bioremediation appeared to be the most cost-effective and appropriate remedial alternative for the Site.

In conjunction with BP/Atlantic Richfield Company's Remediation and Engineering Technology Group, Broadbent developed a pilot-scale work plan to: (1) assess the effectiveness of nitrate/sulfate injections as a remedial approach to further enhance the natural biodegradation of petroleum hydrocarbon constituents in site groundwater; and (2) provide a basis for full-scale, long-term implementation of the nitrate/sulfate injection technology. Components of the pilot study included the following:

- Installation of one injection well (IW-1) approximately 8 feet to the northeast (upgradient) of monitoring well AW-1;
- Completion of a tracer test (using potassium bromide solution) to assess whether IW-1 was hydraulically connected to other wells at the Site and to determine dilution effects in the aquifer;
- Completion of six injection events—each consisting of approximately 831 gallons of 50 milligram per liter (mg/L) nitrate solution and 159 gallons of 250 mg/L sulfate solution—over the course of six months; and
- Completion of three additional monthly groundwater monitoring and sampling events.

Broadbent did not implement the pilot study as outlined in the FS/CAP because ARCADIS took over remediation of the site in 2009.

4.2.3 FS/CAP Addendum

On May 10, 2010, ARCADIS submitted an addendum letter outlining proposed revisions to the pilot study work plan as described in the CAP Addendum (CAP Addendum; ARCADIS 2010). Modifications were recommended in the following areas:

- Injection test objectives;
- Injection and monitoring well installation details;
- Injection design; and
- Groundwater monitoring plan.

4.2.4 Injection Pilot Study Implementation

Implementation of the injection pilot study was completed in accordance with the FS/CAP Addendum (ARCADIS 2010).

In September 2010, ARCADIS installed three injection wells (IW-1 through IW-3) at the Site. Following the installation activities, downgradient injection well IW-3 was sampled to further delineate the plume in the vicinity of the pilot study area. Laboratory analytical results indicated the presence of benzene at 5.8 µg/L, ethylbenzene at 8.3 µg/L, toluene at 2.9 µg/L, xylenes at 8.5 µg/L, MTBE at 2.5 µg/L, and TPHg at 1,000 µg/L. Based on the low levels of COCs, it was decided to wait until the first quarter 2011 sampling event to evaluate groundwater concentrations in the wells in the vicinity of the pilot test.

Results of the first quarter 2011 sampling event indicated non-detectable to very low concentrations of COCs. Based on these data, the pilot test was postponed, and additional groundwater samples were collected from AW-1 and downgradient wells MW-1 and AW-2. Results of the sampling indicated that MTBE, benzene, and TAME were present in AW-1 at low concentrations of 4.4 µg/L, 0.92 µg/L, and 0.80 µg/L, respectively; AW-2 contained MTBE at a concentration of 0.52 µg/L; and MW-1 contained TPHg at a concentration of 230 µg/L.

Based on the low COC levels in the vicinity of the pilot test and downgradient wells, ARCADIS recommended that the pilot injection test be postponed until third quarter 2011 sampling results could be reviewed; and the ACEH approved this postponement in an e-mail dated May 31, 2011. Third quarter 2011 sampling results were discussed in Section 3.3.2 and are summarized as follows:

- TPHg, benzene, ethylbenzene, xylenes, MTBE, TBA, and TAME were present in AW-1 at concentrations of 1,600 µg/L, 35 µg/L, 92 µg/L, 6.8 µg/L, 26 µg/L, 20 µg/L, and 4.9 µg/L, respectively;

- TPHg was present in MW-1 at a concentration of 330 µg/L; and

- COCs were not detected at AW-2.

5. Remedial Effectiveness

Operation of the former SVE and GWE systems, along with periodic free product removal and biodegradation processes, have proven to be effective for substantially reducing contamination at the Site. Based on available records, the SVE and GWE treatment systems removed approximately 13,495 pounds of hydrocarbons from site soil between November 1994 and December 1995, and approximately 344 pounds of hydrocarbons from site groundwater between November 1994 and December 1998 (Broadbent 2009b). Operational data for the SVE system after December 1995 was not available.

Concentration trend charts provided as **Appendix D** illustrate the success of the remedial activities to date.

6. Beneficial Uses

6.1 East Bay Plain Beneficial Use Report and RWQCB Basin Plan

The Site is located within the Oakland Sub-Area of the East Bay Plain of the San Francisco Basin (RWQCB 1999). According to the Beneficial Use Report, the City of Oakland does not have "any plans to develop local groundwater resources for drinking water purposes, because of existing or potential saltwater intrusion, contamination, or poor or limited quantity" (RWQCB 1999). However, the RWQCB San Francisco Bay Region's Basin Plan denotes existing beneficial uses of municipal and domestic supply, industrial process supply, industrial service supply, and agricultural supply for the East Bay Plain groundwater basin (RWQCB 2007).

6.2 Sensitive Receptor Survey and Potential Exposure Pathways

The Site is located approximately two miles east of San Leandro Bay, which is a small portion of the San Francisco Bay. The nearest surface water drainage is Arroyo Viejo, located approximately one mile north of the Site. Another creek, San Leandro Creek is located approximately 1.25 miles south of the Site. Both creeks originate in the East Bay Hills and drain directly into San Leandro Bay (Broadbent 2009b).

ARCADIS completed a local internet search of the area surrounding the Site to identify nearby schools. One school, Reach Academy, was identified within a quarter mile radius of the Site (approximately 0.15 miles south of the Site). No hospitals are known to be located within a quarter mile of the Site.

6.2.1 URS Sensitive Receptor and Well Survey

In October 2004, URS conducted a one-mile radius well survey for the Site (URS 2004). A review of the State of California Department of Water Resources (DWR) files and Environmental Data Resources, Inc., files identified 11 domestic wells, seven irrigation wells, and one industrial well located within a one-mile radius of the Site. Fifteen well logs provided by the DWR did not include addresses and, therefore, the corresponding well locations could not be determined. Nine of the identified domestic wells and four irrigation wells were located approximately 0.75 miles downgradient from the Site. However, no wells were identified within a 2,000-foot radius of the Site. Two former leaking UST sites with closed regulatory status were identified within 2,000 feet of the Site, but available records did not indicate the presence of associated monitoring wells. In addition, according to the RWQCB Beneficial Use Report, Figures 16 and 17, one irrigation and one industrial shallow well (less than 100 feet bgs), and

one deep irrigation well (greater than 100 feet bgs) were located within 0.5 miles southwest of the Site (RWQCB 1999).

Based on the sensitive receptor and well survey results, URS concluded that no identified sensitive receptors, including wells, were located sufficiently close such that hydrocarbon-impacted soil and groundwater from the Site could likely pose a threat.

6.2.2 URS Underground Utility Survey and Preferential Pathway Evaluation

In October 2004, URS conducted an underground utility survey in order to identify potential migration pathways and conduits to assess the probability of petroleum hydrocarbon plume migration. The underground utilities identified during this survey included sanitary sewer lines, storm drains, East Bay Municipal Utility District water lines, Pacific Gas and Electric lines, and trench lines associated with the former onsite remediation system.

Identified underground utilities of potential concern included: (1) trenching extending to approximate depths of less than 4 to 5 feet bgs associated with the former onsite remediation system; and (2) sanitary sewer lines running directly beneath the south to southwestern portion and north to northwestern portion of the Site at approximate depths of 4 to 4.5 feet bgs. All other identified underground utilities were offsite, and the underground utilities located downgradient of the Site did not extend below a maximum depth of approximately 6.5 feet bgs. Depth to groundwater beneath and in the immediate vicinity of the Site had historically ranged from 6.77 to 28.51 feet bgs (between April 1991 and July 2004), fluctuating seasonally. Consequently, URS concluded that the identified underground utilities (both onsite and offsite) were unlikely to act as significant preferential conduits for dissolved hydrocarbon migration. Furthermore, because no wells were identified within 2,000 feet of the Site, the potential for offsite wells acting as preferential conduits for dissolved hydrocarbon plume migration was not of concern.

The potential for onsite utilities to act as preferential conduits was further evaluated as part of the preferential pathway evaluation completed by URS in July and September of 2005 (URS 2005). Evaluation activities are discussed in further detail in Section 3.1.6. Based on (1) the non-detectable concentrations of COCs in soil; and (2) the absence of groundwater in two soil borings, SB-3 and SB-4, advanced in the vicinity of the sanitary sewer line, URS concluded that the sanitary sewer was not being used as a preferential pathway, even during seasons of high water level. In addition, after reviewing cross-sections and boring logs for the Site, URS determined that there was

potentially a confining layer that prevented groundwater from entering the sanitary sewer line.

6.2.3 Risk Assessment and Environmental Screening Results

The Property is currently a fenced, vacant lot located at the southeastern corner of 98th Avenue and Bancroft Avenue in Oakland. Review of historical investigation data indicates that the majority of residual soil impacts associated with the Site appear to be present at depths greater than 10 feet bgs. Public and general occupational exposure to impacted soil at these depths is believed to be remote and/or of short duration.

Current potential exposure pathways associated with this Site include human inhalation, ingestion, and absorption risks by environmental professionals. Refer to Figure 3 for Potential Exposure Pathway Flowchart. A remote potential exposure pathway might be human inhalation by tradesmen in the underground utility installation and maintenance occupation. In addition, future construction workers may be exposed to impacted soil via ingestion or dermal contact. However, the soil concentrations present are unlikely to present a viable exposure pathway of concern. In addition, the absence of buildings onsite suggests that site visitors would be congregating in open-air areas, greatly reducing the potential for exposure to vapor migration. Exposure pathways relating to current site conditions and property use do not appear to be a concern.

As discussed in Section 3.1.5, previous RBCA evaluations have been completed using soil, soil vapor, and groundwater data collected at the Site. Results of all the investigations, including the most recent (completed by MWH; MWH 2002), indicated that the theoretical upper-bound incremental lifetime cancer risks and non-cancer hazard indices associated with levels of TPH, BTEX, and MTBE in onsite soils and groundwater were below acceptable levels. Accordingly, it was concluded that no further action was necessary for the protection of human health and the environment at the Site.

In addition, ARCADIS used the revised May 2008 Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater (RWQCB 2008) to obtain current environmental screening levels (ESLs) and assess potential human health risk associated with current site conditions. The ESLs were developed using USEPA and California Department of Toxic Substances Control human health risk assessment methodologies. In general, the presence of a chemical in soil or groundwater at concentrations below the corresponding ESL can be inferred to not pose a significant threat to human health or the environment. Soil quality ESLs were developed

considering the protection of human health, ecological receptors, and groundwater from the leaching pathway. Groundwater ESLs were developed considering drinking water standards, protection of human health, and aquatic habitats.

To further evaluate the potential long-term fate of COCs associated with the Site, the most recent and the maximum concentrations of contaminants detected in soil and groundwater have been compared to the appropriate ESLs (**Table 4**). The use of residential screening levels is based on land use in the immediate vicinity of the Site (i.e., mixed commercial and residential). Soil and groundwater ESLs were obtained from the Table C ESLs for deep soils (greater than 3 meters bgs) where groundwater is a current or potential source of drinking water (RWQCB 2008). Soil vapor results were compared to ESLs obtained in Table E-2 shallow soil gas screening levels for evaluation of potential vapor intrusion concerns.

Site soil was last sampled in 2005, and laboratory analytical results indicated that all COCs were either non-detect or detected at levels below the corresponding soil ESLs with the exception of benzene, which was detected at a concentration slightly above the corresponding ESL of 0.023 milligrams per kilogram (mg/kg; **Table 4**). Current (third quarter 2011) concentrations of toluene, xylenes, and 1,2-DCA are all below their corresponding groundwater ESLs; TPHg was detected in three wells, AW-1 (1,600 µg/L), MW-1 (330 µg/L), and RW-1 (310 µg/L) at concentrations exceeding the ESL of 100 µg/L. Benzene was detected in two wells, AW-1 (35 µg/L)and AW-4 (5.4 µg/L), at concentrations exceeding the ESL of 1.0 µg/L. Ethylbenzene was detected in one well, AW-1 (92 µg/L), at a concentration exceeding the ESL of 30 µg/L. MTBE was detected in two wells, AW-1 (26 µg/L) and AW-6 (47 µg/L), at concentrations exceeding the ESL of 5.0 µg/L; and TBA was detected in one well, AW-1 (20 µg/L) , at a concentration exceeding the ESL of 12 µg/L. Concentrations of all the analytes detected above the ESLs indicate overall decreasing trends. Soil vapor samples were collected in 2001; results indicated two of the 18 samples exceeded the ESL for TPHg all other analytes were below the respective ESLs. The ESL for TPHg is 6.9 ppmv; B-1-V2 collected at 10 feet bgs and B-3-V1 collected at 5 feet bgs contained 9.9 ppmv and 7.0 ppmv, respectively.

7. Conclusions

Laboratory analytical results for the most recent soil characterization sampling event (2005) indicated that COCs in site soil were either non-detect or detected at very low concentrations below their respective ESLs, with the exception of MTBE which was detected slightly above the ESL. Furthermore, groundwater data collected during the most recent (third quarter 2011) sampling event generally indicate that COCs in site wells are either non-detect or detected at concentrations below their respective ESLs. The exceptions are low levels of: TPHg in MW-1, AW-1 and RW-1; benzene in AW-1 and AW-4; MTBE in AW-1 and AW-6; and ethylbenzene and TBA in AW-1. Review of historical groundwater data indicates that concentrations of these analytes have declined and this trend is expected to continue. Soil vapor slightly exceeded the ESL for TPHg (6.9 ppmv) in two of 18 samples collected in 2001. One sample was collected at 5 feet bgs and contained 7.0 ppmv, the second sample was collected at 10 feet bgs and contained 9.0 ppmv. Based on the depth and the years since the samples were collected it is unlikely a soil vapor threat to human health or the environment remains at the site.

The Site meets all published criteria and qualifies as low risk, as described in the Supplemental Instructions to State Water Board December 18, 1995 Interim Guidance of Required Cleanup at Low-Risk Fuel Sites (RWQCB 1996). Therefore, ARCADIS requests approval for case closure and no further action at this Site based on the following:

- The Site has been adequately characterized through regular groundwater monitoring and various soil and/or soil vapor sampling events;
- Petroleum hydrocarbon sources at the Site have been removed, and the absence of high COC concentrations observed in soil and groundwater suggests that residual hydrocarbons in soil have been removed via previous remedial activities and through natural attenuation;
- Active remediation (i.e., operation of an SVE and GWE system) was conducted at the Site between 1994 and 1998;
- COC concentrations in site groundwater have exhibited decreasing trends (**Appendix D**);

- The plume is not migrating offsite as evidenced by the non-detect or low detected COC concentrations in downgradient monitoring wells;

- No sensitive receptors are likely to be impacted, including surface water bodies, municipal wells, and drinking water sources; and

- The Site presents no significant risk to human health and the environment.

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