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Mr. Mark E. Detterman, PG, CEG
Alameda County Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

ENVIRONMENT

Subject:
Data Gaps Investigation Work Plan
Former ARCO Service Station No.11126
1700 Powell Street, Emeryville, California
Regulatory Site No: RO0000066

Date:
August 12, 2014

Contact:
Hollis Phillips

Phone:
415.432.6903

Email:
hollis.phillips@arcadis-us.com

Our ref:
GP09BPNA.C044.K0000

Dear Mr. Detterman:

ARCADIS U.S., Inc. (ARCADIS) has prepared this *Data Gaps Investigation Work Plan* on behalf of Atlantic Richfield Company (ARCO), a BP affiliated company, for the former ARCO service station listed below.

BP-ARCO Facility No.	ACEH Site No.	Location
11126	RO0000066	1700 Powell Street Emeryville, California

I declare, 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. If you have any questions or comments regarding the content of this report, please contact Jamey Peterson by telephone at 707.889.6739 or by e-mail to jamey.peterson@arcadis-us.com or Hollis Phillips by telephone at 415.432.6903 or by e-mail to hollis.phillips@arcadis-us.com.

Sincerely,

ARCADIS U.S., Inc.

Jamey Peterson
Staff Geologist

Hollis E. Phillips, P.G. (No. 6887)
Project Manager/ Principal Geologist

REGISTERED GEOLOGIST
HOLLIS E. PHILLIPS
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STATE OF CALIFORNIA

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Atlantic Richfield Company (ARCO), a BP affiliated company

Data Gaps Investigation Work Plan

Former ARCO Service Station No. 11126
1700 Powell Street
Emeryville, California
ACEH LOP Case No. RO0000066

August 12, 2014

ARCADIS

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Data Gaps Investigation Work Plan

Former BP Service Station No. 11126
Emeryville, California
ACEH LOP No. RO0000066

Prepared for:

Atlantic Richfield Company (ARCO),
a BP affiliated company

Prepared by:

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ARCADIS

Table

Figures

Appendix

1. Introduction and Purpose

On behalf of Atlantic Richfield Company (ARCO), a BP affiliated company, ARCADIS U.S., Inc. (ARCADIS) has prepared this *Data Gaps Investigation Work Plan* (Work Plan) for the former BP service station No. 11126 located at 1700 Powell Street in Emeryville, California (the Site; Figure 1). This Work Plan was prepared at the request of Alameda County Environmental Health (ACEH) in a letter dated June 30, 2014. The purpose of this Work Plan is to fill potential data gaps in the existing site conceptual model (SCM). Investigation activities are proposed to adequately characterize site impacts in support of the Low Threat Closure (LTC) policy at the Site.

2. Background Information

The Site is currently in use as a 76-branded gasoline station located on the northwest corner of the intersection of Powell Street and Christie Avenue in Emeryville, California (Figure 1). Three unleaded gasoline underground storage tanks (USTs) are located at the Site (one 6,000-gallon UST, one 10,000 gallon UST, and one 12,000-gallon UST). Historical documents indicate that these USTs were installed in the late 1980s (SECOR 2007). Site features include a station building and two dispenser islands with three dispensers each for a total of six dispensers. The majority of the Site surface is paved with concrete and asphalt.

Surrounding land use is largely commercial: a Denny's restaurant is located west of the Site; a shopping plaza is located south of the Site, a bank and offices are located to the north, and a furniture store is located to the east.

3. Data Gaps and Proposed Field Activities

ACEH identified data gaps in the SCM in their letter dated June 30, 2014 (ACEH 2014). ARCADIS reviewed the data gaps identified by ACEH and concurs that the following site activities are required to be addressed in order to provide sufficient data that would allow the Site to be eligible for LTC:

- Evaluate soil in the vicinity of the former waste oil USTs and MW-9;
- Assess groundwater conditions in the area upgradient of the USTs; and
- Evaluate the extent of Total Petroleum Hydrocarbons as Diesel Range Organics (C10-C28) (DRO) in groundwater.

To investigate the data gaps described above, ARCADIS proposes the following field activities.

- Installation of 3 soil borings to approximately 10 feet below ground surface (bgs) to collect additional soil samples. Two borings will be in the vicinity of the former waste oil USTs and one boring will be in the vicinity of MW-9;

- Collection of one grab groundwater sample in the upgradient direction, east of the onsite station building and north of the USTs; and

- Analyze groundwater samples at all groundwater monitoring wells for DRO during forthcoming semi-annual groundwater monitoring events performed at the Site.

Figure 2 presents the proposed boring locations.

3.1 Pre-Field Activities

Prior to initiation of subsurface activities, several pre-field tasks will be performed. These pre-field tasks will include the following:

- Update the site-specific health and safety plan (HASP);

- Mark the proposed soil boring locations and contact Underground Service Alert a minimum of 48 hours prior to initiating the field activities;

- Use of the private utility locator to mark the locations of underground utilities in the vicinities of the proposed soil boring locations; and

- Secure the necessary permits from local agencies.

3.2 Soil Boring Installations

To minimize the potential for encountering subsurface utilities, the soil boring locations will be hand cleared to a minimum of 6.5 feet bgs with a hand auger or air knife/vacuum truck equipment prior to drilling. Once cleared, the borings will be advanced using direct-push probing equipment to an approximate total depth of 10 feet bgs by a C-57 licensed drilling contractor. The total depth was selected based on criteria presented in the LTC policy for direct contact and outdoor air exposure.

3.2.1 Soil Borings and Sampling

Soil samples will be collected continuously to the extent feasible from ground surface to the total depth and will be logged by a field geologist under the supervision of a California Professional Geologist. Soil samples will be screened for volatile organic compounds with a photo ionization detector (PID) and visually inspected for petroleum hydrocarbon impacts.

Soil samples will be collected for analytical testing at the following approximate depth intervals:

- 4.5 feet to 5 feet bgs

- To be determined within the 5 to 10 feet bgs interval. Sample collection will be determined based on depth of encountered groundwater/saturated soils. Sample will be collected above the first encountered groundwater in effort to collect sample representative of soil conditions.

Additional soil samples will be submitted for analytical testing if indications of petroleum hydrocarbon-impacts (odor, elevated PID readings, staining, etc.) are observed at additional depth intervals.

Soil from sample intervals designated for laboratory analysis will be collected in the direct push acetate liner. Sample sleeves will be cut in approximate 0.5-foot increments in the field. The boring subsections will then be capped with Teflon squares and plastic end caps, labeled, sealed in plastic wrap, and placed in an ice-chilled cooler for delivery to Eurofins Calscience, Inc. (Eurofins Calscience) in Garden Grove, California, a California Department of Public Health certified analytical laboratory, under proper chain-of-custody procedures. The selected soil samples will be analyzed for the presence of the following constituents:

- Total petroleum hydrocarbons as gasoline range organics (C6-C12) (GRO) using United States Environmental Protection Agency (USEPA) Test Method 8260B Modified;

- DRO using USEPA Method 8015B Modified with Silica Gel Cleanup;

- Benzene, toluene, ethylbenzene and xylenes (BTEX) using USEPA Method 8260B;

- Methyl tertiary butyl ether (MTBE) and naphthalene using USEPA Method 8260B; and

- Polycyclic Aromatic Hydrocarbons (PAHs) using USEPA Method 8270.

3.2.2 Grab Groundwater Sampling

The proposed soil boring located east of the onsite service station building and north of the USTs (Figure 2) will be installed to collect a grab groundwater sample for the purpose of evaluating potential petroleum hydrocarbon impacts to groundwater in the predominately upgradient area of the Site according to the historical groundwater flow direction. As measured during 30 of 45 groundwater monitoring events conducted between the First Quarter of 2001 through the Second Quarter of 2014, the groundwater flow direction at the Site has been to the southwest (Figure 3; ARCADIS 2014). The location of the proposed boring will be upgradient of the Site's USTs and may be slightly adjusted in the field based on the presence of overhead and underground utilities and obstructions.

The soil boring will be advanced using a hand auger. ARCADIS health and safety protocol requires clearing borings to 6.5 feet bgs. Groundwater is encountered as shallow as 6 feet bgs. If groundwater is not encountered at 6.5 feet bgs, the boring will be advanced using direct-push probing equipment to an approximate total depth of 10 feet bgs by a C-57 licensed drilling contractor. The exact depth of the soil boring will be identified by the depth at which groundwater is encountered, based on the observation of saturated soils and/or groundwater flowing into the bottom of the borehole. Review of boring logs from the active groundwater monitoring well network indicates that first groundwater has been encountered at an average depth between approximately 6 to 8 feet bgs. The soil borings will be advanced slightly past the first encountered groundwater to facilitate grab groundwater sample collection.

Following the completion of the hand augering, a grab groundwater sample will be collected by placing a 1-inch-diameter PVC casing with a 5-foot screened interval of 0.010-inch slotted PVC at the bottom of the boring. Blank PVC riser pipe will be connected to the PVC screen to facilitate sample collection at the surface. Prior to grab groundwater sample collection, the static water level will be measured using an electronic water level indicator.

Once a sufficient volume of groundwater is present in the sampling device, several casing volumes of groundwater will be purged, and a sample will be collected using a peristaltic pump, disposable polyethylene bailer, or similar sampling device. The grab groundwater sample will be sealed, labeled, and placed in an ice-chilled cooler for delivery to Eurofins Calscience under proper chain-of-custody procedures. Grab groundwater samples will be analyzed for the following constituents:

- GRO using USEPA Method 8260B Modified;
- DRO using USEPA Method 8015B Modified with Silica Gel Cleanup;
- BTEX using USEPA Method 8260B;
- Fuel additives MTBE, tertiary butyl alcohol (TBA), tertiary amyl methyl ether (TAME), Di-isopropyl ether (DIPE), ethyl tertiary butyl ether (ETBE), 1,2-Dichloroethane (1,2-DCA), and 1,2-Dibromoethane (EDB) using USEPA Method 8260B;
- Naphthalene using USEPA Method 8260B; and
- PAHs using USEPA Method 8270.

3.2.3 Boring Abandonment and Investigation-Derived Waste

Upon completion of sampling activities, the PVC casings will be removed (from the grab groundwater sample location), and the borings will be abandoned by grouting from the total depth to ground surface using neat cement (composed of one sack [94 pounds] of Portland Type II/V and five gallons of clean water). The borehole will be completed with a concrete cap. Investigation-derived waste generated during the field activities will be contained in Department of Transportation-approved, 55-gallon steel drums. These drums will be appropriately labeled and temporarily stored onsite pending analytical results. Upon receipt of analytical results, the drums will be removed from the Site and transported to an offsite disposal facility.

4. Response to Comments

In their June 30, 2014 letter, ACEH stated that several other data gaps are present in the SCM for the Site. ARCADIS evaluated these potential data gaps and concluded that not all of the data gaps identified in the ACEH letter warrant additional site investigation activities. Site data to date indicate that the Site is generally characterized and that the dissolved-phase constituent plume is delineated. Furthermore, site data collected to date have demonstrated that the majority of both the general and applicable media-specific criteria are satisfied according to the measures within State Water Resources Control Board (SWRCB) LTC policy, and therefore, additional site investigation will not bring significant value to the current SCM.

The following is a response to the potential data gaps ACEH stated exist at the Site.

ACEH Comment: LTCP Media Specific Criteria for Groundwater – Site hydrogeologic conditions have not been adequately defined.

A groundwater flow direction rose diagram for the Site is included on Figure 3. The figure shows that groundwater flow has predominately been to the southwest for at least the past 13 years, between 2001 through 2014. This is consistent with the regional hydrogeology as San Francisco Bay is located west of the Site, and groundwater is expected to generally flow toward San Francisco Bay.

ACEH contends that groundwater flow direction at the Site is radial centered near the USTs. The USTs are surrounded by groundwater monitoring wells MW-1 (to the southeast), MW-2 (to the west), MW-8 (to the northeast), and MW-9 (to the southwest). Groundwater elevations from these four groundwater monitoring wells indicate a relatively flat gradient in the vicinity of the USTs, however, the groundwater flow direction is generally to the southwest. Since June 2007, the groundwater elevations of the monitoring wells located east of the USTs (MW-1 and MW-8) and the monitoring wells located immediately to the west of the USTs (MW-2 and MW-9) have averaged a difference of only 0.15 foot, indicating a flat groundwater gradient in the vicinity of the USTs. The predominant southwest groundwater flow direction at the Site is indicated by the measured groundwater elevations in groundwater monitoring wells located further to the west and southwest of the USTs. These groundwater monitoring wells, including MW-3, MW-5, MW-6, MW-7, MW-10, and MW-11, consistently have had measured groundwater elevations less than the groundwater elevations of the monitoring wells in the vicinity of the USTs for at least the past 9 years of monitoring at the Site for MW-10 and MW-11, and for at least the past 20 years of monitoring at the Site for MW-3, MW-5, MW-6, and MW-7. On average the groundwater elevations measured at MW-3, MW-5, MW-6, MW-7, MW-10, and MW-11 are typically 1 to 2 feet lower than the measured groundwater elevations of the wells in the vicinity of the USTs (MW-1, MW-2, MW-8, and MW-9) during groundwater monitoring events performed at the Site (ARCADIS 2014). These lower groundwater elevations in monitoring wells west and southwest of USTs indicate the likelihood that despite a relatively flat gradient in the vicinity of the USTs, groundwater does flow away from the USTs and to the southwest.

Further site investigations relating to evaluation of the Site's groundwater flow direction are not warranted as groundwater flow direction has been defined in the southwest direction.

ACEH Comment: LTCP Media Specific Criteria for Groundwater – The groundwater plume has not been defined.

ARCADIS concurs with ACEH that further delineation of DRO in groundwater is warranted at the Site in order to assess the extent of the dissolved-phase DRO plume. Beginning with the next groundwater sampling event, tentatively scheduled for December 2014, DRO, as well as naphthalene and PAHs, will be added to the list of analytes for all groundwater monitoring wells as directed by ACEH in their letter dated June 30, 2014 (ACEH 2014). If results indicate concentrations are near the cleanup goals, they will not be sampled again for the analytes.

Further site characterization focused on defining the dissolved-phase plumes for GRO, BTEX, MTBE, and TBA in groundwater does not appear warranted as sufficient hydrogeological and constituent-concentration data exist and indicate that the extent and magnitude of these constituent plumes are defined. Moreover, petroleum-hydrocarbon concentrations in groundwater have been stable or decreasing at all monitoring well locations, with the exception of TBA concentrations at MW-7. A linear regression analysis was conducted and is included in Appendix A. Concentration contour maps are included for GRO, benzene, MTBE, and TBA as Figures 4 to 7.

As stated above, groundwater flow direction at the Site is defined to the southwest. The extents of the constituent plumes are defined by the non-detect to trace concentrations of site constituents in groundwater samples collected from downgradient groundwater monitoring wells MW-10 and MW-11, cross gradient groundwater monitoring wells MW-3, MW-6, and MW-7, as well as in the groundwater sample results collected during the January 2011 cone penetrometer testing (CPT) site investigation.

Offsite groundwater monitoring wells MW-10 and MW-11 are the furthermost downgradient monitoring wells from the Site according to the predominant groundwater flow direction. Trace concentrations of MTBE (maximum of 3.0 micrograms per liter [µg/L]) and TBA (6.2 µg/L) have been detected in groundwater samples collected from MW-10. No other site constituents have ever been detected above laboratory reporting limits in groundwater samples collected from MW-10 since routine groundwater sampling began at this well in 2005. Furthermore, MTBE and TBA have not been detected at concentrations greater than laboratory reporting limits at MW-10 respectively since June 2010 and March 2009. Since routine groundwater sampling began at MW-11 in 2005, no site constituent has ever been detected above laboratory reporting limits in groundwater samples collected from MW-11. The groundwater sample results from MW-10 and MW-11 indicate that the downgradient extents of site constituent plumes for GRO, BTEX, MTBE, and TBA have been defined and that these constituent plumes terminate in Powell Street, just south of the Site.

Groundwater monitoring wells MW-3, MW-6, and MW-7 are located in the west portion of the Site and generally range from crossgradient to downgradient of likely site-constituent source features (former used oil UST, gasoline USTs, dispenser islands). With the exception of DRO and TBA, groundwater samples collected from MW-3, MW-6, and MW-7 for at least the past 5 years (since May 2009) have either not contained concentrations of site constituents above laboratory reporting limits, or have had limited detected concentrations. The groundwater sample results at MW-3, MW-6, and MW-7 indicate that the extents of the dissolved-phase GRO, BTEX, and MTBE plumes in groundwater are defined in the general crossgradient direction according the predominate groundwater flow direction measured at the Site, and do not extend to the west portions of the Site.

Site constituent delineation is further observed in the grab groundwater samples collected during the January 2011 site investigation. Grab groundwater samples were collected from soil boring UCPT-01 which was completed downgradient of MW-5 and MW-7 nearby a utility corridor in Powell Street. Concentrations of GRO and BTEX were not detected above respective laboratory reporting limits in the groundwater sample collected at UCPT-01, indicating that these constituents are delineated by the existing groundwater monitoring well network and GRO and benzene are not significantly present downgradient of MW-5. Concentrations of MTBE and TBA were detected in the grab groundwater sample collected from UCPT-01 at 14 µg/L and at 63 µg/L, respectively. The groundwater results collected from UCPT-01 also provide evidence that utility corridors in Powell Street, south and southwest of the Site, are not significantly facilitating migration of constituents away from the Site. GRO and BTEX were not detected above laboratory reporting limits in the groundwater sample collected from UCPT-01, however, GRO and benzene concentrations at MW-5, located approximately 120 feet northeast (upgradient) of UCPT-01 have been detected as high as 3,800 µg/L and 3.3 µg/L, respectively, over the past 5 years of sampling at the Site (Table 1). Although MTBE and TBA were detected in the groundwater sample collected from UCPT-01, concentrations of MTBE at UCPT-01 are consistent with observed MTBE concentrations at MW-5 and TBA concentrations are an order of magnitude lower than the current concentrations at MW-5. Although the detected MTBE and TBA concentrations at UCPT-01 were above the San Francisco Bay Regional Water Quality Control Board (SF-RWQCB) environmental screening level (ESL) where groundwater is a current or potential drinking water resource of 5 µg/L and 12 µg/L, respectively (*Table F-3*, SF-RWQCB 2013), the MTBE and TBA concentrations are significantly below the SF-RWQCB groundwater screening level where groundwater is not a current or potential drinking water resource of 1,800 µg/L and 18,000 µg/L, respectively (*Table F-1b*, SF-RWQCB 2013).

During the same January 2011 site investigation, two grab groundwater samples from two different depth intervals were collected from UCPT-02. UCPT-02 was installed northwest of monitoring well MW-7 and one grab groundwater sample was collected at 7 feet bgs and one at 21 feet bgs. Both grab groundwater samples at UCPT-02 indicated that there were no detected concentrations above laboratory reporting limits for GRO, BTEX, MTBE and TBA at this location.

The dissolved-phase constituent plumes for BTEX, MTBE, and TBA are further defined upgradient (to the north and northeast) of the Site's USTs and dispenser islands as indicated by the groundwater flow direction to the southwest away from these former and current site fueling features, and in the groundwater sample results from MW-8. MW-8 is located northeast of the USTs and dispenser islands, is located along the northeastern site boundary, and is predominantly the most upgradient monitoring well at the Site according to the historical groundwater flow direction. BTEX has either not been detected above laboratory reporting limits or has been detected at trace concentrations just above laboratory reporting limits in all groundwater samples collected from MW-8 since October 1993. Concentrations of MTBE and TBA have either been below laboratory reporting limits or have been below respective SF-RWQCB ESLs where groundwater is a current or potential drinking water resource since June 2011 and June 2013, respectively. The historical and recent concentrations of BTEX, MTBE, and TBA demonstrate that the extents of these constituent plumes are defined in the upgradient direction of the Site.

GRO has been detected in groundwater samples collected from MW-8 at concentrations slightly above the SF-RWQCB ESL of 100 µg/L (where groundwater is a current or potential drinking water resource), with the most recent concentration at 150 µg/L during the June 2014 groundwater monitoring event. Although MW-8 contains concentration of GRO above the ESL protective of a drinking water resource, GRO at MW-8 shows a decreasing trend (Appendix A). Groundwater sample results from the proposed soil boring described above in Section 3.2.2 is anticipated to fulfill assessment of the dissolved-phase GRO plume in groundwater upgradient (north-northeast) of MW-8.

ACEH Comment: LTCP Media Specific Criteria for Groundwater – Five years of declining groundwater concentrations have not been demonstrated.

ARCADIS evaluated the stability of dissolved petroleum hydrocarbon constituents in groundwater by conducting statistical analyses and comparing the results to groundwater concentration trend charts. The objective of these analyses is to determine if statistically significant concentration trends exist for the site constituents-of-potential-concern (COPCs) and to calculate approximate dates to achieve water quality objectives (WQOs). SF-RWQCB ESLs protective of a drinking water resource (SF-RWQCB 2013; *Table F-3 Summary of Drinking Water Screening Levels*) were used as the WQOs evaluated in the linear regression analyses.

Concentration trends for GRO, DRO, BTEX, MTBE, and TBA were evaluated for 9 of the 11 monitoring wells (MW-1 through MW-9) using linear regression analyses to determine if they are statistically significant. COPC concentration trends were evaluated on monitoring well-constituent combinations that have exceeded groundwater WQOs since 2010, contained sufficient data (greater than six data points), and have had less than 50 percent of the results below laboratory detection limits. A total of 33 monitoring well-constituent combinations had sufficient data to run linear regression analyses.

The data collected across the Site indicate statistically significant decreasing groundwater concentration trends for the majority of COPCs, with the exception of TBA concentrations at MW-7. Although TBA concentrations at MW-7 demonstrate an increasing trend, TBA concentrations at all other monitoring wells upgradient and cross-gradient of this location are stable or decreasing. Additionally, concentrations of TBA at MW-7 have decreased since the historical maximum of 3,900 µg/L in December 2010, indicating that concentrations appear to have stabilized since 2010. Results of the regression trend analyses are presented in Appendix A and are summarized below:

DRO: Results of the linear regression analysis indicate decreasing trends for DRO concentrations in wells MW-6 and MW-8 with a significantly decreasing trend at MW-8. No trend was observed in groundwater

DRO concentrations at MW-3 and MW-4. However, DRO concentrations at MW-3 and MW-8 were below the DRO WQO of 100 µg/L during the most recent groundwater monitoring event (June 2014). All groundwater monitoring wells will be analyzed for DRO during forthcoming semi-annual groundwater sampling events to further assess DRO trends.

GRO: Results of the linear regression analysis indicate statistically significant decreasing trends for GRO concentrations in wells MW-1, MW-2, MW-5, MW-8 and MW-9. The remaining 6 of the potential 11 GRO and monitoring well pairs did not meet the screening method criteria for a linear regression analysis.

Benzene: Results of the linear regression analysis indicate statistically significant decreasing trends for benzene in wells MW-1, MW-2, MW-5 and MW-9. The remaining 7 of the potential 11 benzene and monitoring well pairs did not meet the screening method criteria for a linear regression analysis.

Toluene: Linear regression analysis was not performed for this constituent because it did not fit the screening method criteria stated above for any of the 11 site monitoring wells.

Ethylbenzene: Results of the linear regression analysis indicate statistically significant decreasing trends for ethylbenzene in wells MW-2 and MW-9. The remaining 9 of the potential 11 ethylbenzene and monitoring well pairs did not meet the screening method criteria for a linear regression analysis

Total Xylenes: Results of the linear regression analysis indicate statistically significant decreasing trend for total xylenes in MW-2. The groundwater total xylenes concentration at MW-2 has been generally less than the WQO of 1,750 µg/L since December 2009. The remaining 10 of the potential 11 xylene and monitoring well pairs did not meet the screening method criteria for a linear regression analysis.

MTBE: Results of the linear regression analysis indicate statistically significant decreasing trends for MTBE in wells MW-1, MW-2, MW-4, MW-7, MW-8 and MW-9. The groundwater MTBE concentrations at MW-5 indicate a decreasing trend albeit not statistically significant. However, the groundwater MTBE concentrations at MW-5 have generally been at or below the WQO of 5 µg/L since February 2008. The remaining 4 of the potential 11 MTBE and monitoring well pairs did not meet the screening method criteria for a linear regression analysis.

TBA: Results of the linear regression analysis indicate a statistically significant decreasing trend for TBA in well MW-8. The groundwater TBA concentrations at monitoring wells MW-1, MW-2, MW-3, MW-4, MW-6 and MW-9 indicated no trend. Monitoring well MW-7 is the only location that indicates a statistically significant increasing trend in TBA concentrations through time. An additional trend analysis was performed for data since 2008 at MW-7; although concentrations of TBA are increasing, this additional trend analysis indicated no statistical significance. The remaining 4 of the potential 11 TBA and monitoring well pairs did not meet the screening method criteria for a linear regression analysis.

Overall, significant attenuation of the groundwater impacts is observed at the Site. Concentrations of DRO, GRO, BTEX, MTBE, and TBA concentrations in two (MW-10 and MW-11) of the 11 groundwater monitoring wells have been below reporting limits and/or their respective WQOs for the entire monitoring history. The remaining nine monitoring wells show either declining or stable trends for all COPCs, with predicted times to reach the cleanup goals between 1 and 37 years, with the exception of TBA at MW-7. Although TBA concentrations at well MW-7 demonstrate an increasing trend, the strong evidence of natural attenuation contributing to stable and decreasing petroleum hydrocarbon concentration trends at other wells located closer to the source areas and the stable TBA concentrations reported in groundwater at MW-7 since 2010 suggest that natural attenuation will also eventually result in a decrease in TBA concentration at this location.

ACEH Comment: LTCP Media Specific Criteria for Vapor Intrusion to Indoor Air – The collection of site data and analysis fail to support the requisite characteristics of one of the four scenarios. Although the site is an active commercial fueling station, it does not qualify for an exemption from the Media Specific Criteria for Vapor Intrusion to Indoor Air due to an undefined extent of the groundwater plume.

The Site is currently an active, commercial fueling station and the entire site is paved. As described in the LTC Policy (SWRCB 2012), exposures to petroleum vapors associated with historical fuel system releases are comparatively insignificant relative to exposures from small surface spills and fugitive vapor releases that typically occur at active fueling facilities. Therefore, satisfaction of the media-specific criteria for petroleum vapor intrusion to indoor air is not required at active commercial petroleum facilities, except in cases where release characteristics can be reasonably believed to pose an unacceptable health risk. Since the Site is an active commercial petroleum facility, this criterion is satisfied according to the State Water Resource Control Board (SWRCB) LTC Policy.

The site investigation activities described above in Section 3.2, as well as the addition of DRO, naphthalene, and PAHs to the list of analytes for all groundwater monitoring wells during at least one future groundwater sampling event (December 2014) will provide data that will facilitate assessment of these constituents at the Site and provide information necessary to evaluate potential vapor intrusion risks related to DRO, naphthalene, and PAHs.

ACEH contends that the Site does not qualify for an exemption from the Vapor Intrusion Criteria because the extent of constituent plumes are not defined due to ACEH's interpretation of a data gap relating to the groundwater flow direction at the Site, which ACEH declares precludes the ability to determine the risk of vapor intrusion to the local vicinity downgradient of the Site. ACEH additionally contends that the Site is not exempt from the Vapor Intrusion Criteria due to elevated benzene, TBA, and DRO concentrations, uncharacterized naphthalene and PAHs, and waste motor oil contamination, which ACEH asserts prevents the ability to evaluate vapor risk.

The groundwater flow direction has been established to the southwest and the extents of the dissolved-phase GRO, benzene, MTBE, and TBA plumes in groundwater are defined by the current groundwater monitoring well network and groundwater sample data collected during the January 2011 site investigation. As shown on Figures 4 through 7, the majority, if not the entire mass, of the dissolved-phase GRO, benzene, MTBE, and TBA plumes are within the Site boundaries and are generally centered around the Site's fueling equipment (USTs and dispenser islands) where exposures from small surface spills and fugitive vapor releases that typically occur at active fueling facilities (SWRCB 2012) are common. These constituent plumes generally flow with the path of groundwater, to the southwest, and terminate south and southwest of the Site in Powell Street.

Soil borings completed during the January 2011 site investigation demonstrated that the adjacent commercial property, currently operating as a Denny's, is not affected by site COPC-related plumes (ARCADIS 2011). The commercial building on this adjacent property is located west-southwest of the Site, and is the only potential offsite receptor in the local vicinity downgradient of the Site. Results of the January 2011 investigation indicated no to low site COPC-related impacts to offsite groundwater (ARCADIS 2011). When the January 2011 site investigation data are combined with the current groundwater sampling data, site COPC-related plumes do not extend onto the adjacent commercial property, with the exception of the dissolved-phase TBA plume that slightly passes under a portion of the parking lot in the southeast corner of the commercial property (Figure 7). COPC concentrations detected in groundwater samples from locations between the Site and the downgradient commercial building, including, MW-3, MW-4, MW-6, MW-7, and UPT-02, for at least the past 5 years (since 2009) have been below SF-RWQCB 2013 groundwater ESLs for evaluation of potential vapor intrusion concerns (Table E-1; SF-RWQCB 2013). These data indicate that exposures to petroleum vapors in indoor air will not pose unacceptable health risks to occupants of the commercial building located at the neighboring commercial property west of the Site. The SF-RWQCB 2013 groundwater ESLs for evaluation of potential vapor intrusion concerns are shown on Table 1 with the groundwater analytical results for the past 5 years.

Vapor intrusion risks and potential exposures to petroleum vapors in indoor air are further demonstrated to be incomplete at properties in the local vicinity of the Site as these are used for commercial purposes or they are major thoroughfares, included Powell Street and Interstate 580 (I-580). The nearest residential properties, which have much lower vapor intrusion ESLs (typically an order of magnitude lower) than commercial properties, are located over 1,000 feet northeast (upgradient) of the Site. Moreover, it is unlikely that vapor-intrusion-to-indoor-air risks are present in the local vicinity of the Site as the parcels that directly border the Site are paved parking lots for the commercial properties (north and west of the Site) or are thoroughfares (south and east of the Site).

Potential vapor migration concerns are not considered to be present for current and future offsite commercial workers as all recently detected COPC concentrations in groundwater are below human health risk-based screening criteria (ESLs) for potential vapor migration concerns for commercial exposures, with the exception of benzene at MW-2 (Table 1). MW-2 is located onsite, immediately between the USTs and dispenser islands (Figure 2). As noted above, the SWRCB LTC Policy considers exposures to petroleum vapors associated with historical fuel system releases as comparatively insignificant relative to exposures from small surface spills and fugitive vapor releases that typically occur at active fueling facilities. The remainder of all other current COPC concentrations detected in groundwater are below SF-RWQCB groundwater ESLs for evaluation of potential vapor intrusion concerns (Table E-1; SF-RWQCB 2013). Table 1 compares groundwater concentrations for the past 5 years to SF-RWQCB ESLs for evaluation of potential vapor intrusion concerns. Based on the evaluation of potential vapor migration into current and future offsite commercial buildings, the Site satisfies the LTC Policy Petroleum Vapor Intrusion to Indoor Air Criteria.

Further investigation to determine potential vapor intrusion risk in Powell Street, south and southwest of the Site, is unwarranted. Powell Street is a major thoroughfare in the City of Emeryville, with freeway on-ramps and off-ramps from I-580. The Powell Street exits from I-580 are significantly traveled due to their close proximity to the MacArthur Maze which consistently contains a significant high volume of traffic as its principal function is to split Bay Bridge traffic into three freeways (I-80/I-580, MacArthur [I-580] and Nimitz [I-880]) and incorporate other important local transitions (e.g. Powell Street exits). It is highly unlikely that Powell Street will be redeveloped into another type of property, and it will remain a thoroughfare for the foreseeable future. Site investigation activities focused on assessing potential vapor-intrusion-to-indoor-air risks in Powell Street will bring little value to the SCM as the extents of the site COPC-related plumes do not extend past Powell Street, the area where site COPC-related plumes terminate will undoubtedly continue to be used as a thoroughfare for the foreseeable future, and data that would be obtained from site investigation activities in Powell Street would cause significant disruption to local businesses and traffic in the immediate and greater vicinity of the Site.

5. Conclusion

ARCADIS concurs with ACEH that further site assessment is required relating to the extent of the dissolved-phase DRO plume, the potential presence of GRO in the north-northeast (upgradient) portion of the Site, and to soil conditions according to the *Media-Specific Criteria – Direct Contact and Outdoor Air Exposure* within the SWRCB LTC Policy. It is anticipated that these data gaps will be addressed and understood by the results of the activities described in this Work Plan.

ARCADIS does not concur with ACEH's contentions that additional field work must be performed to address ACEH-asserted data gaps including:

- Groundwater flow directions;
- The extents of dissolved-phase plumes for GRO, BTEX, MTBE, and TBA;
- Declining groundwater concentrations have not been demonstrated;
- Potential vapor migration concerns for commercial exposures; and
- Constituent fate and migration south and southwest of the Site in Powell Street.

Hydrogeological and site-constituent data has been collected at the Site for at least the past 22 years. Site data collected to date demonstrate that the above items have been sufficiently assessed and that further characterization activities focused on the above items will add little value to the SCM. ARCADIS hopes that the information provided in this Work Plan will assist ACEH in reexamining their asserted data gaps.

6. Schedule and Reporting

Soil boring installation is anticipated to take a total of 3 days to complete. The implementation schedule for all field events will be dependent on approval of this work plan by ACEH and obtaining necessary permits. Following the site investigation activities, a report of field activities and results will be prepared for submittal to ACEH within 60 days of receiving final laboratory analytical results. The report will include the following:

- A summary of site conditions and background information;
- A scaled site plan illustrating the soil boring locations and other relevant site features;
- Documentation of field activities performed in connection with the site assessment;
- Geologic boring logs;
- Figure illustrating sample results;
- An updated SCM that addresses data gaps described in this work plan; and

- Conclusions relevant to the assessment objective.

7. References

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TABLE

Table 1
Current Groundwater Monitoring and Analytical Data
Former BP Service Station No. 11126
1700 Powell Street, Emeryville, California

Sample ID	Sample Date	Approximate Depth (feet bgs)	TOC (ft)	DTW (ft)	Measured LNAPL Thickness (ft)	GW Elevation (ft)	DRO (µg/L)	GRO (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	TBA (µg/L)
Maximum detected result since 2009							3,900	55,000	6,100	740	3,800	8,100	2,800	44,000
Drinking Water Screening Level[1]							100	100	1.0	150	300	1,800	5	12
Groundwater Screening Levels[1A]							640	500	27	130	43	100	1,800	18,000
Residential Groundwater ESL for Evaluation of Potential Vapor Intrusion Concerns[2]							--	--	27	95,000	310	37,000	9,900	--
Commercial Groundwater ESL for Evaluation of Potential Vapor Intrusion Concerns[2]							--	--	270	--	3,100	--	100,000	--
MW-01	5/28/2009	--	10.16	4.02	--	6.14	--	**880**	**64**	1.5	3.4	9.4	**48**	**1,800**
MW-01	12/10/2009	--	10.16	3.92	--	6.24	--	**1,300**	**46**	6.9	2.6	10	**65**	**560**
MW-01	6/29/2010	--	10.16	3.6	--	6.56	--	**530**	**18**	1.3	<0.50	4.3	<0.50	**2,000**
MW-01	12/30/2010	--	10.16	3.55	--	6.61	--	**1,000**	**19**	3.2	1.4	8.2	**46**	**1,900**
MW-01	6/29/2011	--	10.16	3.58	--	6.58	--	60	**<0.50**	<0.50	<0.50	<1.0	3.9	**840**
MW-01	1/30/2012	--	10.16	3.82	--	6.34	--	**1,100**	**42**	4.5	0.9	7.2	**64**	**900**
MW-01	6/27/2012	--	10.16	3.79	--	6.37	--	**420**	**15**	0.74	<0.50	3.1	**18**	**1,400**
MW-01	12/7/2012	--	10.16	3.3	--	6.86	--	**700**	**6.3**	2.3	<0.50	4.8	**32**	**1,400**
MW-01	6/6/2013	--	10.16	3.73	--	6.43	--	**240**	**11**	6.7	14	9.8	**6.9**	**170**
MW-01	12/13/2013	--	10.16	3.88	--	6.28	--	**680**	**23**	3.2	3.4	9.9	**36**	**1,500**
MW-01	6/30/2014	--	10.16	3.77	--	6.39	--	**160**	**7.8**	0.58	<0.50	<1.0	4.2	**970**
MW-02	5/28/2009	--	11.39	4.9	--	6.49	--	**55,000**	**4,700**	**740**	**3,800**	**8,100**	**2,800**	**2,000**
MW-02	12/10/2009	--	11.39	5.29	--	6.10	--	**2,200**	**250**	7.3	13	14	**360**	**44,000**
MW-02	6/29/2010	--	11.39	5.03	--	6.36	--	**5,300**	**800**	<25	250	300	**770**	**31,000**
MW-02	12/30/2010	--	11.39	4.22	--	7.17	--	**19,000**	**3,500**	58	**2,000**	1,000	**1,700**	**4,700**
MW-02	6/29/2011	--	11.39	4.51	--	6.88	--	**12,000**	**3,200**	41	**920**	150	**2,100**	**2,400**
MW-02	1/30/2012	--	11.39	4.93	--	6.46	--	**13,000**	**3,000**	45	**640**	370	**1,700**	**1,900**
MW-02	6/27/2012	--	11.39	4.72	--	6.67	--	**23,000**	**3,900**	110	**2,300**	**2,000**	**2,600**	**2,900**
MW-02	12/7/2012	--	11.39	4.11	--	7.28	--	**10,000**	**2,600**	31	**350**	72	**1,300**	**3,400**
MW-02	6/6/2013	--	11.39	4.95	--	6.44	--	**20,000**	**6,100**	86	**670**	1,200	**2,000**	**2,600**
MW-02	12/13/2013	--	11.39	5.29	--	6.10	--	**<10,000**	**200**	<100	<100	<200	**140**	**32,000**
MW-02	6/30/2014	--	11.39	4.95	--	6.44	--	**<10,000**	**1,800**	<100	140	<200	**700**	**25,000**
MW-03	5/28/2009	--	10.73	5.77	--	4.96	**1,600**	<50	<1.0	<1.0	<1.0	<1.0	2.1	**580**
MW-03	12/10/2009	--	10.73	5.67	--	5.06	--	<50	<0.50	<0.50	<0.50	<1.0	0.86	**270**
MW-03	12/18/2009	--	--	--	--	--	**450**	--	--	--	--	--	--	--
MW-03	6/29/2010	--	10.73	5.85	--	4.88	**2,700**	<50	<0.50	<0.50	<0.50	<1.0	1.9	**2,900**
MW-03	12/30/2010	--	10.73	4.33	--	6.40	**520**	<50	<0.50	<0.50	<0.50	<1.0	<0.50	**<4.0**
MW-03	6/29/2011	--	10.73	5	--	5.73	**250**	<50	--	--	--	--	0.73	**73**
MW-03	1/30/2012	--	10.73	5.22	--	5.51	**160**	<50	--	--	--	--	<0.50	**65**
MW-03	6/27/2012	--	10.73	5.19	--	5.54	**270**	<50	--	--	--	--	1.6	**250**

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MW-03	12/7/2012	--	10.73	4.65	--	6.08	**110**	<50	--	--	--	--	<0.50	**20**
MW-03	6/6/2013	--	10.73	5.51	--	5.22	**300**	<50	--	--	--	--	1.9	**540**
MW-03	12/13/2013	--	10.73	5.77	--	4.96	<49	<50	--	--	--	--	0.54	**680**
MW-03	6/30/2014	--	10.73	5.56	--	5.17	<47	<50	--	--	--	--	1.5	**1,900**
MW-04	5/28/2009	--	10.58	7.06	--	3.52	--	**330**	<1.0	<1.0	<1.0	<1.0	**21**	**36,000**
MW-04	12/10/2009	--	10.58	6.24	--	4.34	--	**660**	<0.50	<0.50	<0.50	<1.0	**10**	**39,000**
MW-04	6/29/2010	--	10.58	6.57	--	4.01	--	<500	<5.0	<5.0	<5.0	<10	**7.3**	**38,000**
MW-04	12/30/2010	--	10.58	7.32	--	3.26	--	<500	<5.0	<5.0	<5.0	<10	**11**	**31,000**
MW-04	6/29/2011	--	10.58	6.43	--	4.15	**610**	<500	--	--	--	--	**11**	**30,000**
MW-04	1/30/2012	--	10.58	6.72	--	3.86	**530**	72	--	--	--	--	**11**	**23,000**
MW-04	6/29/2012	--	10.58	5.5	--	5.08	**480**	<500	--	--	--	--	**9.3**	**28,000**
MW-04	12/7/2012	--	10.58	7.05	--	3.53	**330**	<500	--	--	--	--	**8.7**	**18,000**
MW-04	6/6/2013	--	10.58	6.53	--	4.05	**600**	<500	--	--	--	--	**6.7**	**26,000**
MW-04	12/13/2013	--	10.58	7.15	--	3.43	<49	<500	--	--	--	--	**7.2**	**19,000**
MW-04	6/30/2014	--	10.58	5.85	--	4.73	**800**	<500	--	--	--	--	**5.5**	**24,000**
MW-05	6/29/2011	--	10.18	5.38	--	4.8	--	**3,300**	**1.7**	0.6	<0.50	2.4	1.9	<4.0
MW-05	1/30/2012	--	10.18	5.24	--	4.94	--	**3,200**	**2.4**	1.1	<0.50	3.6	2.1	**17**
MW-05	6/27/2012	--	10.18	5.39	--	4.79	--	**--**	**--**	--	--	--	--	--
MW-05	6/29/2012	--	--	--	--	--	--	**3,000**	**1.5**	<0.50	<0.50	3.5	2.0	<4.0
MW-05	12/7/2012	--	10.18	5.11	--	5.07	--	**3,200**	**2.9**	0.79	0.89	2.9	**6.2**	**89**
MW-05	6/6/2013	--	10.18	5.47	--	4.71	--	**3,800**	**2.1**	0.67	<0.50	3.2	3.7	**41**
MW-05	12/13/2013	--	10.18	5.47	--	4.71	**600**	**3,300**	**3.3**	1.0	0.79	4.1	**9.5**	**410**
MW-05	6/30/2014	--	10.18	5.49	--	4.69	**340**	**2,800**	**2.5**	0.67	<0.50	3.9	**5.2**	**160**
MW-06	5/28/2009	--	11.01	6.19	--	4.82	--	<50	<1.0	<1.0	<1.0	<1.0	**6.6**	**55**
MW-06	12/10/2009	--	11.01	6.15	--	4.86	--	<50	<0.50	<0.50	<0.50	<1.0	2.0	**40**
MW-06	6/29/2010	--	11.01	6.18	--	4.83	--	<50	<0.50	<0.50	<0.50	<1.0	2.7	**49**
MW-06	12/30/2010	--	11.01	5.34	--	5.67	--	<50	<0.50	<0.50	<0.50	<1.0	2.2	**44**
MW-06	6/29/2011	--	11.01	5.53	--	5.48	**2,100**	<50	--	--	--	--	3.6	**37**
MW-06	1/30/2012	--	11.01	5.89	--	5.12	**710**	<50	--	--	--	--	4.0	**110**
MW-06	6/27/2012	--	11.01	5.68	--	5.33	**1,200**	<50	--	--	--	--	2.2	**49**
MW-06	12/7/2012	--	11.01	5.35	--	5.66	**610**	<50	--	--	--	--	2.4	**300**
MW-06	6/6/2013	--	11.01	5.99	--	5.02	**3,900**	160	--	--	--	--	3.8	**150**
MW-06	12/13/2013	--	11.01	6.36	--	4.65	**140**	<50	--	--	--	--	4.4	**160**
MW-06	6/30/2014	--	11.01	5.94	--	5.07	**300**	<50	--	--	--	--	2.4	**57**

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MW-07	5/28/2009	--	10.11	5.91	--	4.20	--	<50	<1.0	<1.0	<1.0	<1.0	**5.7**	**110**
MW-07	12/10/2009	--	10.11	5.88	(Sheen)	4.23	--	62	<0.50	<0.50	<0.50	<1.0	**6.5**	**1,200**
MW-07	6/29/2010	--	10.11	5.48	--	4.63	--	<50	<0.50	<0.50	<0.50	<1.0	3.0	**2,000**
MW-07	12/30/2010	--	10.11	4.8	--	5.31	--	<50	<0.50	<0.50	<0.50	<1.0	**5.6**	**3,900**
MW-07	6/29/2011	--	10.11	5.18	--	4.93	--	<500	<5.0	<5.0	<5.0	<10	<5.0	**2,200**
MW-07	1/30/2012	--	10.11	5.29	--	4.82	--	<50	<0.50	<0.50	<0.50	<1.0	4.0	**2,700**
MW-07	6/27/2012	--	10.11	5.19	--	4.92	--	<50	<0.50	<0.50	<0.50	<1.0	2.7	**1,400**
MW-07	12/7/2012	--	10.11	4.78	--	5.33	--	<50	<0.50	<0.50	<0.50	<1.0	3.0	**2,600**
MW-07	6/6/2013	--	10.11	5.43	--	4.68	--	<50	<0.50	<0.50	<0.50	<1.0	2.8	**1,600**
MW-07	6/14/2013	--	--	--	--	--	**570**	--	--	--	--	--	--	--
MW-07	12/13/2013	--	10.11	5.84	--	4.27	<51	<50	<0.50	<0.50	<0.50	<1.0	4.4	**3,100**
MW-07	6/30/2014	--	10.11	5.42	--	4.69	**130**	<250	<2.5	<2.5	<2.5	<5.0	2.7	**2,300**
MW-08	5/28/2009	--	11.08	4.98	--	6.10	--	**270**	<1.0	<1.0	<1.0	<1.0	**6.5**	**710**
MW-08	12/10/2009	--	11.08	5.06	--	6.02	--	90	<0.50	<0.50	<0.50	<1.0	**9.0**	**960**
MW-08	6/29/2010	--	11.08	4.71	--	6.37	--	**170**	<0.50	<0.50	<0.50	<1.0	**10**	**1,700**
MW-08	12/30/2010	--	11.08	4.37	--	6.71	--	**190**	<0.50	<0.50	<0.50	<1.0	**6.6**	**1,500**
MW-08	6/29/2011	--	11.08	4.57	--	6.51	**1,000**	**140**	--	--	--	--	4.7	**2,000**
MW-08	1/30/2012	--	11.08	4.63	--	6.45	**1,500**	**240**	--	--	--	--	3.8	**250**
MW-08	6/27/2012	--	11.08	4.49	--	6.59	**1,100**	**300**	--	--	--	--	2.2	**270**
MW-08	12/7/2012	--	11.08	3.99	--	7.09	**800**	**210**	--	--	--	--	1.2	**31**
MW-08	6/6/2013	--	11.08	4.43	--	6.65	**830**	**200**	--	--	--	--	0.5	5.7
MW-08	12/13/2013	--	11.08	4.42	--	6.66	**100**	**270**	--	--	--	--	<0.50	<10
MW-08	6/30/2014	--	11.08	4.18	--	6.90	<55	**150**	--	--	--	--	<0.50	<20
MW-09	5/28/2009	--	10.55	4.17	--	6.38	--	**4,400**	**420**	14	270	170	**720**	**840**
MW-09	12/10/2009	--	10.55	4.11	(Sheen)	6.44	--	**4,400**	**240**	7.9	17	19	**780**	**4,200**
MW-09	6/29/2010	--	10.55	4.3	--	6.25	--	**4,200**	**680**	15	110	130	**1,200**	**4,200**
MW-09	12/30/2010	--	10.55	2.79	--	7.76	--	**420**	**6.7**	<0.50	2.1	2.0	**13**	**22**
MW-09	6/29/2011	--	10.55	3.72	--	6.83	--	**4,700**	**600**	13	**370**	120	**900**	**960**
MW-09	1/30/2012	--	10.55	4.09	--	6.46	--	**2,300**	**210**	5.1	10	20	**630**	**1,600**
MW-09	6/27/2012	--	10.55	3.51	--	7.04	--	**810**	**78**	<2.5	4.6	7.9	**130**	**160**
MW-09	12/7/2012	--	10.55	3.38	--	7.17	--	**2,000**	**130**	5.1	6.1	11	**250**	**340**
MW-09	6/6/2013	--	10.55	4.3	--	6.25	--	**3,400**	**480**	14	8.9	15	**680**	**2,200**
MW-09	12/13/2013	--	10.55	4.6	--	5.95	--	**1,600**	**110**	6.4	4.2	<5.0	**220**	**2,500**
MW-09	6/30/2014	--	10.55	4.25	--	6.30	--	**2,500**	**170**	12	4.0	10	**370**	**3,800**

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Former BP Service Station No. 11126
1700 Powell Street, Emeryville, California

Sample ID	Sample Date	Approximate Depth (feet bgs)	TOC (ft)	DTW (ft)	Measured LNAPL Thickness (ft)	GW Elevation (ft)	DRO (µg/L)	GRO (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	TBA (µg/L)
MW-10	5/28/2009	--	12.53	8.71	--	3.82	--	<50	<1.0	<1.0	<1.0	<1.0	1.3	<5.0
MW-10	12/10/2009	--	12.53	8.35	--	4.18	--	<50	<0.50	<0.50	<0.50	<1.0	1.5	<4.0
MW-10	6/29/2010	--	12.53	8.43	--	4.10	--	<50	<0.50	<0.50	<0.50	<1.0	1.6	<4.0
MW-10	12/30/2010	--	12.53	6.62	--	5.91	--	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<4.0
MW-10	6/29/2011	--	12.53	7.16	--	5.37	--	--	--	--	--	--	<0.50	--
MW-10	1/30/2012	--	12.53	7.33	--	5.2	--	--	--	--	--	--	--	--
MW-10	6/27/2012	--	12.53	7.70	--	4.83	--	--	--	--	--	--	<0.50	--
MW-10	12/7/2012	--	12.53	6.29	--	6.24	--	--	--	--	--	--	--	--
MW-10	6/6/2013	--	12.53	7.65	--	4.88	--	--	--	--	--	--	<0.50	--
MW-10	12/13/2013	--	12.53	8.10	--	4.43	--	--	--	--	--	--	--	--
MW-10	6/30/2014	--	12.53	7.87	--	4.66	--	--	--	--	--	--	<0.50	--
MW-11	5/28/2009	--	14.55	10.4	--	4.15	--	<50	<1.0	<1.0	<1.0	<1.0	<1.0	<5.0
MW-11	12/10/2009	--	14.55	10.41	--	4.14	--	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<4.0
MW-11	6/29/2010	--	14.55	10.19	--	4.36	--	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<4.0
MW-11	12/30/2010	--	14.55	9.22	--	5.33	--	<50	<0.50	<0.50	<0.50	<1.0	<0.50	<4.0
MW-11	6/29/2011	--	14.55	9.40	--	5.15	--	--	--	--	--	--	<0.50	--
MW-11	1/30/2012	--	14.55	9.49	--	5.06	--	--	--	--	--	--	--	--
MW-11	6/27/2012	--	14.55	9.70	--	4.85	--	--	--	--	--	--	<0.50	--
MW-11	12/7/2012	--	14.55	8.85	--	5.70	--	--	--	--	--	--	--	--
MW-11	6/6/2013	--	14.55	10.03	--	4.52	--	--	--	--	--	--	<0.50	--
MW-11	12/13/2013	--	14.55	10.25	--	4.30	--	--	--	--	--	--	--	--
MW-11	6/30/2014	--	14.55	10.12	--	4.43	--	--	--	--	--	--	<0.50	--
UCPT-01	1/6/2011	7	--	--	--	--	--	<50	<0.5	<0.5	<0.5	<1	**14**	**63**
UCPT-02	1/6/2011	7	--	--	--	--	--	<50	<0.5	<0.5	<0.5	<1	<0.5	<4
UCPT-02	1/6/2011	21	--	--	--	--	--	<50	<0.5	<0.5	<0.5	<1	<0.5	<4

Table 1
Current Groundwater Monitoring and Analytical Data
Former BP Service Station No. 11126
1700 Powell Street, Emeryville, California

Sample ID	Sample Date	Approximate Depth (feet bgs)	TOC (ft)	DTW (ft)	Measured LNAPL Thickness (ft)	GW Elevation (ft)	DRO (µg/L)	GRO (µg/L)	B (µg/L)	T (µg/L)	E (µg/L)	X (µg/L)	MTBE (µg/L)	TBA (µg/L)

Notes:

1. Drinking Water Screening Levels (Table F-3 Final Screening Levels, SF-RWQCB 2013)
   Contaminant Levels for all constituents except GRO, which is based on noncarcinogenic effects.

1A: Groundwater Screening Levels (Table F-1b, Groundwater is not a current or potential drinking water resource, SF-RWQCB 2013).

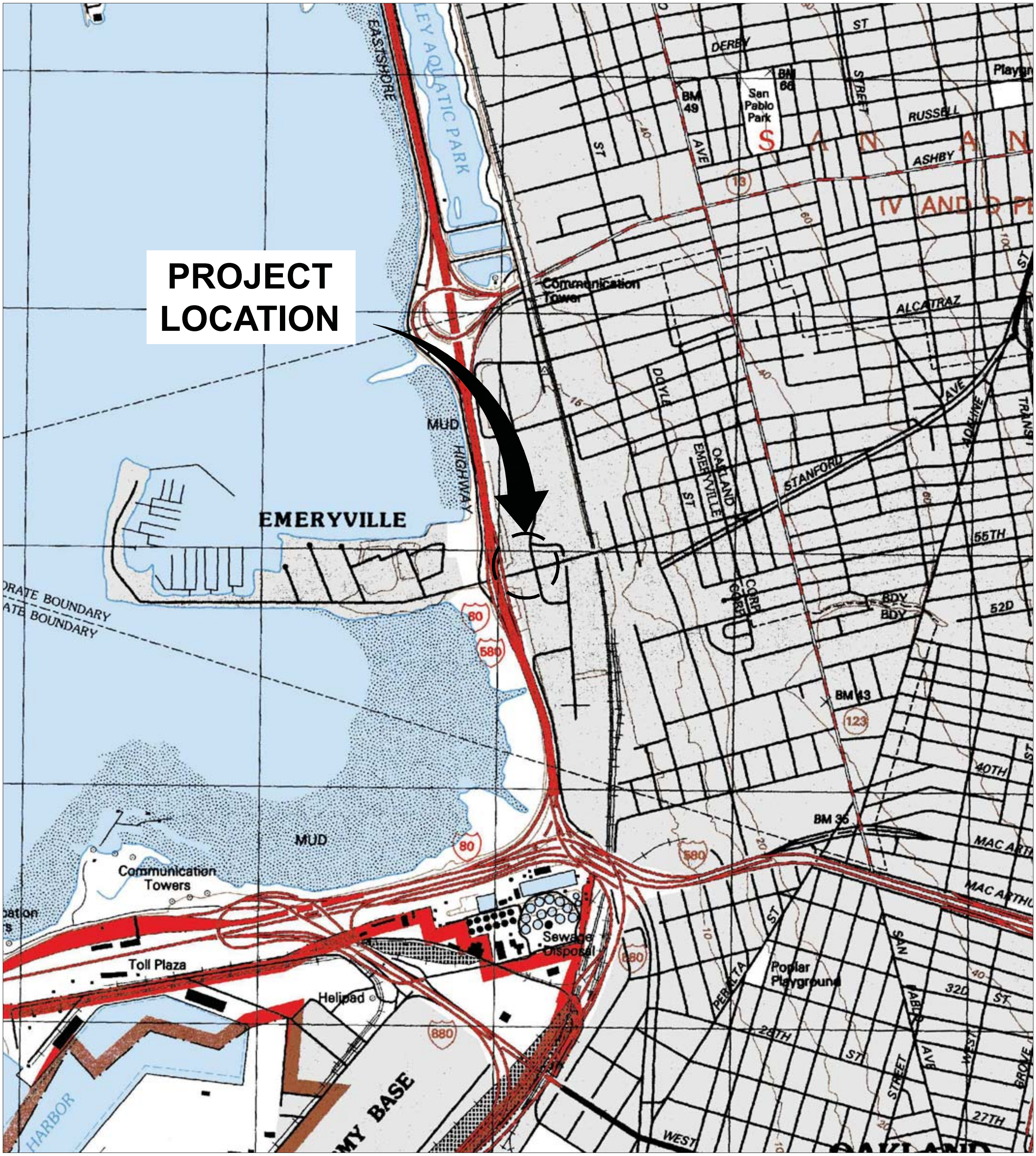
2. Groundwater Screening Levels (GSLs) for evaluation of potential vapor intrusion concerns (Table E-1, Fine-coarse Mix, SF-RWQCB 2013).

Abbreviations:

Depth = depth sample was collected
bgs = below ground surface
TOC = Top of casing (surveyed)
DTW = Depth to water
LNAPL = Light non-aqueous phase liquid
GW Elevation = Calculated groundwater elevation; adjusted assuming a specific gravity of 0.75 for SPH when present.
ft = feet
µg/L = micrograms per liter
< = Analyte was not detected above the laboratory method reporting limit
-- = Not measured or analyzed
DRO = Diesel Range Organics - Analysis by U.S. EPA Method 8015M
GRO = Gasoline Range Organics - Analysis by U.S. EPA Method 8260B
BTEX = Benzene, Toluene, Ethylbenzene and Xylenes - Analysis by U.S. EPA Method 8260B
MTBE = Methyl tertiary-butyl ether - Analysis by U.S. EPA Method 8260B
TBA = Tertiary-butyl alcohol by USEPA Method 8260B
Bold values indicate concentrations meeting or exceeding Drinking Water Screening Levels.
Highlighted cells indicate concentrations detected above the Commercial/Industrial (C/I) Direct Exposure Screening Level. Concentrations evaluated to Residential Direct Exposure Screening Level if a C/I Exposure Screening Level is unavailable.

ARCADIS

FIGURES



REFERENCE: BASE MAP USGS 7.5. MIN. TOPO. QUAD., OAKLAND WEST, CALIFORNIA

0 2000' 4000'

Approximate Scale: 1 in. = 200

FORMER BP STATION #11126
1700 POWELL STREET
EMERYVILLE, CALIFORNIA

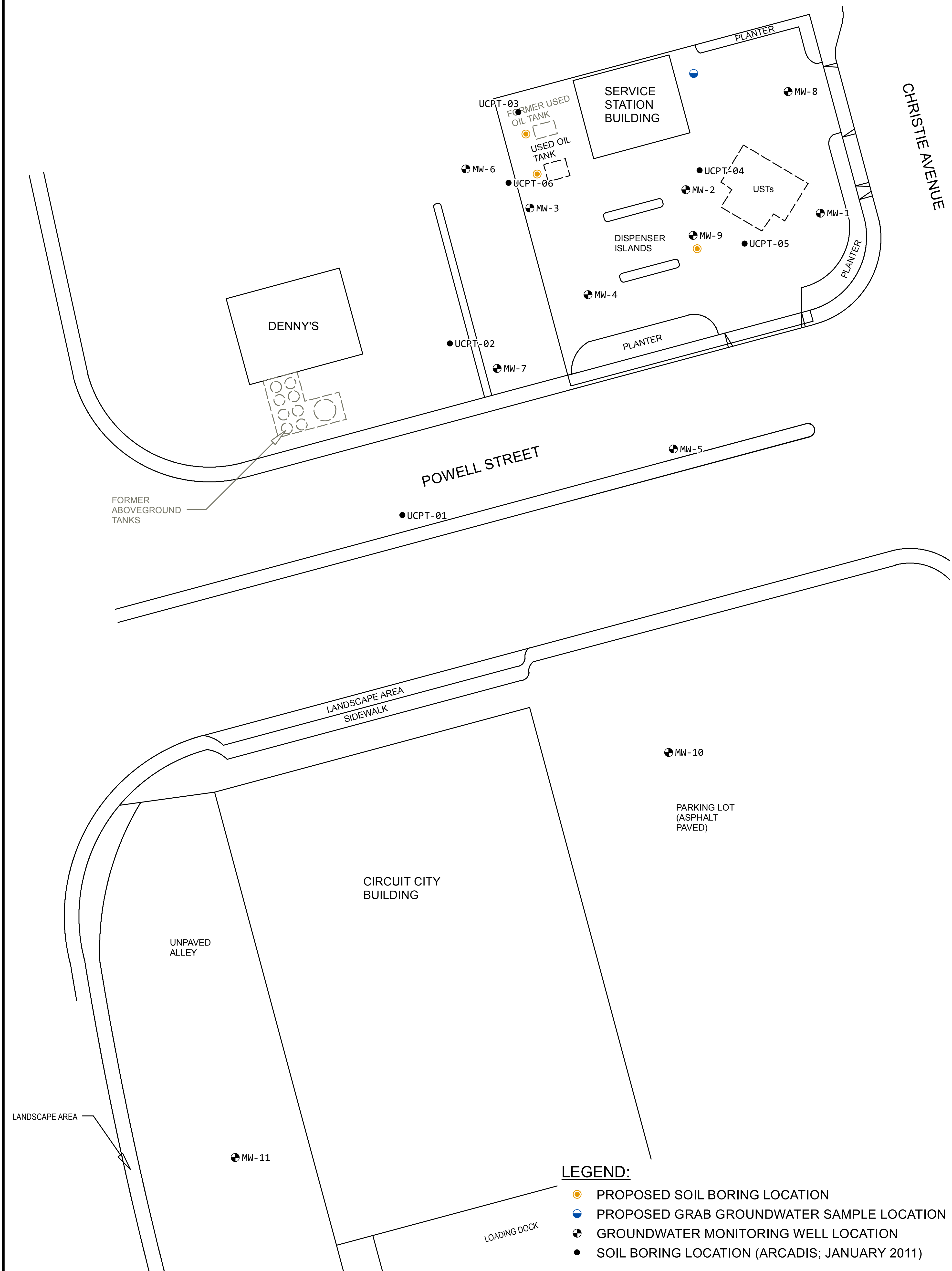
SITE VICINITY MAP

ARCADIS

FIGURE
1

CITY: PETALUMA, CA DIV/GROUP: ENV TEAM 2A
C:\Users\jharris\Desktop\ENV\CAD\GP09BPNAC044\DWG\GP09BPNAC044-N01.dwg LAYOU 1 SAVE 7/8/2012 1:34 ACADVE 18.1S (LMS TEC PAGESETU SETUP1 PLOTSTYLETABLE ARCADIS.CTB PLOTTE 7/8/2012 1:34 B HARRIS, JESSIC
XREFS: IMAGES: Oakland West.j PROJECTNAME: ----

CITY: SAN FRANCISCO DIV/GROUP: ENV/IM DB: KGPETERS LD: PIC: PM: TM:
PROJECT: PATH: Z:\GISPROJECTS_ENV\BP_FOXGLOVE\CA\CA11126\GIS\MXD\Q2_2014\CA11126_FIG2_SITEPLAN.MXD DATE: 8/11/2014 10:08:08 AM



NOTES:

1. SITE MAP ADAPTED FROM STANTEC FIGURES

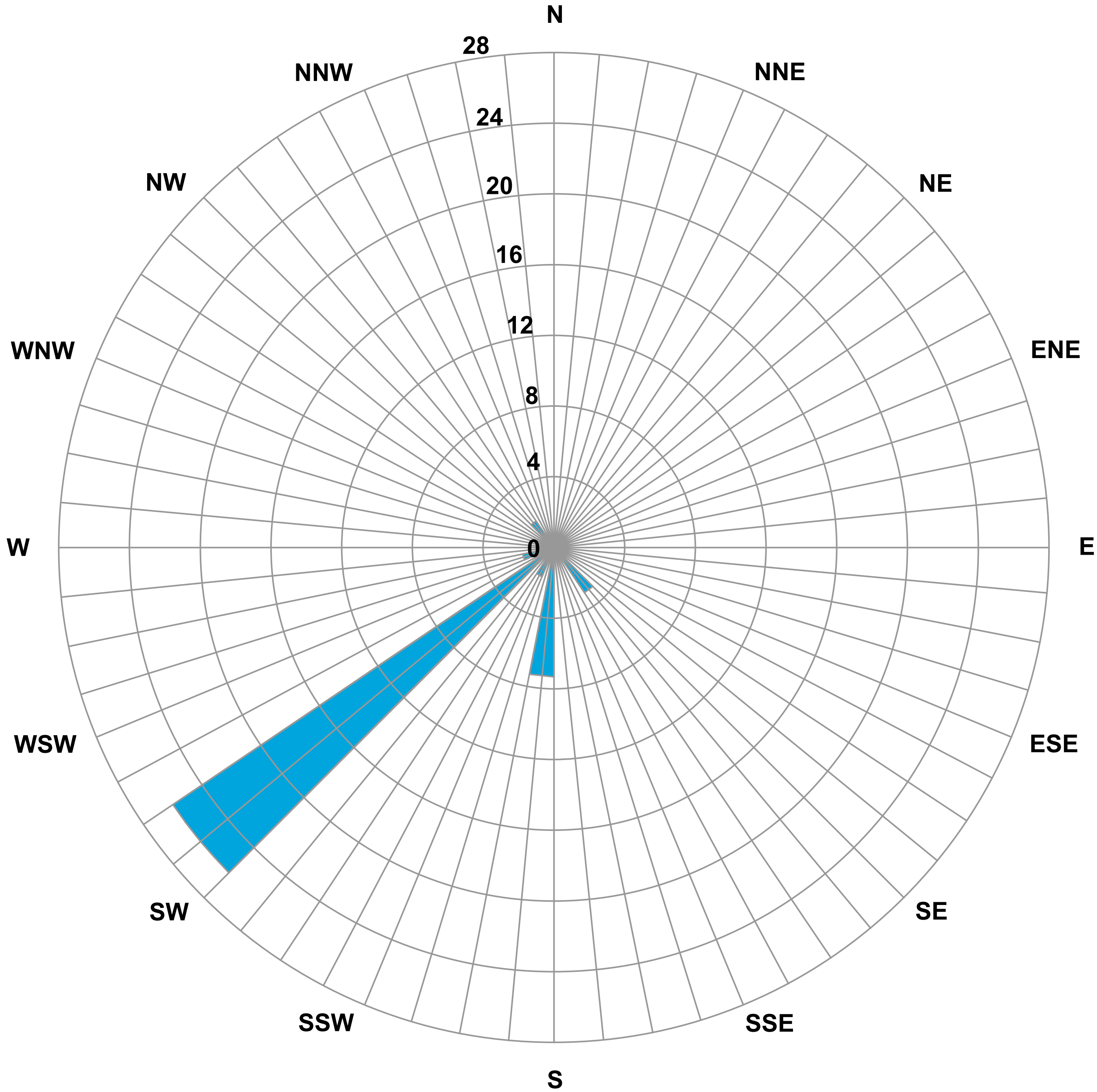
2. SITE DIMENSIONS AND FACILITY LOCATIONS NOT VERIFIED

FORMER BP STATION #11126
1700 POWELL STREET, EMERYVILLE, CALIFORNIA

SITE PLAN WITH PROPOSED SOIL BORING LOCATIONS

ARCADIS

FIGURE
2



LEGEND

CONCENTRIC CIRCLES REPRESENT 45 MONITORING EVENTS CONDUCTED BETWEEN THE FIRST QUARTER 2001 AND THE SECOND QUARTER 2014.

GROUNDWATER FLOW DIRECTION

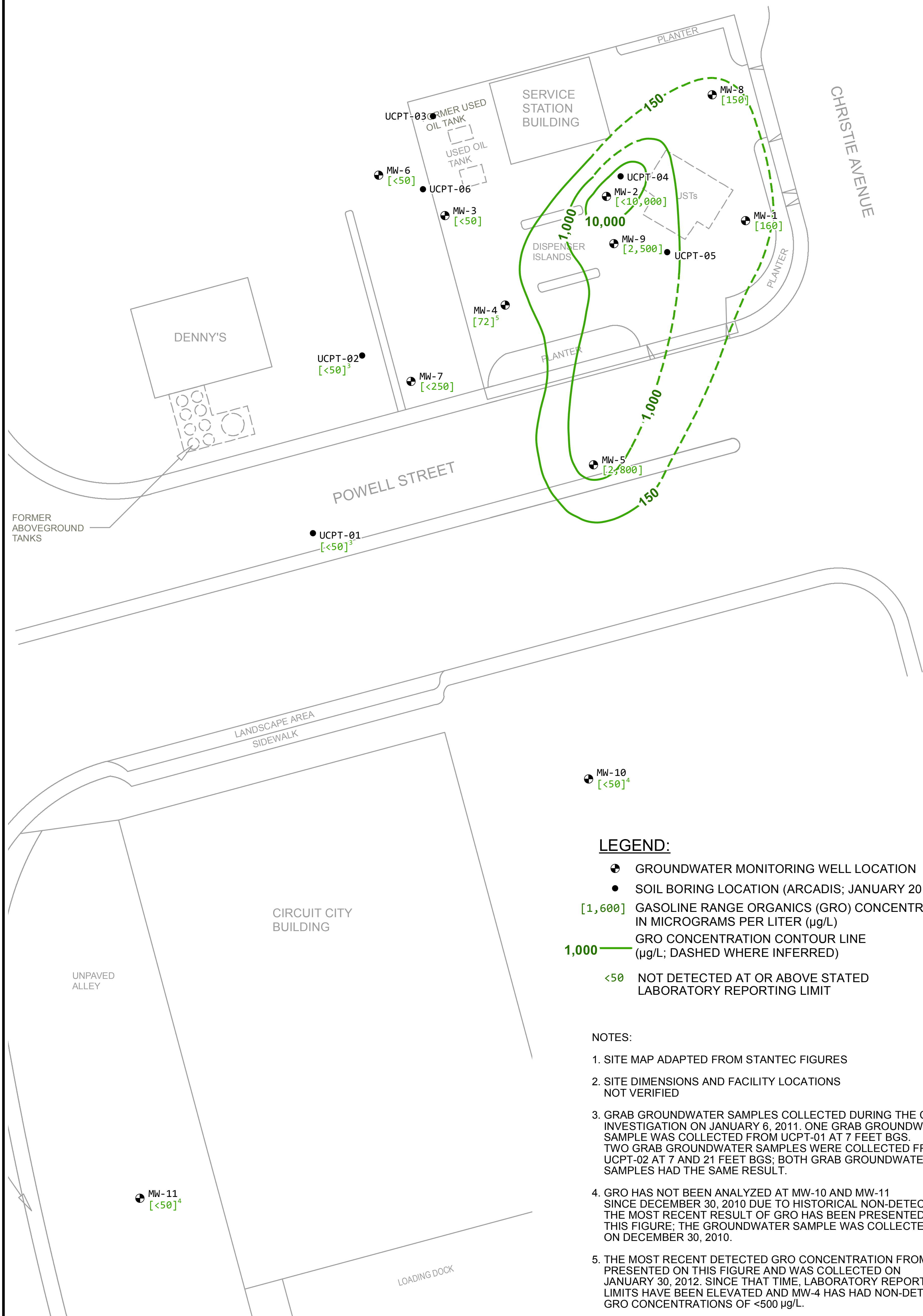
FORMER BP STATION #11126
1700 POWELL STREET
EMERYVILLE, CALIFORNIA

GROUNDWATER FLOW DIRECTION ROSE DIAGRAM

ARCADIS

FIGURE
3

CITY: SAN FRANCISCO DIV/GROUP: ENV/IM DB: KGPETERS LD: PIC: PM: TM:
PROJECT: PATH: Z:\GISPROJECTS_ENV\BP_FOXGLOVE\CA\CA11126\GIS\MXD\Q2_2014\CA11126_FIG4_GRO.MXD DATE: 8/11/2014 10:24:09 AM



LEGEND:

- GROUNDWATER MONITORING WELL LOCATION
- SOIL BORING LOCATION (ARCADIS; JANUARY 2011)
- [1,600] GASOLINE RANGE ORGANICS (GRO) CONCENTRATION IN MICROGRAMS PER LITER (µg/L)
- 1,000 GRO CONCENTRATION CONTOUR LINE (µg/L; DASHED WHERE INFERRED)
- <50 NOT DETECTED AT OR ABOVE STATED LABORATORY REPORTING LIMIT

NOTES:

1. SITE MAP ADAPTED FROM STANTEC FIGURES
2. SITE DIMENSIONS AND FACILITY LOCATIONS NOT VERIFIED
3. GRAB GROUNDWATER SAMPLES COLLECTED DURING THE CPT INVESTIGATION ON JANUARY 6, 2011. ONE GRAB GROUNDWATER SAMPLE WAS COLLECTED FROM UCPT-01 AT 7 FEET BGS. TWO GRAB GROUNDWATER SAMPLES WERE COLLECTED FROM UCPT-02 AT 7 AND 21 FEET BGS; BOTH GRAB GROUNDWATER SAMPLES HAD THE SAME RESULT.
4. GRO HAS NOT BEEN ANALYZED AT MW-10 AND MW-11 SINCE DECEMBER 30, 2010 DUE TO HISTORICAL NON-DETECTS. THE MOST RECENT RESULT OF GRO HAS BEEN PRESENTED ON THIS FIGURE; THE GROUNDWATER SAMPLE WAS COLLECTED ON DECEMBER 30, 2010.
5. THE MOST RECENT DETECTED GRO CONCENTRATION FROM MW-4 IS PRESENTED ON THIS FIGURE AND WAS COLLECTED ON JANUARY 30, 2012. SINCE THAT TIME, LABORATORY REPORTING LIMITS HAVE BEEN ELEVATED AND MW-4 HAS HAD NON-DETECTED GRO CONCENTRATIONS OF <500 µg/L.

0 40 80
SCALE IN FEET

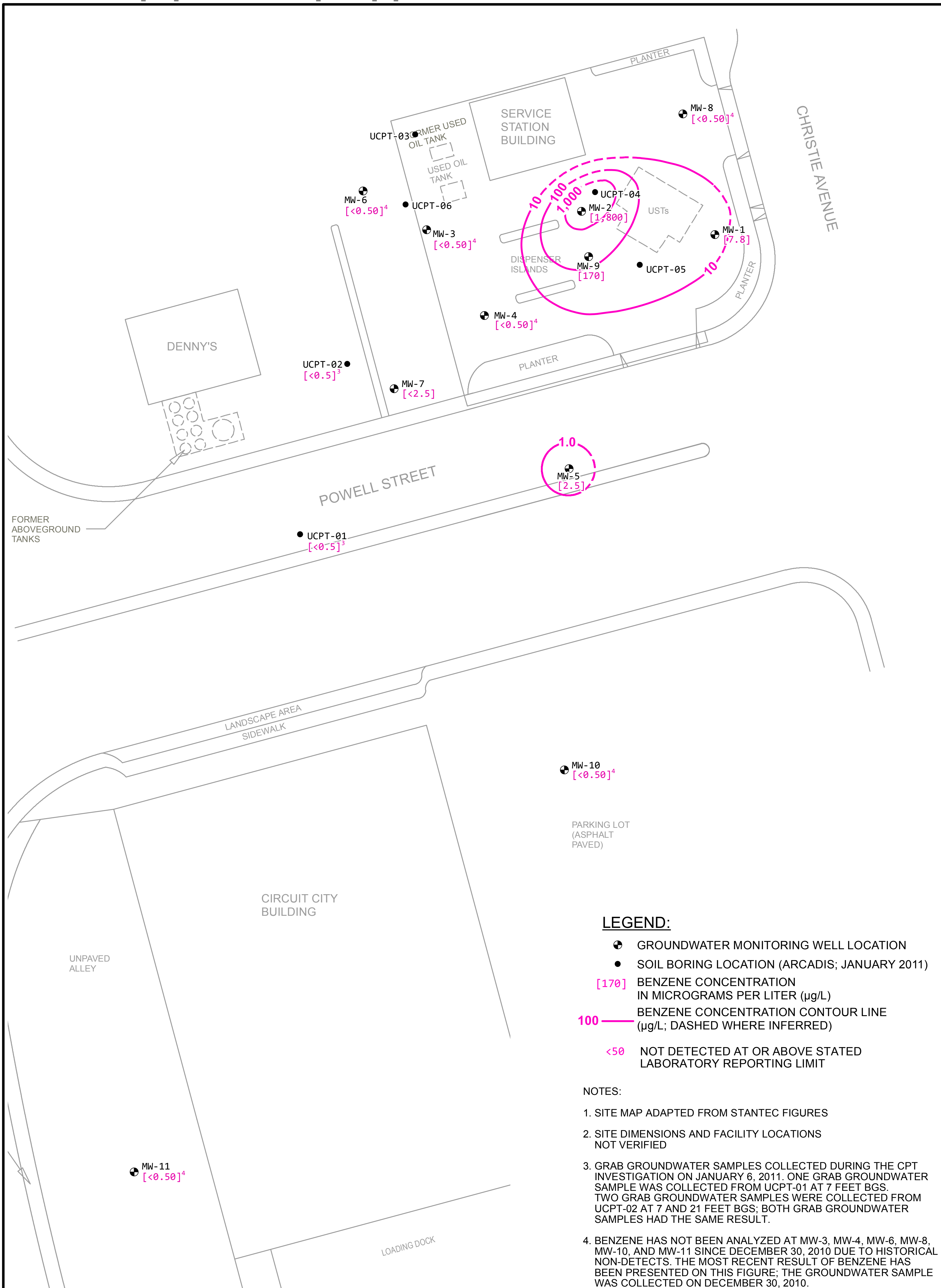
FORMER BP STATION #11126
1700 POWELL STREET, EMERYVILLE, CALIFORNIA

GRO ISOCONCENTRATION MAP
JUNE 30, 2014

ARCADIS

FIGURE
4

CITY: SAN FRANCISCO DIV/GROUP: ENV/IM DB: KGPETERS LD: PIC: PM: TM:
PROJECT: PATH: Z:\GISPROJECTS_ENV\BP_FOXGLOVE\CA\CA11126\GIS\MXD\Q2_2014\CA11126_FIG5_BENZENE.MXD DATE: 8/11/2014 10:31:47 AM



LEGEND:

- GROUNDWATER MONITORING WELL LOCATION
- SOIL BORING LOCATION (ARCADIS; JANUARY 2011)
- [170] BENZENE CONCENTRATION IN MICROGRAMS PER LITER (µg/L)
- 100 BENZENE CONCENTRATION CONTOUR LINE (µg/L; DASHED WHERE INFERRED)
- <50 NOT DETECTED AT OR ABOVE STATED LABORATORY REPORTING LIMIT

NOTES:

1. SITE MAP ADAPTED FROM STANTEC FIGURES
2. SITE DIMENSIONS AND FACILITY LOCATIONS NOT VERIFIED
3. GRAB GROUNDWATER SAMPLES COLLECTED DURING THE CPT INVESTIGATION ON JANUARY 6, 2011. ONE GRAB GROUNDWATER SAMPLE WAS COLLECTED FROM UCPT-01 AT 7 FEET BGS. TWO GRAB GROUNDWATER SAMPLES WERE COLLECTED FROM UCPT-02 AT 7 AND 21 FEET BGS; BOTH GRAB GROUNDWATER SAMPLES HAD THE SAME RESULT.
4. BENZENE HAS NOT BEEN ANALYZED AT MW-3, MW-4, MW-6, MW-8, MW-10, AND MW-11 SINCE DECEMBER 30, 2010 DUE TO HISTORICAL NON-DETECTS. THE MOST RECENT RESULT OF BENZENE HAS BEEN PRESENTED ON THIS FIGURE; THE GROUNDWATER SAMPLE WAS COLLECTED ON DECEMBER 30, 2010.

0 40 80
SCALE IN FEET

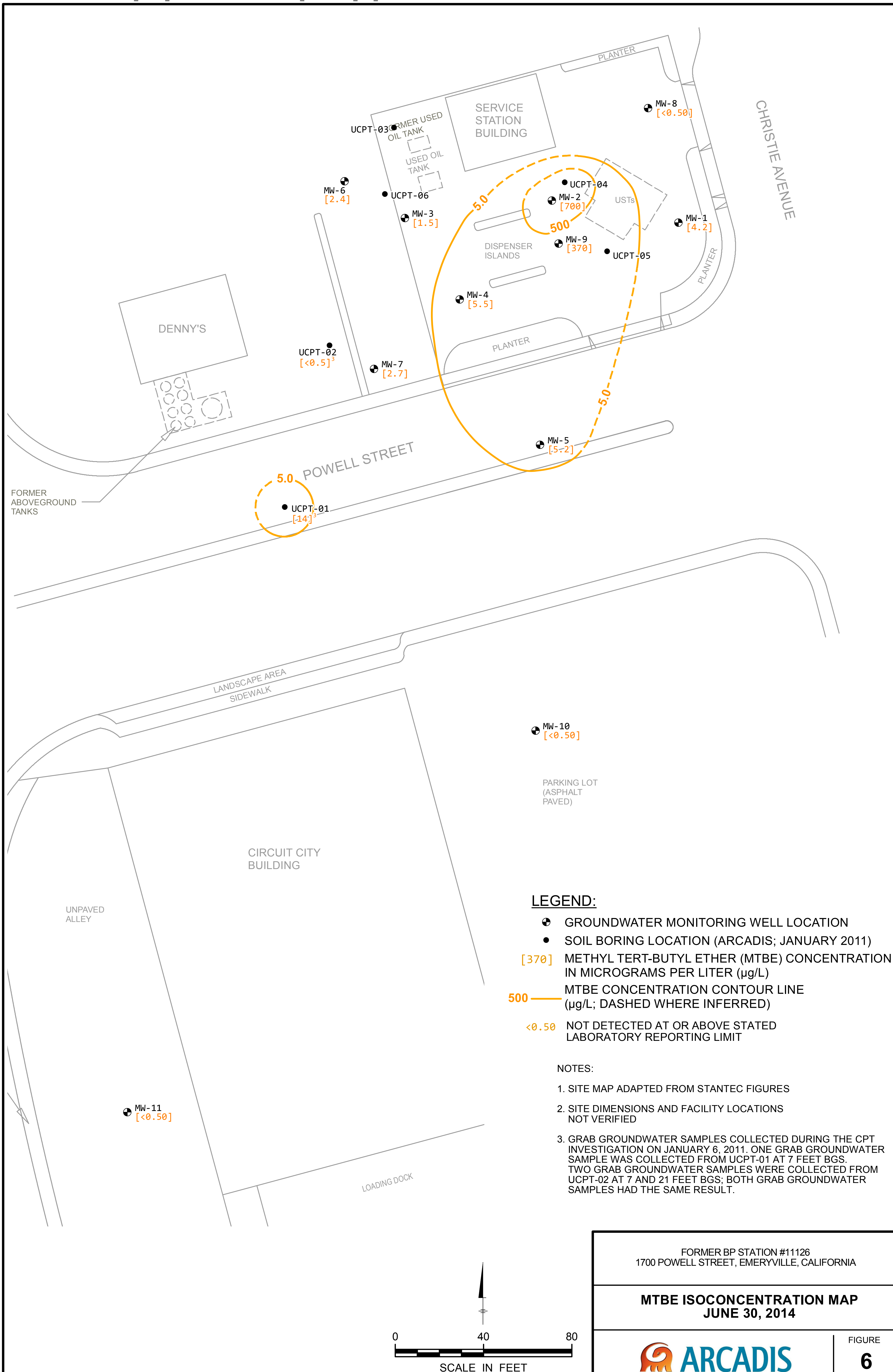
FORMER BP STATION #11126
1700 POWELL STREET, EMERYVILLE, CALIFORNIA

BENZENE ISOCONCENTRATION MAP
JUNE 30, 2014

ARCADIS

FIGURE
5

CITY: SAN FRANCISCO DIV/GROUP: ENV/IM DB: KGPETERS LD: PIC: PM: TM:
PROJECT: PATH: Z:\GISPROJECTS_ENV\BP_FOXGLOVE\CA\CA11126\GIS\MXD\Q2_2014\CA11126_FIG6_MTBE.MXD DATE: 8/11/2014 10:36:23 AM



LEGEND:

- GROUNDWATER MONITORING WELL LOCATION
- SOIL BORING LOCATION (ARCADIS; JANUARY 2011)
- [370] METHYL TERT-BUTYL ETHER (MTBE) CONCENTRATION IN MICROGRAMS PER LITER (µg/L)
- 500 MTBE CONCENTRATION CONTOUR LINE (µg/L; DASHED WHERE INFERRED)
- <0.50 NOT DETECTED AT OR ABOVE STATED LABORATORY REPORTING LIMIT

NOTES:

1. SITE MAP ADAPTED FROM STANTEC FIGURES
2. SITE DIMENSIONS AND FACILITY LOCATIONS NOT VERIFIED
3. GRAB GROUNDWATER SAMPLES COLLECTED DURING THE CPT INVESTIGATION ON JANUARY 6, 2011. ONE GRAB GROUNDWATER SAMPLE WAS COLLECTED FROM UCPT-01 AT 7 FEET BGS. TWO GRAB GROUNDWATER SAMPLES WERE COLLECTED FROM UCPT-02 AT 7 AND 21 FEET BGS; BOTH GRAB GROUNDWATER SAMPLES HAD THE SAME RESULT.

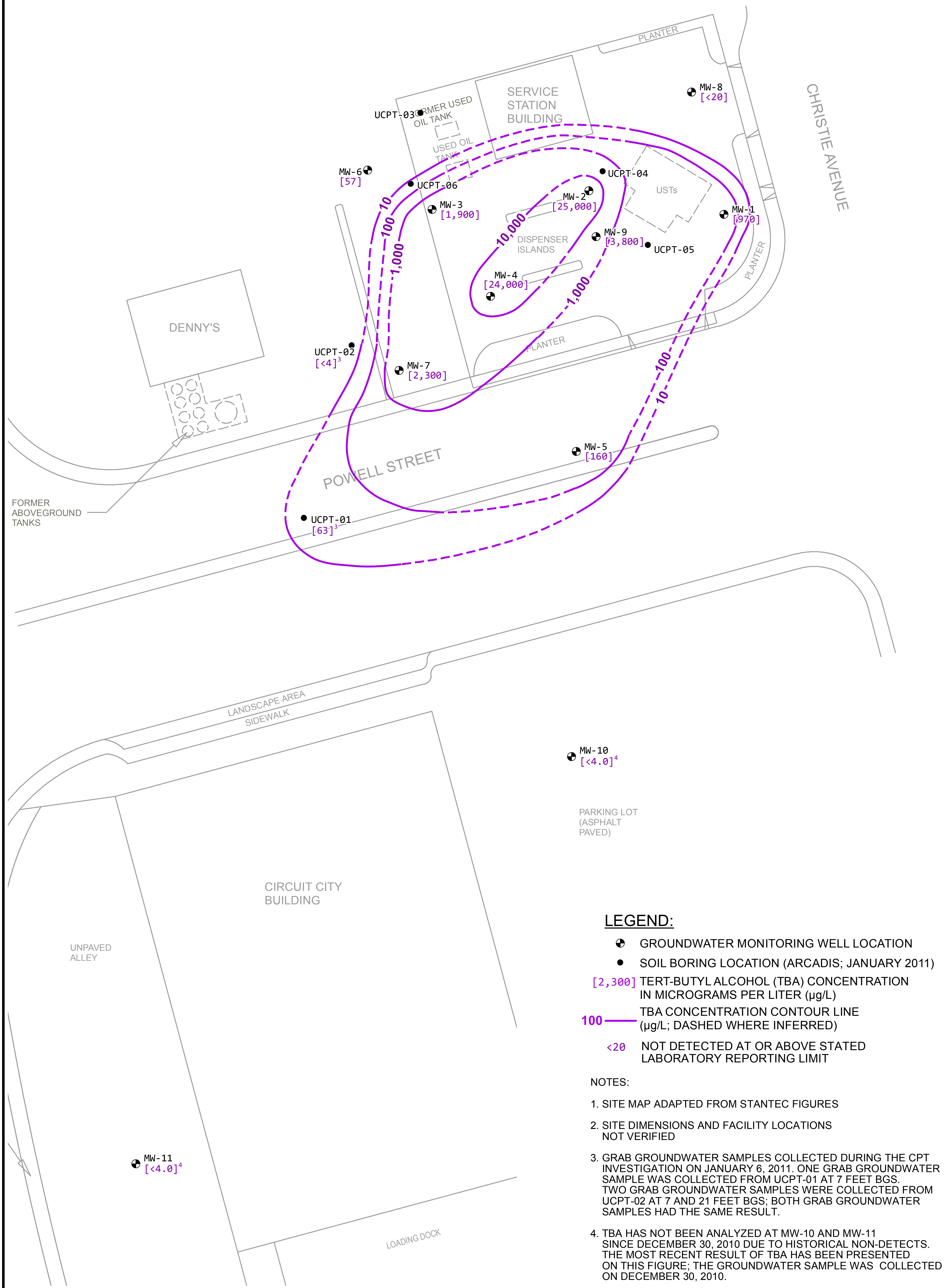
FORMER BP STATION #11126
1700 POWELL STREET, EMERYVILLE, CALIFORNIA

MTBE ISOCONCENTRATION MAP
JUNE 30, 2014

ARCADIS

FIGURE
6

CITY: SAN FRANCISCO DIV/GROUP: ENV/IM DB: KGPETERS LD: PIC: PM: TM:
PROJECT: PATH: Z:\GISPROJECTS_ENV\BP_FOXGLOVE\CA\CA11126\GIS\MXD\Q2_2014\CA11126_FIG7_TBA.MXD DATE: 8/12/2014 8:19:45 AM



LEGEND:

- GROUNDWATER MONITORING WELL LOCATION
- SOIL BORING LOCATION (ARCADIS; JANUARY 2011)
- [2,300] TERT-BUTYL ALCOHOL (TBA) CONCENTRATION IN MICROGRAMS PER LITER (µg/L)
- 100 TBA CONCENTRATION CONTOUR LINE (µg/L; DASHED WHERE INFERRED)
- <20 NOT DETECTED AT OR ABOVE STATED LABORATORY REPORTING LIMIT

NOTES:

1. SITE MAP ADAPTED FROM STANTEC FIGURES
2. SITE DIMENSIONS AND FACILITY LOCATIONS NOT VERIFIED
3. GRAB GROUNDWATER SAMPLES COLLECTED DURING THE CPT INVESTIGATION ON JANUARY 6, 2011. ONE GRAB GROUNDWATER SAMPLE WAS COLLECTED FROM UCPT-01 AT 7 FEET BGS. TWO GRAB GROUNDWATER SAMPLES WERE COLLECTED FROM UCPT-02 AT 7 AND 21 FEET BGS; BOTH GRAB GROUNDWATER SAMPLES HAD THE SAME RESULT.
4. TBA HAS NOT BEEN ANALYZED AT MW-10 AND MW-11 SINCE DECEMBER 30, 2010 DUE TO HISTORICAL NON-DETECTS. THE MOST RECENT RESULT OF TBA HAS BEEN PRESENTED ON THIS FIGURE; THE GROUNDWATER SAMPLE WAS COLLECTED ON DECEMBER 30, 2010.

0 40 80
SCALE IN FEET

FORMER BP STATION #11126
1700 POWELL STREET, EMERYVILLE, CALIFORNIA

TBA ISOCONCENTRATION MAP
JUNE 30, 2014

ARCADIS

FIGURE 7

Appendix A

Linear Regression Analysis

ARCADIS U.S., Inc.
1687 Cole Blvd
Suite 200
Lakewood, Colorado 80401
Tel 303 231 9115
Fax 303 231 9571

MEMO

To:
Jamey Peterson

Copies:

From:
Shandra Justicia-Leon
Erica Whiting

Date:
July 28, 2014

ARCADIS Project No.:
GP09BPNA.C044

Subject:
Natural Attenuation Evaluation Memorandum
Former BP Facility #11126
Emeryville, California

This Natural Attenuation Evaluation Memorandum (memorandum) evaluates plume stability and natural attenuation of petroleum hydrocarbons in groundwater at the former BP facility #11126, located at 1700 Powell Street, Emeryville, California (site). Natural attenuation is the reliance on natural physical, chemical, and/or biological processes to achieve site-specific remediation objectives (United States Environmental Protection Agency [USEPA] 1999). Stable or decreasing trends in the concentrations of hydrocarbon constituents represent the primary line of evidence for natural attenuation of petroleum hydrocarbons in groundwater and overall plume stability.

To verify that the dissolved-phase plume is stable or shrinking, ARCADIS U.S., Inc. (ARCADIS) evaluated trends in groundwater total petroleum hydrocarbons in the diesel range organics (TPH-DRO), total petroleum hydrocarbons in the gasoline range organics (TPH-GRO), benzene, toluene, ethylbenzene, total xylenes (collectively BTEX), methyl tertiary-butyl ether (MTBE), and tertiary-butyl alcohol (TBA) concentrations through time at monitoring wells located throughout the plume. This memorandum discusses the results of these analyses.

Groundwater Hydrocarbon Constituent Concentration Trends

To evaluate dissolved-phase TPH-DRO, TPH-GRO, BTEX, MTBE, and TBA concentration trends at the site, ARCADIS performed linear regression analysis using available historical groundwater monitoring data. The analyses were conducted for monitoring locations where concentrations have exceeded the applicable screening levels for TPH-DRO (100 micrograms per liter [µg/L]), TPH-GRO (100 µg/L), benzene (1 µg/L), toluene (150 µg/L), ethylbenzene (300 µg/L), total xylenes (1,750 µg/L), MTBE (5 µg/L), and TBA (12 µg/L). San Francisco Bay Regional Water Quality Control Board [SF-RWQCB] environmental screening levels [ESLs] protective of a drinking water resource were used as the applicable screening levels for the constituents listed above (SF-RWQCB 2013 [*Table F-3 Summary of Drinking Water Screening Levels, Final Screening Level MCL Priority*]).

Trends were not evaluated at monitoring locations where:

- Concentrations have not exceeded the screening levels since 2010
- Insufficient data are available (less than six data points)
- Greater than 50 percent of the results are below detection

Groundwater analytical data are available at the site as early as 1992; however, trend analyses were performed for groundwater analytical data collected since December 2004 after cessation of active remediation activities, to represent natural attenuation conditions at the site. With exception to monitoring wells MW-10 and MW-11, trend analyses were performed on at least one of the analytes listed above. It should be noted that toluene concentrations have been below the screening level of 150 µg/L across the site since 2010.

Linear regression analyses using natural log normalized concentration data were conducted to evaluate trend direction and to estimate attenuation rates for the locations with significant decreasing concentration trends (USEPA 2002). The p-value of the correlation provides a measure of the significance of the slope, or the correlation between the x and y variables. Correlations were accepted as significant at the 95 percent confidence level, indicated by a p-value of 0.05 or less. The trend direction was defined as decreasing if the slope of the trend line was negative, and increasing if the slope of the trend line was positive. The R^2 value is a measure of how well the linear regression fits the site data; R^2 values closer to zero indicate weak model fits, while R^2 values closer to one indicate stronger model fits. Results with R^2 values less than 0.1, indicating substantial variability in the data, were defined as having no apparent trend. Where non-detect results were included in linear regression analyses, the reporting limit was substituted.

The linear regression analyses were conducted in Microsoft® Excel following USEPA (2002, 2009) guidance. Results of the analyses are summarized in Table 1 and discussed below.

Total Petroleum Hydrocarbons – Diesel Range Organics

Four monitoring locations (MW-3, MW-4, MW-6, and MW-8) met the criteria described above for statistical analysis of the TPH-DRO concentration trend. Results from the linear regression analyses indicated decreasing concentration trends for TPH-DRO in groundwater at MW-6 and MW-8, the trend for MW-8 was statistically significant. No trend was observed in groundwater TPH-DRO concentrations at MW-3 and MW-4. Notably, groundwater TPH-DRO concentrations at locations MW-3 and MW-8 were at or below the TPH-DRO screening level (100 µg/L) during the two most recent monitoring events (December 2013 and June 2014).

Overall, the results from the statistical analyses demonstrate that TPH-DRO concentrations are stable at all well locations. In addition, half of the evaluated wells have already achieved the TPH-DRO screening level. These data suggest that natural attenuation is contributing to overall plume stability.

Total Petroleum Hydrocarbons – Gasoline Range Organics

Five monitoring locations (MW-1, MW-2, MW-5, MW-8, and MW-9) met the criteria described above for statistical analysis of the TPH-GRO concentration trend. Based on the results of linear regression analyses, all five monitoring wells exhibit statistically significant decreasing trends in TPH-GRO concentrations. It should be noted that TPH-GRO concentrations at MW-8 were non-detect with elevated reporting limits from 2004 through May 2008. For this reason, an additional trend analysis was performed for data since September 2008 at MW-8. Although the results of this additional trend analysis indicated no statistically significant trend, the TPH-GRO concentrations in groundwater at MW-8 are stable. The projected dates to reach the screening level for TPH-GRO (100 µg/L) at monitoring locations MW-1, MW-2, MW-5, and MW-9 are 2020, 2029, 2051, and 2024, respectively.

The results from the statistical analyses demonstrate that TPH-GRO concentrations are stable or decreasing at all well locations, and evaluated wells have estimated dates to achieve the TPH-GRO screening level within reasonable time frames. Although the time frame to achieve the TPH-GRO screening level at well MW-5 is longer than for the remaining evaluated wells, concentrations are decreasing. These data suggest that natural attenuation is contributing to overall plume reduction.

Benzene

Four monitoring locations (MW-1, MW-2, MW-5, and MW-9) met the criteria described above for statistical analysis of the benzene concentration trends. As shown in Table 1, statistically significant decreasing groundwater benzene concentration trends are demonstrated at all four monitoring wells. The projected dates to reach the benzene screening level (1 µg/L) at MW-1, MW-2, MW-5, and MW-9 are 2018, 2045, 2016, and 2030, respectively. Although the time frame to achieve the benzene screening level at well MW-2 is longer than for the remaining evaluated wells, this well is located well within the site boundaries directly adjacent to the UST pit area and near the location that yielded that highest petroleum hydrocarbon concentrations in soil during field activities performed in March 2001.

The results from the statistical analyses demonstrate benzene concentrations in groundwater beneath the site are decreasing, and wells have reasonable estimated time frames for achieving the benzene screening level. These data suggest that natural attenuation is contributing to overall plume reduction.

Ethylbenzene

Two monitoring locations (MW-2 and MW-9) met the criteria described above for statistical analysis of the ethylbenzene concentration trends. As per the results of linear regression analyses, statistically significant decreasing groundwater ethylbenzene concentration trends are demonstrated at both monitoring wells MW-2 and MW-9. The measured ethylbenzene concentrations in groundwater at MW-9 have been generally below the ethylbenzene screening level (300 µg/L) since March 2007, and have consistently been below the screening level since 2012. Monitoring location MW-2 also yielded a groundwater ethylbenzene concentration below the screening level during the two most recent monitoring events (December 2013 and June 2013).

The results from the statistical analyses demonstrate that natural attenuation is contributing to a shrinking dissolved-phase ethylbenzene plume, and ethylbenzene screening levels have been met at all monitoring locations.

Total Xylenes

One monitoring location (MW-2) met the criteria described above for statistical analysis of the total xylenes concentration trend. According to linear regression trend analysis, a statistically significant decreasing groundwater total xylenes concentration trend is demonstrated at MW-2. The groundwater total xylenes concentration at MW-2 has been generally less than the screening level (1,750 µg/L) since December 2009.

The result from the statistical analysis at monitoring location MW-2 demonstrates that natural attenuation is contributing to a shrinking dissolved-phase total xylenes plume, and total xylenes screening levels have already been achieved.

Methyl Tert-Butyl Ether

Seven monitoring locations (MW-1, MW-2, MW-4, MW-5, MW-7, MW-8, and MW-9) met the criteria described above for statistical analysis of the MTBE concentration trends. Based on the results of linear regression analyses, statistically significant decreasing groundwater MTBE concentration trends are demonstrated at monitoring wells MW-1, MW-2, MW-4, MW-7, MW-8, and MW-9. Groundwater MTBE concentrations at locations MW-7 and MW-8 have been at or below the MTBE screening level (5 µg/L) since June 2011. Additionally, MTBE concentrations at monitoring well MW-4 are not far from the screening level, with concentrations below 10 µg/L since June 2012. The projected date to reach the MTBE screening level at the three remaining monitoring locations with decreasing concentration trends (MW-1, MW-2, and MW-9) are 2015, 2027, and 2028, respectively. The groundwater MTBE concentrations at monitoring location MW-5 indicate a decreasing trend (negative trend line slope), albeit not statistically significant. However, the groundwater MTBE concentrations at MW-5 have been generally below the screening level since February 2008.

Overall, the results from the statistical analyses demonstrate that natural attenuation is contributing to a stable or shrinking dissolved-phase MTBE plume, and the MTBE screening level has either already been achieved, or will be met within a reasonable time frame at evaluated well locations.

Tert-Butyl Alcohol

Eight monitoring locations (MW-1, MW-2, MW-3, MW-4, MW-6, MW-7, MW-8, and MW-9) met the criteria described above for statistical analysis of the TBA concentration trends. The results of linear regression analyses demonstrate a statistically significant decreasing groundwater TBA concentration trend at one monitoring well (MW-8). The groundwater TBA concentrations at location MW-8 have been below the screening level (12 µg/L) during the two of the three most recent sampling events (since June 2013). Results of the statistical analyses indicate no trend in the groundwater TBA concentrations through time at wells MW-1, MW-2, MW-3, MW-4, MW-6, and MW-9. Only monitoring location MW-7 indicates a statistically significant increasing trend in TBA concentrations through time; however, TBA is the only analyte present at concentrations above screening levels in MW-7. An additional trend analysis performed for MW-7 well data since 2008 indicates that, although concentrations of TBA are increasing, the trend analysis lacks statistical significance.

Although TBA concentrations are increasing in groundwater in the vicinity of MW-7, TBA concentrations at all other monitoring wells upgradient and cross-gradient of this location are stable or decreasing. Additionally, concentrations of TBA at MW-7 have decreased since the historical maximum of 3,900 µg/L in December 2010, indicating that concentrations appear to have stabilized since 2010. Overall, the results from the statistical analyses demonstrate that natural attenuation is contributing to a stable dissolved-phase TBA plume.

Conclusions

Linear regression analyses of TPH-DRO, TPH-GRO, BTEX, MTBE, and TBA concentration trends at monitoring locations that have exceeded the screening levels during recent monitoring events demonstrate that natural attenuation is contributing to an overall stable or shrinking dissolved-phase plume at the site. Although TBA concentrations at well MW-7 demonstrate an increasing trend, the strong evidence of natural attenuation contributing to stable and decreasing petroleum hydrocarbon concentration trends at other wells located closer to the source areas, and the stable TBA concentrations reported in groundwater at MW-7 since 2010 suggest that natural attenuation will also eventually bring about a decrease in TBA concentration at this location.

Attachments

Table 1 Summary of Statistical Analysis of Groundwater Analytical Data

References

California Environmental Protection Agency. 2013. Environmental Screening Levels, December 2013.

San Francisco Bay Regional Water Quality Control Board (SF-RWQCB). 2013. Environmental Screening Levels, Table F-1a Groundwater Screening Levels (groundwater is a current or potential drinking water resource). December. http://www.waterboards.ca.gov/sanfranciscobay/water_issues/programs/esl.shtml

United States Environmental Protection Agency. 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. United States Environmental Protection Agency Office of Solid Waste and Emergency Response Directive 9200.4-17P.

United States Environmental Protection Agency. 2002. Calculation and Use of First-Order Rate Constants for Monitored Natural Attenuation Studies. EPA/540/S-02/500.

United States Environmental Protection Agency. 2009. Statistical Analysis of Groundwater Monitoring Data at RCRA Facilities. Office of Resource Conservation and Recovery. Unified Guidance. EPA 530-R-09-007.

Table 1
Summary of Statistical Analysis of Groundwater Analytical Data
Former BP Facility #11126
1700 Powell Street, Emeryville, California

			Data Range						Linear Regression Analysis						
Constituent	Well	Cleanup Goal/Screening Level/Remediation goal (µg/L)[1]	Minimum Concentration (µg/L)	Maximum Concentration (µg/L)	Concentration Measured Most Recently (µg/L)	% of Data Above Laboratory Reporting Limit	Start Date	End Date	Coefficient of Determination, R-squared[2]	p-value of Correlation (Significance of Slope)	Attenuation Half-life (days)	Trend Direction	Significance of Trend[3]	Projected Year to Screening Level	Notes
TPH-DRO	MW-3	100	*47*	3,000	*47*	93	12/1/2004	6/30/2014	0.09	0.11	NA	No Trend	NS	NA	BSL since 12/2013
TPH-DRO	MW-4	100	*49*	800	800	86	6/29/2011	6/30/2014	0.09	0.52	NA	No Trend	NS	NA	
TPH-DRO	MW-6	100	140	3,900	300	100	6/29/2011	6/30/2014	0.31	0.20	NA	Decreasing	NS	NA	
TPH-DRO	MW-8	100	*55*	1,500	*55*	86	6/29/2011	6/30/2014	0.74	0.01	239	Decreasing	Significant	2014	at SL or BSL since 12/2013
TPH-GRO	MW-1	100	60	4,600	160	100	12/1/2004	6/30/2014	0.37	<0.01	1,305	Decreasing	Significant	2020	
TPH-GRO	MW-2	100	2,200	210,000	*10,000*	90	12/1/2004	6/30/2014	0.42	<0.01	924	Decreasing	Significant	2029	
TPH-GRO	MW-5	100	2,800	7,700	2,800	100	12/28/2005	6/30/2014	0.66	<0.01	2,798	Decreasing	Significant	2051	
TPH-GRO	MW-8	100	90	2,500	150	72	12/1/2004	6/30/2014	0.36	<0.01	1,543	Decreasing	Significant	2016	
TPH-GRO	MW-8	100	90	300	150	100	9/26/2008	6/30/2014	<0.01	0.83	NA	No Trend	NS	NA	Since 2008
TPH-GRO	MW-9	100	420	36,000	2,500	100	12/1/2004	6/30/2014	0.56	<0.01	1,025	Decreasing	Significant	2024	
Benzene	MW-1	1	*0.5*	1,000	7.8	97	12/1/2004	6/30/2014	0.57	<0.01	602	Decreasing	Significant	2018	
Benzene	MW-2	1	200	15,000	1,800	100	12/1/2004	6/30/2014	0.25	<0.01	1,147	Decreasing	Significant	2045	
Benzene	MW-5	1	*1*	36	2.5	88	12/1/2004	6/30/2014	0.40	<0.01	1,468	Decreasing	Significant	2016	
Benzene	MW-9	1	6.7	3,500	170	100	12/1/2004	6/30/2014	0.31	<0.01	916	Decreasing	Significant	2030	
Ethylbenzene	MW-2	300	13	7,300	140	97	12/1/2004	6/30/2014	0.29	<0.01	747	Decreasing	Significant	2012	BSL since 12/2013
Ethylbenzene	MW-9	300	2.1	1,600	4.0	100	12/1/2004	6/30/2014	0.70	<0.01	456	Decreasing	Significant	2006	BSL since 01/2012
Xylenes	MW-2	1,750	14	31,000	*200*	90	12/1/2004	6/30/2014	0.44	<0.01	457	Decreasing	Significant	2008	BSL since 12/2012
MTBE	MW-1	5	*0.5*	250	4.2	97	12/1/2004	6/30/2014	0.46	<0.01	729	Decreasing	Significant	2015	BSL in 06/2014
MTBE	MW-2	5	140	22,000	700	100	12/1/2004	6/30/2014	0.64	<0.01	717	Decreasing	Significant	2027	
MTBE	MW-4	5	5.5	450	5.5	79	12/1/2004	6/30/2014	0.79	<0.01	657	Decreasing	Significant	2013	5.5 µg/L in 06/2014
MTBE	MW-5	5	*0.5*	16	5.2	81	12/1/2004	6/30/2014	0.11	0.10	NA	Decreasing	NS	NA	5.2 µg/L in 06/2014
MTBE	MW-7	5	2.7	41	2.7	97	12/1/2004	6/30/2014	0.70	<0.01	1,131	Decreasing	Significant	2010	BSL since 06/2011
MTBE	MW-8	5	*0.5*	41	*0.5*	93	12/1/2004	6/30/2014	0.86	<0.01	619	Decreasing	Significant	2010	BSL since 06/2011
MTBE	MW-9	5	13	8,300	370	100	12/1/2004	6/30/2014	0.31	<0.01	1,021	Decreasing	Significant	2028	
TBA	MW-1	12	170	6,700	970	100	12/1/2004	6/30/2014	0.09	0.10	NA	No Trend	NS	NA	
TBA	MW-2	12	1,900	77,000	25,000	97	12/1/2004	6/30/2014	0.02	0.46	NA	No Trend	NS	NA	
TBA	MW-3	12	*4*	8,200	1,900	90	12/1/2004	6/30/2014	<0.01	0.81	NA	No Trend	NS	NA	
TBA	MW-4	12	10,000	42,000	24,000	100	12/1/2004	6/30/2014	<0.01	0.90	NA	No Trend	NS	NA	
TBA	MW-6	12	32	300	57	97	12/1/2004	6/30/2014	<0.01	0.97	NA	No Trend	NS	NA	
TBA	MW-7	12	110	3,900	2,300	100	12/1/2004	6/30/2014	0.30	<0.01	NA	Increasing	Significant	NA	
TBA	MW-7	12	110	3,900	2,300	100	12/23/2008	6/30/2014	0.13	0.22	NA	Increasing	NS	NA	Since 2008
TBA	MW-8	12	5.7	45,000	*20*	90	12/1/2004	6/30/2014	0.51	<0.01	419	Decreasing	Significant	2016	
TBA	MW-9	12	22	12,000	3,800	97	12/1/2004	6/30/2014	0.07	0.15	NA	No Trend	NS	NA	

Notes, Abbreviations and Assumptions:
µg/L = micrograms per liter
NS = not significant
NA = not applicable due to increasing trend or non-significant trend
BSL = below screening level
SL = screening level
MTBE = methyl tert-butyl ether
TPH-DRO = total petroleum hydrocarbons as diesel
TPH-GRO = total petroleum hydrocarbons as gasoline
TBA = tert-butyl alcohol
[1] Screeneing Levels obtained from California Environmental Protection Agency, Environmental Screening Levels, December 2013
[2] Linear regression analysis with R^2 values <0.1 and no statistically significant trend were defined as having no apparent trend (No Trend)
[3] Statistically significant trend defined as having p-value ≤ 0.05
Data in italics ND taken at reporting limit/reported value
Data is underlined Qualified data converted to reported value

STATE WATER RESOURCES CONTROL BOARD

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