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May 22, 2015

Mr. Karel Detterman, P.G.
Hazardous Materials Specialist
Alameda County Department of Environmental Health
1131 Harbor Bay Parkway
Alameda, CA 94502
San Francisco, CA 94102

Re: Feasibility Study and Corrective Action Plan, 3093 Broadway, Oakland, CA
Site Cleanup Program Case No. Ro0000199

Dear Ms. Detterman,

Please find attached Feasibility Study and Corrective Action Plan for the Former Connell Oldsmobile site, located at 3093 Broadway in Oakland, California. The Feasibility Study and Corrective Action Plan has been prepared by Langan Treadwell Rollo.

I declare, under penalty of perjury, that the information and/or recommendations contained in the attached document or report is true and correct to the best of my knowledge.

OWNER:

3093 BROADWAY HOLDINGS, L.L.C.

By: ______________________
Name: J David Martin
Title: Chairman of the Investment Committee

FEASIBILITY STUDY AND CORRECTIVE ACTION PLAN
3093 Broadway
Oakland, California

Prepared For:

3093 Broadway Holdings, L.L.C.
555 California Street, 10th Floor
San Francisco, California 94104

Prepared By:

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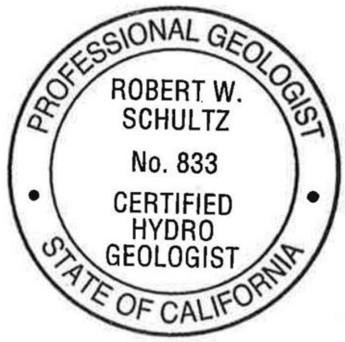
Christopher N. Glenn, P.E., LEED GA
Senior Project Engineer



Robert W. Schultz, CHG
Senior Project Manager

21 May 2015
731637001

LANGAN TREADWELL ROLLO

Technical Excellence
Practical Experience
Client Responsiveness

21 May 2015

Ms. Karel Detterman, P.G.
Hazardous Materials Specialist
Alameda County Department of Environmental Health
1131 Harbor Bay Parkway
Alameda, CA 94502

Subject: **Feasibility Study and Corrective Action Plan**
3093 Broadway
Oakland, California
Langan Project No. 731637001

Dear Ms. Detterman,

On behalf of 3093 Broadway Holdings, L.L.C (Broadway Holdings), Langan Treadwell Rollo (Langan) has prepared the enclosed Feasibility Study and Corrective Action Plan (FS/CAP) for the Former Connell Oldsmobile Site (site), located at 3093 Broadway in Oakland, California (Figure 1). Broadway Holdings is in the process of developing a mixed-use project at the site.

This report was prepared by Langan under the supervision of the Professional Engineer whose seal and signature appear hereon. The findings, recommendations, specifications, or professional opinions are presented within the limits described by the client, after being prepared in accordance with generally accepted professional engineering practice. No warranty is expressed or implied.

If you have any questions or comments, please do not hesitate to call us at (415) 955-5200.

Sincerely yours,
Langan Treadwell Rollo

Chris N. Glenn, P.E., LEED GA
Senior Project Engineer

Robert W. Schultz, CHG No. 833
Senior Project Manager

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Acronym and Abbreviation List

1,2-DCA	1,2-Dichloroethane
ACEH	Alameda County Department of Environmental Health
AS/DPE	air sparging and dual phase extraction
Basin Plan	Water Quality Control Plan for the San Francisco Bay Basin
bgs	below ground surface
BTEX	benzene, toluene, ethylbenzene and xylenes
CAP	Corrective Action Plan
COCs	Constituents of concern
CPT	cone penetration test
CSM	Conceptual Site Model
DO	Dissolved oxygen
DPE	dual phase extraction
DTSC	Department of Toxic Substances Control
DWR	Department of Water Resources
EPA	United States Environmental Protection Agency
ESLs	Environmental Screening Levels
FS/CAP	Feasibility Study and Corrective Action Plan
Langan	Langan Treadwell Rollo
LTCP	Low-Threat Underground Storage Tank Case Closure Policy
MCL	maximum contaminant level
MSL	mean sea level
MTBE	methyl-t-butyl ether
ORP	oxidation reduction potential
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PE	Professional engineer
PID	photoionization detector
QA/QC	quality control/quality assurance

Acronym and Abbreviation List (Continued)

RBCA	risk-based corrective action
SCI	Subsurface Consultants, Inc.
SMP	Soil Management Plan
SWRCB	State Water Resources Control Board
SVE	soil vapor extraction
SVOCs	Semivolatile Organic Compounds
TBA	t-Butyl Alcohol
TPHd	Diesel-range Total Petroleum Hydrocarbons
TPHg	Gasoline-range Total Petroleum Hydrocarbons
TPHmo	Motor Oil-range Total Petroleum Hydrocarbons
UST	underground storage tank
VMS	vapor mitigation system
VOCs	Volatile Organic Compounds
Water Board	San Francisco Bay Regional Water Quality Control Board
WQOs	Water Quality Objectives
µg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter

FEASIBILITY STUDY AND CORRECTIVE ACTION PLAN
3093 Broadway
Oakland, California

1.0 INTRODUCTION

On behalf of 3093 Broadway Holdings, L.L.C. (Broadway Holdings), Langan Treadwell Rollo (Langan) has prepared this Feasibility Study and Corrective Action Plan (FS/CAP) for the site located at 3093 Broadway in Oakland, California (site, Figure 1). This FS/CAP was prepared to progress the Leaking Underground Storage Tank (LUST) case toward closure, and was requested by the Alameda County Department of Environmental Health (ACEH) at the December 12, 2014, meeting between ACEH, Langan, Broadway Holdings, and the Hill Family Trust.

Broadway Holdings is in the process of developing the site for mixed commercial and residential use. Three underground storage tanks (USTs) that previously contained gasoline, diesel, and waste oil were removed from a northern area of site in December 1989, as indicated on Figure 2. Environmental investigations have been ongoing since 1990 and have concluded that soil and groundwater at the site are impacted by petroleum compounds due to the release from the former USTs.

The objectives of this FS/CAP are to screen the residual petroleum impacts at the site for potential environmental and human health risks based on the future site development, evaluate potential remedial alternatives, propose corrective action measures, and describe tasks to progress the LUFT case to regulatory closure. Implementation of this FS/CAP is intended to achieve case closure under the State Water Resources Control Board's (SWRCB's) Low-Threat Underground Storage Tank Case Closure Policy (LTCP).

This FS/CAP presents the site background, site geology and hydrogeology, future use risk screening, corrective action objectives, an evaluation of corrective action technologies, selected corrective action alternatives, corrective action alternatives implementation plans, post corrective action activities, and the rationale supporting case closure following implementation of this FS/CAP.

2.0 BACKGROUND

The site is located in Oakland, California, in a mixed-use area, near commercial, medical and residential properties. The approximately 3.4-acre site is bounded by Hawthorne Street to the north, Broadway to the east, Webster Street to the west, and a surface parking lot to the south. The current use of adjoining properties include a parking garage and various medical facilities to the north, commercial facilities and automotive repair shops to the east, a public parking area to the south, and private residences and medical centers to the west.

The site is currently occupied by a vacant, two-story concrete structure that was formerly a car dealership. The site structure consists of an auto repair shop, offices, and showrooms along the existing site grade with raised mezzanine areas accessible from interior stairwells. Asphalt and concrete paved access ways extend along the south and west sides of the structure; sidewalks extend along the north, east, and west perimeters of the site. The remainder of the site consists of asphalt paved parking areas, currently used for the parking/storage of new and used vehicles associated with nearby automotive dealerships. Site development plans propose mixed-use development, including residential and commercial space.

2.1 Site History

The site was occupied by St. Mary's College until 1928, after which the college's buildings were demolished. Thereafter, the site was occupied by several auto businesses, including the Connell Motor Company. A review of historical photographs and maps indicated that the current site structure was likely constructed in the late 1940s or early 1950s (Langan, 2014).

2.2 Previous Environmental Investigations and Remediation

<u>*UST Removal*</u>

Three USTs were removed from beneath the Hawthorne Street sidewalk adjacent to the site on December 18 and 19, 1989 (Figure 2). The Underground Tank Removal Report prepared by Subsurface Consultants, Inc. (SCI, 1990) describes the three USTs as one 2,000-gallon gasoline tank, one 650-gallon diesel tank, and one 425-gallon waste oil tank. The dispenser was reported to have been inside the Service Bay and was removed in 1989 (SCI, 1997). It is unknown whether associated product pipelines have been removed from the site. SCI excavated visually contaminated soil in the former UST area to approximately 12 feet below ground surface (bgs) following tank removal activities. SCI collected soil samples from the sidewalls and bottom of excavation, at depths up to 12 feet below grade. The soil samples contained detectable concentrations of total hydrocarbons, volatile organic compounds (VOCs) and heavy metals. SCI collected one water sample from accumulated water in the excavation. The water sample contained detectable concentrations of petroleum compounds.

Following sampling activities, the excavated area was backfilled with imported fill material.

Environmental Investigations and Remediation

The corrective action history and the ACEH oversight of the site were summarized in a letter by Cambria Environmental Technology, Inc. (Cambria, 2004) of Emeryville, California, and included the following information:

Soil and groundwater monitoring at the site have been ongoing since 1990. Groundwater was analyzed for total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylenes (BTEX), methyl-t-butyl ether (MTBE), t-butyl alcohol (TBA), 1,2-dichloroethane (1,2-DCA), PAHs (2-methylnaphthalene and naphthalene) and other petroleum and non-petroleum VOCs. The manual removal of free-phase hydrocarbons from site monitoring wells took place from 1991 to 2010. In November 1995, SCI submitted a Corrective Action Plan (CAP) for the installation and operation of a soil vapor extraction system (SVE). The ACEH approved the CAP.

Between October 1996 and March 1998, an SVE remediation system was used at the site to remove volatilized contaminants from unsaturated soil and soil vapor. Following meetings and discussions with the ACEH and the California UST Cleanup Fund, SVE operation ceased in March 1998. The SVE system reportedly had removed approximately 1,421 pounds (lbs.) of hydrocarbons. SCI conducted an additional investigation in May 1998 and concluded that the site would require additional remedial efforts. Between July and October 1998 several agency meetings were held with the ACEH, San Francisco Bay Regional Water Quality Control Board (Water Board), City of Oakland, and representatives of the site owners. The culmination of the meetings resulted in regulatory conditional approval of a risk-based approach for site management and closure, according to SCI's Workplan for Expanded CAP Preparation, dated 15 April 1999. The 'Expanded CAP' scope focused on risk-based corrective action (RBCA), limited free product removal, and natural attenuation as the selected corrective action for the site.

Cambria submitted the Workplan Addendum on 8 May 2000, which the ACEH approved on 14 July 2000. The scope of the Expanded CAP was increased to incorporate results of planned feasibility testing.

Groundwater monitoring and evaluation of the site continued through 2011. In April 2011 and May 2011, air sparging and dual phase extraction remediation systems (AS/DPE) commenced operation in the areas where petroleum concentrations in groundwater were elevated, and where LNAPL had been historically observed in monitoring wells. The AS/DPE system was shut down in June 2013. Between April 2011 and June 10, 2013, the DPE system reportedly removed approximately 8,837 lbs of Gasoline-range Total Petroleum Hydrocarbons (TPHg) and 541 lbs benzene (Pangea, 2013).

Groundwater sampling performed by Langan in May 2014 indicated that the hydrocarbon impacts to groundwater are located within the site property in an upper plume area located beneath the Service Bay, and a lower plume area located beneath the paved parking area and showroom, as shown by estimated benzene isoconcentration contours on Figure 5. Due to a difference in screened intervals between certain wells (e.g. MW-16A and MW-16B), differences between analytical results for sampling events, and an absence of groundwater samples collected from beneath the showroom, the 1,000 μg/L benzene isoconcentration contours are inferred or approximated. Additional groundwater data will be collected and used to further evaluate the extent of residual petroleum impacts, as discussed in Section 6.2. Soil, groundwater, and soil vapor sampling was most recently conducted by Langan in November 2014. Soil sampling results indicated that petroleum hydrocarbons are located beneath the Service Bay. Soil vapor sampling results indicated that BTEX compounds are present in soil vapor beneath the Service Bay and the showroom. Recent results for petroleum compounds in soil, groundwater and soil vapor are discussed in Section 3.2.

2.3 Site Development Plan and Schedule

Broadway Holdings plans to demolish the existing building, with the exception of a portion of the show room in the northeast corner of the site. The City of Oakland planning department has approved the development of a multi-story mixed use building that will occupy nearly the entire property. The ground floor will consist of parking and retail (commercial) space. The upper levels will include residential units. Site excavation for the development will reduce existing grade by approximately 0 to 18 feet; the ground floor will be roughly level with Broadway. The conceptual plan for the future ground floor site development is presented on Figure 2. The future ground floor elevation is projected to be approximately 52 feet above mean sea level (MSL; [North American Datum 83]), and the foundation bottom elevations are conservatively assumed to be 47 feet MSL.

The design and permitting process for the planned site development is currently on-going and is expected to continue through October 2015. Demolition may commence in September2015. Grading and utility work and other construction activities are expected to commence in October 2015. Remediation activities, including a pre-design investigation, will be conducted concurrently with permitting through 2015. Remediation verification monitoring will be conducted following site development in 2017 with the goal of obtaining case closure by early 2018. The environmental work schedule is further detailed in Section 9.0 and a Gantt chart of activities is provided in Appendix F.

3.0 CONCEPTUAL SITE MODEL

A Conceptual Site Model (CSM) was prepared for the site and submitted to ACEH in October 2014 (Langan, 2014). The CSM begins by describing the regional geology and hydrogeology and identifying key regional hydrogeologic features and potential sensitive receptors, including surface water bodies and the results of a well search. After establishing the regional context, the CSM progresses to the site-scale and describes the site use and history, site geology, the depth to groundwater beneath the site and the groundwater flow direction, potential preferential pathways for petroleum migration in the subsurface, UST (source) releases, contaminants of concern, impacts to soil, groundwater and soil vapor, source removal and remediation, remediation technique assessment, remediation performed at the site, and risk evaluation considerations. To support the risk screening presented in this section, the geology and hydrogeology, as described in the CSM, are summarized below. Section 3.2 presents a future use risk screening of petroleum concentrations in soil, soil vapor, and groundwater at the site.

3.1 Geology and Hydrogeology

The regional geology and observations of site lithology and groundwater are summarized below.

3.1.1 Geology

The site surficial geology is mapped as alluvial fan deposits. The ages of the unconsolidated deposits are reported as Pleistocene and Holocene. The Pleistocene deposits (Qpaf) occupy the higher topographic position at the site, forming the topographic feature known as “Pill Hill.” These Pleistocene fan deposits are described as brown, dense, gravely and clayey sand or clayey gravel fining upward to sandy clay (Graymer, 2000). The Holocene deposits (Qhaf) overlie the Pleistocene deposits at the base of Pill Hill, downslope from the site. The Holocene deposits are described as brown or tan, medium dense to dense, gravely sand or sandy gravel that generally fine upwards to sandy or silty clay (Graymer, 2000). The Pleistocene deposits can be distinguished from the Holocene deposits by higher topographic position, greater degree of dissection, more pronounced soil profile development and lower permeability (Graymer, 2000). The thickness of the Holocene alluvium on the eastern portion of the site, and the location of the boundary between the two units are unknown. Regional geologic features of surrounding site soils are presented in Figure 4 of the CSM (Langan, 2014).

Previous consultants have collected data describing the site subsurface geology by direct observation during installation of monitoring wells at the site, and using cone penetration tests (CPTs). Site soils were logged in 1990, 1991, 1992 and 1998 by SCI and in 2007 by Pangea Environmental Services, Inc. (Pangea). Observations recorded during logging of soils by SCI and Pangea indicate varying amounts of silty to clayey sand and gravel within the fine-grained units. In October 1992, a total of 17 CPTs were conducted across the site for SCI. The 1992 CPT logs indicate the site is predominantly underlain by fine-grained, low permeability deposits consisting of clayey to sandy silts and silty clay, with occasional thin beds of sand and silty sand.

In June 2014, four CPTs were advanced for Langan by Gregg Drilling of Martinez, California. Depths of CPTs were approximately 50 feet bgs. Additionally, four borings were logged by a Langan professional engineer in August 2014. The 2014 CPT logs were consistent with the 1992 CPT logs, indicating the site is predominantly underlain by clayey to sandy silts and silty clay, with occasional thin beds of sand and silty sand. The Langan boring logs indicate underlying deposits are predominantly sandy and silty clay, and clayey sand with gravel as shown by the cross section A-A' on Figure 3.

3.1.2 Hydrogeology

Langan reviewed groundwater investigation reports for the site prepared between 1990 and 2014. The depth to water in the groundwater monitoring wells at the site ranged from 15.19 to 33.65 feet below the tops of the well casings (corresponding to elevations of approximately 23.41 to 41.84 feet above MSL, based on the 2014 BKF Engineers site survey). Historical site data indicates an annual water level fluctuation on the order of one to four feet.

In wells MW-5, MW-6, MW-8 and MW-13, groundwater levels are on the order of 10 feet lower than those measured in wells MW-1, MW-3, MW-4, MW-7, MW-9, MW-10, MW-11, MW-14, MW-15, MW-16A and MW-17A. Hydrographs for site monitoring wells were compared in Figure 10 of the 24 October 2014 Conceptual Site Model (CSM, [Langan, 2014]) for the site.

Wells MW-5, MW-6, MW-8 and MW-13 are located near Broadway. The interpreted groundwater table surface is illustrated in the vertical profile shown on Figure 3.

The predominant site-scale groundwater flow direction is to the east-southeast. Since the UST release, groundwater flow directions have reportedly ranged from southeast to east. Based on literature values for the observed soil types, the groundwater seepage velocity at the site is low to very low, with an estimated range of groundwater seepage velocities of approximately 0.2 to 20 feet per year.

Former Glen Echo Creek is located approximately 670 feet east of the subject site. Lake Merritt is located approximately 3,300 feet south. The San Francisco Bay is approximately 1.8 miles to the northwest of the site and there is one fresh emergent wetland located 1.6 miles to the west and one freshwater pond (201,832 sq ft) located approximately 1.08 miles to the northeast (Langan, 2014).

3.2 Future Use Risk Screening

This section compares the petroleum concentrations detected in site soil, groundwater, and soil vapor to conservative, non-site-specific environmental screening levels based on potentially complete future exposure pathways. The objective of this risk screening is to identify potential human health concerns related to the residual petroleum impacts likely to be in site soil, soil vapor, and groundwater, following site grading for the planned residential development. The selected screening levels consider excavation of the site to approximately 52 feet above MSL and residential use of the property, except for future ground-level retail along Broadway. This section presents an evaluation of the petroleum concentration data, an assessment of the bioattenuation zone for soil vapor impacts, identification of likely future site occupants, potential exposure pathways to future site occupants, the selected human health screening criteria, and the resulting soil, groundwater and soil vapor risk screening results.

3.2.1 Data Evaluation

The results for samples collected after the June 2013 shutdown of the former AS/DPE system are used to evaluate petroleum concentrations in soil, groundwater and soil vapor. The analytical data is summarized in Tables 1 through 4.

Soil

Langan collected soil samples from 11 locations (SV-1 through SV-9, SV-11 and SV-12) in the northern portion of the site in November 2014, as presented in Table 1 and Figure 4. Soil samples were collected at depths that approximately correspond to shallow soil expected to be left in place after grading for the planned site development. Soil sample depths range from 4.25 to 6.0 feet below the future site grade, except one deep soil sample was collected at 22 feet below the planned site grade, at SV-11, in the current showroom area.

Soil samples were analyzed for TPH, BTEX compounds and MTBE. Soil samples were not analyzed for PAHs; however, additional soil sampling, including analysis for PAHs, is proposed as part of this FS-CAP (Section 6.2). TPH were detected above laboratory reporting limits in the samples analyzed, and concentrations of TPH as gasoline, diesel, or motor oil, ranged from 1.1 to 1,200 mg/kg. Ethylbenzene and xylenes were detected in soil above laboratory reporting limits in soil collected from sample location SV-2. Benzene, toluene, and MTBE were not detected above laboratory reporting limits in the samples analyzed. Constituents of concern (COCs) in soil are petroleum compounds, potentially including BTEX and PAHs. Additional soil sampling and analysis will be conducted to further evaluate COCs, including BTEX and PAHs (including naphthalene) in shallow soil under the former Service Bay area, as discussed in Section 6.2. Outside of the Service Bay area, residual petroleum impacts are limited to deeper soil, near the water table.

Groundwater

After shutdown of the AS/DPE system in June 2013, groundwater was collected and analyzed for petroleum compounds and VOCs during three sampling events from wells AS-1B, MW-1 through MW-10, MW-13 through MW-17, RW-2, RW-4, and RW-5. Samples were analyzed for TPHg, TPHd, BTEX compounds, MTBE, naphthalene and other VOCs. Overall, the highest concentrations of dissolved hydrocarbon contamination are present in two onsite areas: (1) between 25 and 40 feet bgs beneath the Service Bay, and (2) 15 to 35 feet bgs in the area south of the showroom. Beneath the Service Bay area, TPHg concentrations range from 170 to 68,000 micrograms per liter (μg/L), and south of the showroom, TPHg concentrations range from 3,600 to 88,000 μg/L, respectively. Petroleum compounds in groundwater extend from beneath the former UST system to the downgradient property boundary, near Broadway. Analytical results for petroleum compounds and VOCs in groundwater are presented in Table 2 and Figure 5. Detected COCs in groundwater are petroleum compounds including BTEX, TBA, 1,2-DCA and naphthalene. Detected concentrations of BTEX compounds, TBA, 1,2-DCA and naphthalene range from 0.63 to 18,000 μg/L, 6.2 to 3,400 μg/L, 9.7 to 100 μg/L, and 11 to 1,100 μg/L, respectively.

The onsite extent of TPH compounds in groundwater beneath the showroom is approximated in Figure 5. No groundwater samples have been collected from beneath the showroom to date; however, groundwater sampling is planned in the showroom area, as described in section 6.2.3 and as shown on Figure 8. Additionally, benzene concentrations detected in groundwater beneath the Service Bay vary, as demonstrated by the benzene detected at MW-16A and MW-16B (Figure 5). In the May 2014 groundwater sampling event, benzene concentrations ranged from 5.3 µg/L benzene in well MW-16A (screened interval from 20 to 30 feet bgs) to 11,000 µg/L benzene in well MW-16B (screened interval from 35 to 40 feet bgs).

Soil Vapor

Langan collected soil vapor samples from 11 temporary soil vapor wells in the northern portion of the site in November 2014 (Figure 6). The proposed semi-permanent soil vapor well SV-5 was not installed or sampled due to the presence of shallow groundwater in the borehole. Soil vapor samples were analyzed for VOCs (including naphthalene), oxygen, carbon dioxide, and methane (Tables 3 and 4). Soil vapor samples were collected at varying depths above and below future site grade, ranging from 8.5 feet below to 8 feet above to future site grade (Table 3). Away from the former UST system, soil vapor concentrations are expected to be highest immediately above the water table and decrease upwardly. Oxygen concentrations in soil vapor support aerobic biodegradation of petroleum compounds and are discussed below in Section 3.2.5.

Benzene, toluene, and ethylbenzene were detected in the samples at concentrations ranging from 3.7 to 4,300 micrograms per cubic meter (µg/m^3). 1,2-DCA was detected in one sample with a concentration of 290 µg/m^3. Naphthalene, MTBE and other VOCs were not detected at or above the laboratory reporting limits in the soil vapor samples. Based on these results, the COCs for soil vapor are petroleum compounds, including benzene, toluene, ethylbenzene and 1,2-DCA.

3.2.2 Future Site Uses

Future site occupants are expected to include residents, site visitors (retail customers), workers, and construction workers. Figure 4 shows the planned ground floor development, including a retail area along Broadway and a parking garage. For the purposes of this risk screening, future use is assumed commercial in the retail area along Broadway, and residential elsewhere at the site.

3.2.3 Potential Exposure Pathways

This evaluation considers the future site uses described in Section 3.2.2, above, and assumes the property will be excavated to approximately 52 feet above MSL. Although a parking garage and commercial properties will be constructed, the future site construction is not included in this evaluation.

Soil

After grading, residents or workers at the site could come into contact with petroleum compounds in shallow soil beneath the former Service Bay area of the site, if the future site buildings or pavement are not maintained. In addition, during trenching for utility repairs or other soil excavation activities, construction workers have the potential for dermal contact with petroleum compounds in shallow soil in the area beneath the former Service Bay. In addition, residual soil impacts could be a source of petroleum compounds to groundwater.

Groundwater

Groundwater at the site is identified by the Water Board as a potential drinking water source. If a shallow water supply well were installed at the site, future occupants (commercial and residential) could be exposed to petroleum compounds in groundwater by ingestion of or dermal contact with site groundwater.

Soil Vapor

Workers in the future retail area and future residents at the site could be exposed to petroleum compounds in soil vapor at the site via vapor intrusion into future structures. The planned garage will eliminate concerns related to the potential for vapor intrusion. Construction workers may also be exposed to petroleum compounds in soil vapor during trenching. Petroleum compounds in groundwater are a potential source of petroleum compounds in soil vapor, so this risk screening also compares groundwater concentrations to vapor intrusion screening levels.

3.2.4 Screening Criteria

For this conservative risk screening, Langan used the Environmental Screening Levels (ESLs) published by the Water Board (December 2013).

Soil concentrations were compared to the residential screening levels where groundwater is a potential drinking water source (ESL Detail Table A-1) and which considers odor and other aesthetic concerns. Residential screening levels were used because petroleum compounds are likely to be in shallow soil beneath the former Service Bay area, which will be developed for residential use. Soil concentrations were also compared to construction worker screening levels (ESL Detail Table K-3) due to planned site development and construction activities.

Petroleum constituents detected in groundwater were compared to the Water Board's drinking water ESLs (ESL Detail Table F-3) and potential vapor intrusion ESLs for residential and commercial site use (ESL Detail Table E-1).

For comparison purposes, the petroleum concentrations specified in the LTCP are included in Tables 1 through 3. The petroleum concentrations specified in the LTCP were not used for screening against petroleum concentrations at the site because they are higher than the ESLs.

3.2.5 Bioattenuation Zone for Soil Vapor Impacts

A bioattenuation zone is defined by the LTCP as an "area of soil with conditions that support biodegradation of petroleum hydrocarbons" (SWRCB, 2012). Where the characteristics of a bioattenuation zone at a site meet certain criteria, the LTCP specifies a bioattenuation zone factor of 1,000. In other words, petroleum concentrations are conservatively assumed to reduce 1,000-fold when a bioattenuation zone is aerobic and consists of a minimum depth of clean soil. Specifically, the LTCP applies a bioattenuation factor of 1,000 where:

1. There is a minimum of five feet of soil between the soil vapor sample location and the building foundation or site grade;

2. The concentration of TPH (sum of TPHg and TPHd) is less than 100 mg/kg in soil within the bioattenuation zone; and

3. Oxygen in soil vapor in the bioattenuation zone is greater than or equal to 4 percent.

The LTCP also applies a bioattenuation factor where:

1. There is a minimum of ten feet of soil between groundwater (i.e., the source of petroleum concentrations to soil vapor) and the proposed or existing building foundation or site grade; and

2. The concentration of TPH (sum of TPHg and TPHd) is less than 100 mg/kg in soil within the bioattenuation zone.

Oxygen concentration data for soil vapor is not necessary in the LTCP when the depth of the column of clean soil between petroleum impacted groundwater and the building foundation is at least 10 feet.

Results Indicating a Bioattenuation Zone at the Site

Groundwater elevations in wells at the site were measured in September 2014 and are presented in Table 5 of the CSM (Langan, 2014). To assess the likely future depth to groundwater beneath the future building foundation (i.e., structural slab), Langan conservatively assumed a foundation thickness of 5 feet below the future excavation bottom. Excavation will be to the elevation of Broadway, which is approximately 52 feet above MSL, so the foundation bottom could be as deep as 47 feet above MSL. The following wells exhibited a groundwater elevation of 37 feet above MSL or less (i.e., 10 feet below the future foundation bottom) in 2014: MW-2, MW-5 through MW-8, MW-13 and MW-16B. In general, we estimate that the portion of the proposed development within approximately 80 to 100 feet of Broadway is likely to be underlain by a bioattenuation zone that meets the LTCP criteria. This estimate relies on the assumption that the three-dimensional shape of the groundwater table mimics present day surface topography.

The oxygen concentrations in the soil vapor samples collected from the site ranged from 8.97 to 21 percent. This finding indicates a bioattenuation zone will likely be present beneath the future project, except potentially where shallow soil is petroleum-impacted. For the purposes of this risk screening, TPH concentrations in soil beneath the northern portion of the former Service Bay area are assumed likely to exceed 100 mg/kg (Figure 4); however, away from the former UST system, petroleum compounds are not anticipated in shallow soils.

3.2.6 Risk Screening: Soil

One soil sample at SV-2 exceeded residential ESLs for TPHd and motor oil-range total petroleum hydrocarbons (TPHmo) with concentrations of 610 and 1,200 mg/kg, respectively (Table 1). Sample location SV-2 is located in the Service Bay (Figure 4). Soil concentrations for TPH were screened because PAH data has not been collected.

3.2.7 Risk Screening: Groundwater

TPHg and TPHd were detected in 25 groundwater samples at concentrations in exceedance of drinking water ESLs with concentrations ranging from 170 to 110,000 µg/L (Table 2a). The highest detected concentration of TPHg was 110,000 µg/L and was collected from monitoring well MW-4. The highest detected concentration of TPHd was 9,900 µg/L and was collected from well MW-1.

BTEX compounds were detected in 30 groundwater samples at concentrations in exceedance of drinking water ESLs with concentrations ranging from 4.5 to 18,000 µg/L. The highest concentration of benzene was 11,000 µg/L and was collected from monitoring well MW-16B, which is located in the Service Bay. The highest concentration of toluene was 18,000 µg/L and was collected from MW-10. MW-10 is located in the eastern portion of the site, southeast of the existing site building. The highest detected concentration of ethylbenzene was 1,700 µg/L and was collected from monitoring wells MW-4 and MW-10. The highest concentration of xylenes was 13,000 µg/L and was collected from monitoring wells MW-1 and MW-4.

Seven samples exceeded the drinking water ESL for TBA with concentrations ranging from 27 to 3,400 µg/L. The highest concentration of TBA was collected from monitoring well MW-16B. 1,2-DCA was detected in groundwater samples at concentrations in exceedance of its drinking water ESL with concentrations ranging from 9.7 to 100 µg/L. These samples were collected from monitoring wells MW-8 and MW-9, respectively. MW-8 is located on the eastern boundary of the site, along Broadway. MW-9 is located east of the Service Bay. Twelve samples analyzed for TBA were not detected at concentrations at or above the laboratory reporting limit. Seven non-detect samples had laboratory reporting limits that exceeded the drinking water ESL of 12 µg/L.

Naphthalene was detected in 10 samples at concentrations exceeding the drinking water ESLs with concentrations ranging from 11 to 1,100 µg/L. The highest naphthalene concentration was detected in monitoring well MW-4. MTBE was not detected at or above the laboratory reporting limits in the groundwater samples collected after the June 2013 AS/DPE system shutdown.

1,2-DCA was detected in groundwater along the eastern boundary of the property in monitoring well MW-8 at a concentration that exceeded its drinking water screening level. 1,2-DCA was not detected in groundwater wells cross-gradient to well MW-8, and 1,2-DCA concentrations in groundwater decrease with distance from the former UST system. 1,2-DCA was used as a lead scavenger and was likely present in gasoline used at the site prior to the early 1970s; it is unlikely that offsite migration of 1,2-DCA, if occurring, would pose an unacceptable risk to a water supply well.

Groundwater ESLs for vapor intrusion screening are presented in Table 2B. Benzene, ethyl-benzene, and naphthalene concentrations exceed groundwater ESLs for evaluation of potential vapor intrusion. Comparison was performed for residential and commercial land-uses. As described above, bioattenuation in the vadose zone beneath the site is expected to reduce the potential for vapor intrusion to occur. The areas where groundwater concentrations exceeded the vapor intrusion screening levels are generally located beneath the former Service Bay and immediately south of the former showroom (Figure 6). The potential for vapor intrusion is further evaluated in Section 3.2.8, Risk Screening for Soil Vapor.

3.2.8 Risk Screening: Soil Vapor

As described in Section 3.2.5, above, a bioattenuation zone is likely to be present beneath the site after construction. Based on the anticipated presence of a bioattenuation zone, a 1,000-fold bioattenuation factor has been applied in this screening of petroleum soil vapor data, with the exception of data collected at location SV-2. The TPH concentration in soil at location SV-2 exceeded the maximum total TPH criteria with a total of 616.8 mg/kg (Table 1), so the petroleum concentrations detected in sample SV-2 are directly compared to the ESLs (Figure 4, Table 1). Benzene in soil vapor collected from soil vapor well SV-2 exceeded the screening criteria with a concentration of 130 $\mu g/m^3$ (Table 3).

1,2-DCA was detected at a concentration of 290 $\mu g/m^3$ in soil vapor collected from well SV-10, which exceeds the residential ESL for 1,2-DCA of 58 $\mu g/m^3$ (Table 4). SV-10 is located in the current showroom area (Figure 6). A bioattenuation factor was not applied to 1,2-DCA.

4.0 CORRECTIVE ACTION OBJECTIVES

The corrective action objectives are to: 1) mitigate the petroleum concentrations in soil, groundwater, and soil vapor that exceed the future use risk screening levels; and 2) attain the requirements for case closure under the LTCP.

4.1 Corrective Action Objectives for Soil, Groundwater, and Soil Vapor

4.1.1 Corrective Action Objectives for Soil

The TPHd concentration in shallow soil beneath the Service Bay exceeds the residential ESL (Table 1). The resulting corrective action objective for soil is to reduce petroleum concentrations in soil to levels protective of future site users or establish appropriate mitigative controls to eliminate potential pathways for soil exposure

4.1.2 Corrective Action Objectives for Groundwater

Petroleum-related compounds detected at concentrations in groundwater above the WQOs specified in the RWQCB's Water Quality Control Plan for the San Francisco Bay Basin (Basin Plan) include BTEX, naphthalene and 1,2-DCA. Concentrations of compounds in exceedance of WQOs are summarized in Table 2. The areal extent of petroleum impacted groundwater is depicted on Figure 5. The current length of the contaminant plume exceeding the drinking water screening level is at least 260 feet, which is the distance between well RW-05 and MW-8.

Plots of petroleum hydrocarbon concentration trends over time have been prepared for groundwater monitoring wells where elevated concentrations were reported during the May 2014 groundwater monitoring event and are presented in the CSM (Langan, 2014). Although the areal extent of the impacts has decreased over time, petroleum concentrations beneath the Service Bay and in the vicinity of well MW-6, downgradient of the Service Bay, are likely to remain above WQOs for an extended time frame.

The SWRCB Resolution No. 92-49 requires responsible parties to cleanup and abate the effects of discharges in a manner that promotes attainment of either background water quality, or the best reasonable water quality, if background water quality levels cannot be restored. The Basin Plan designates groundwater in the site vicinity as having beneficial uses which include domestic and municipal supply. Therefore, subject to the technical and economic feasibility of further active cleanup, further remediation is required to expedite restoration of the potential use of groundwater as a drinking water source.

The resultant corrective action objective for groundwater is to reduce the petroleum mass in the subsurface contributing to groundwater impacts, such that petroleum concentrations in groundwater will be at or below WQOs in a reasonable time frame, or to reduce the potential for groundwater to pose a potential vapor intrusion concern.

4.1.3 Corrective Action Objectives for Soil Vapor

Benzene and 1,2-DCA are present in soil vapor beneath the Service Bay and showroom, respectively, at concentrations that exceed vapor intrusion screening levels. The corrective action objective for soil vapor is to mitigate potential future vapor intrusion concerns due to petroleum compounds in the site subsurface.

4.2 Application of Low-Threat Underground Storage Tank Case Closure Policy

Former UST sites must meet both the general and media-specific criteria of the LTCP to quality for case closure under the LTCP. The general criteria required for closure include:

1. The unauthorized release is located within a service area of a public water system;
2. The unauthorized release consists of only petroleum;
3. The unauthorized primary release from the UST system has been stopped;
4. Free product has been removed to the maximum extent practicable;
5. A CSM that assesses the nature, extent, and mobility of the release has been developed;
6. The secondary source has been removed to the extent practicable;
7. Soil or groundwater has been tested for MTBE and results reported in accordance with Health and Safety Code section 25296.15; and
8. Nuisance as defined by Water Code section 13050 does not exist at the site (SWRCB, 2012).

Following site grading, the site will meet these general criteria for case closure.

After implementation of the corrective action plan described below, the media-specific criteria outlined the LTCP will also be met, likely according to the following rationale. Class 5 of the groundwater-specific criteria specifies that a case may be closed if the contaminant plume poses a low threat to human health and if WQOs will be achieved in a reasonable time. Closure under Class 5 is anticipated because, based on the current length of the contaminant plume and benzene concentrations (Figure 5), the petroleum impacts to groundwater will likely not meet the groundwater specific criteria for closure in Class 1 through 4 . Implementation of this CAP will qualify the site for closure under Class 5. The soil and soil vapor media-specific criteria will be met using engineering controls (e.g., ventilated parking garage or a vapor mitigation system [VMS]) to mitigate potential vapor intrusion, and project construction and a soil management plan to reduce the potential for direct contact by future residents and construction worker exposure to petroleum compounds. Once vapor intrusion concerns have been addressed (i.e., engineering controls are in place to mitigate potential vapor intrusion), the vapor intrusion (and thus groundwater) corrective action objective will be considered to have been achieved. These media-specific remedies (corrective actions) are described below in Section 5.0.

5.0 EVALUATION AND DESIGN OF CORRECTIVE ACTION ALTERNATIVES

To meet the corrective action objectives outlined above, alternatives for the treatment or mitigation of soil, soil vapor, and groundwater impacts at the site have been evaluated. The design for the selected groundwater corrective action is also presented in this section.

5.1 Screening of Remediation Technologies

Langan performed a screening evaluation of potential remediation technologies that could be implemented to meet the corrective action objectives for soil, soil vapor and groundwater at the site. The potential technologies considered for soil, soil vapor, and groundwater remediation or mitigation are presented in Table 5 and listed below:

- No action;
- Natural Source Zone Depletion/Natural Attenuation;
- LNAPL Skimming;
- Surfactant or Cosolvent Flushing;
- Enhanced Bioremediation;
- Air Sparging with Dual Phase Extraction;
- Physical, Hydraulic, or Treatment Barrier for Containment;
- In Situ Soil Stabilization;
- In Situ Chemical Oxidation;
- Thermal Remediation;
- Excavation;
- Engineered Cover;
- Institutional Controls;
- VMS; and
- Natural or Engineered Building Ventilation.

The alternatives were evaluated based on effectiveness, implementability, remediation timeframe, and relative cost (Table 5). Based on the site geology, nature and extent of contamination, and remedial objectives, the following alternatives were carried forward for further evaluation as corrective action alternatives for groundwater treatment, as presented in Section 5.2:

- Natural Source Zone Depletion/Natural Attenuation;
- Enhanced Bioremediation; and
- Air Sparging with Dual Phase Extraction.

A formal alternatives evaluation was not performed for soil and soil vapor because the appropriate technologies to select were apparent based on the technology screening evaluation. There are five remedial alternatives for soil presented in Table 5: 1) no action; 2) in-situ soil stabilization; 3) excavation, 4) engineered cover, and 5) institutional controls. Excavation, soil cap engineering control, and institutional controls were selected as the soil corrective action alternative because soils across the site will be excavated as part of the site development and grading plan (see Appendix C). There are three remedial alternatives for soil vapor presented in Table 5: 1) no action; 2) VMS; and 3) natural or engineered building ventilation. Building ventilation will be applied where natural ventilation (e.g. parking structure open to air) or engineered ventilation (e.g. HVAC) is sufficient to mitigate vapor intrusion risks. In areas of proposed ground floor retail development, a VMS has been retained as a preemptive measure to mitigate potential vapor intrusion concerns.

The proposed soil and soil vapor correction action alternatives are presented in detail in Sections 6.3 and 6.4, respectively.

5.2 Alternatives Evaluation of Corrective Action Alternatives for Groundwater

The following evaluation for three groundwater corrective action alternatives takes into account the effectiveness, implementability, and cost of the remedy given the site conditions.

5.2.1 Natural Source Zone Depletion/Natural Attenuation

Monitored natural attenuation utilizes naturally-occurring processes in the subsurface that reduce the mass, toxicity, and mobility of the chemicals of concern. In this approach, natural biological activity, as well as other attenuation mechanisms such as adsorption, volatilization, dissolution and degradation, is monitored to predict and evaluate the reduction in concentrations of petroleum constituents in groundwater.

BTEX and hydrocarbon compounds can be rapidly degraded under aerobic conditions by natural microbial populations. When oxygen is depleted, microbes can use other electron acceptors such as nitrate, manganese, ferric iron, and sulfate to degrade hydrocarbons. Concentrations of these electron acceptors were analyzed in November 2014 at four wells within and outside of the groundwater plume (Table 6). The wells with the highest level of groundwater impacts

(MW-1 and MW-6) showed very low levels of nitrate and sulfate, high levels of iron and manganese, and had oxidation reduction potentials (ORPs) ranging from -122 to -260 mV. These data indicate that the electron acceptors are depleted within the source zone. Strong biological activity is occurring at the site; however, the overall rate of degradation is limited by the availability of electron acceptors in the source area. Natural attenuation appears to be restricting dissolved petroleum compounds to the site, but would require an extended time period to restore groundwater quality; therefore, this alternative is rated "low" for technical effectiveness.

Implementation of this alternative would involve a groundwater monitoring program to collect contaminant concentration data and natural attenuation parameters at the site. This type of data collection can be readily performed using existing monitoring wells and site activity would be only briefly disturbed in the vicinity of monitoring wells during periodic groundwater sampling events. For this reason, this alternative is rated "high" for implementability. The relative cost of this alternative is "very low" because the near-term additional costs would be for groundwater sampling and analysis, and potential installation of new wells. The long-term costs of this approach were not considered.

5.2.2 Air Sparging with Dual Phase Extraction

Air sparging involves the injection of atmospheric air into the saturated zone to oxygenate groundwater and volatilize dissolved-phase VOCs and LNAPL from the groundwater. The dissolved oxygen will stimulate biodegradation and volatile compounds will partition from the groundwater into the vapor phase, be captured by vapor extraction wells and transported to the surface for off-gas treatment. Dual-phase extraction involves applying a high vacuum to remove LNAPL, contaminated groundwater and hydrocarbon vapors from wells.

As presented in Section 2.2, an AS/DPE system operated at the site from April 2011 to June 2013. The system components, including the AS/DPE wells and piping, pump and compressor, and off-gas treatment devices are still present at the site. Mass removal rates had reduced to approximately 6 pounds of TPHg per day just prior to system shut down. In low permeability soils, the radius of influence of air sparging and vapor extraction is likely limited such that treatment preferentially removed petroleum compounds from soil units with relatively higher hydraulic conductivity. In addition, while vapor extraction has the potential to remove petroleum from the vadose zone, the air sparging component is used to reduce petroleum concentrations in the saturated zone. Sustained remediation using air sparging can be achieved through downgradient migration of oxygenated groundwater to impacted areas and subsequent aerobic biodegradation; however, the solubility of oxygen is relatively low, and groundwater migration rates at the site are low. For these reasons, this alternative is rated "medium" for effectiveness.

Implementation of this technology is rated "medium-low." Although this approach would utilize the existing network of wells and process equipment, some of the components of the system require upgrades and additional remediation wells would need to be installed to overcome the radius of influence limitation discussed above. In addition, there is not a sufficient duration of time available within the site development schedule to allow for effective AS/DPE operation. Costs for air sparging would include costs for system upgrades, installation of additional remediation wells and operation and monitoring costs during the duration of operation. Considering that some of the infrastructure is existing, this alternative is considered "medium" in cost.

5.2.3 Enhanced Bioremediation

Enhanced bioremediation involves the introduction of an electron acceptor (oxygen, nitrate or sulfate) into the remediation zone to promote the biodegradation of dissolved petroleum compounds (electron donors) in groundwater. Naturally-occurring microbial populations can metabolize dissolved-phase hydrocarbons in the presence of electron acceptors, with oxygen yielding the most energy, followed by nitrate and sulfate. As indicated in Table 6, biological degradation is currently limited by the availability of electron acceptors in the impacted groundwater zones. The low permeability of site soils presents a challenge to delivering electron acceptors throughout the areas with impacted groundwater. Direct injection is likely to emplace a limited mass of electron acceptor material; however, emplacement of a solid-form electron acceptor in trenches or borings could overcome this limitation. For the reasons described above, this alternative is rated a "medium-high" for effectiveness.

This technology will require adding electron acceptors into the subsurface to be available to microbes over the duration of the remediation. Slow-release electron acceptors are available that can enhance bioremediation over a long duration with relatively short initial installation time. Given that the site is currently not in use, the timeframe prior to development is an ideal time for emplacement of a slow-release electron acceptor without impact on current site use. Based on these factors, this alternative is rated "medium-high" for implementability. The relative cost is rated "medium" and includes the cost of bioremediation reagents, injection or installation costs, monitoring and potential periodic re-addition of reagents.

5.2.4 Recommended Corrective Action Alternative for Groundwater

Three possible groundwater remedial alternatives have been formally evaluated: 1) Natural Source Zone Depletion/Natural Attenuation, 2) Air Sparging with Dual Phase Extraction and 3) Enhanced Bioremediation.

The first alternative (Natural Attenuation) is rated "low" for effectiveness and will not accomplish the corrective action objectives identified for the site. Among the remaining two alternatives, enhanced bioremediation would provide more effective long-term treatment at the site. The AS/DPE performance summaries for the site show mass removal rates reaching asymptotic levels, and the expected low radius of influence suggests that remediation would be enhanced only in close proximity to the AS wells. As a result, additional mass removal from the low-permeability formation would require adding a substantial number of wells. It is also unclear whether mass removal would be primarily from the vadose zone, rather than the saturated zone targeted by the corrective action. Furthermore, the development timeframe would limit the duration of operation of an AS/DPE system.

On the contrary to the limitation described above for AS/DPE, enhanced bioremediation using a slow-release electron acceptor can be implemented prior to development. Enhanced bioremediation is not subject to the physical removal limitations that typically limit a AS/DPE to asymptotic removal levels after a certain period of operation. A slow-release electron acceptor can provide the distribution that is necessary within the low-permeability formation, because the electron acceptor will disperse laterally over several years in groundwater. Enhanced bioremediation will target the groundwater and saturated soils, since biological activity occurs in the aqueous phase. Therefore, based on this evaluation, the third alternative (Enhanced Bioremediation) is selected as the Corrective Action for groundwater.

5.3 Groundwater Corrective Action Design

The design of a bioremediation strategy utilizing sulfate as an electron acceptor is presented below and may be updated based on additional sampling data, pilot study experience (see Section 6.2.5 and Appendix A), and field conditions encountered.

5.3.1 Targeted Treatment Area

This groundwater corrective action is designed to achieve the objective presented in Section 4.0, which is to expedite restoration of shallow groundwater at the site. Areas of benzene concentrations greater than 1,000 µg/L are targeted for active treatment with the goal of reducing the source area hydrocarbon mass and allowing the remainder of the plume to naturally attenuate.

Benzene concentrations greater than 1,000 µg/L are present in two areas: under the Service Bay and south of the showroom, as shown by the approximate benzene isoconcentration contours shown on Figure 5. Groundwater beneath the showroom has not been sampled due to access constraints; however, based on elevated soil gas results at SV-10, it is possible that there are groundwater impacts under the showroom as well. This will be confirmed following well installation and sampling at a location near SV-10, which is discussed in Section 6.2.3. Therefore, an approximately 120 feet by 250 feet area, as shown in Figure 8, will be targeted for enhanced bioremediation.

The groundwater elevation in the treatment area ranged from 28.72 to 38.44 feet above MSL in May 2014, with MW-6 at the eastern portion of the property approximately 9 feet lower than the western portion of the site. In evaluating the historical water levels at the site, the current water levels are somewhat than average; historical levels have been as much as two feet higher or six feet lower. Based on this information and the vertical extent of impacts, the depth of treatment will be approximately 15 feet below the seasonally high water table, which corresponds to approximately 25 to 40 feet MSL across the majority of the treatment area. In the eastern portion of the site, near MW-6, the borings may be up to 10 feet deeper due to lower observed water levels. For reference, the anticipated future site grade is 52 feet MSL.

5.3.2 Rationale and Approach

Currently, the biological degradation of petroleum hydrocarbons in groundwater is limited by the availability of electron acceptors, as indicated by the groundwater data in Table 6. Bioremediation can be accelerated by introducing an electron acceptor into the subsurface, such as oxygen, nitrate, or sulfate. Although aerobic bioremediation is the most rapid, the delivery of large amounts of oxygen would be difficult due to the low-permeability formation and the relatively low solubility of oxygen. Sulfate was selected over nitrate, because nitrate is a regulated drinking water contaminant (primary maximum contaminant level [MCL] of 45 mg/L), while sulfate has a secondary MCL of 250 mg/L based on taste and odor. Furthermore, because the groundwater is already anaerobic, less acclimation time is necessary for sulfate-reducing microbial populations that may already be present. Numerous field-scale demonstrations of anaerobic bioremediation of petroleum compounds have been performed under sulfate-reducing conditions. Degradation of heavier BTEX compounds, such as toluene and xylenes (Reinhard, 1999 and Cuthbertson, 2007), and degradation of benzene have been observed in sulfate-reducing conditions (Anderson, 2000). . The rate and pattern of degradation depends on the microbial populations that are present in the groundwater. In the baseline sampling event, we will sample for sulfate reducing bacteria, but expect them to be present due to the ubiquity of the organisms and the depleted sulfate concentrations in the treatment area. In addition to benzene, petroleum compounds such as toluene and xylenes will also be analyzed in the groundwater samples collected.

Emplacement of calcium sulfate (i.e., gypsum) is proposed as a source of sulfate that will slowly dissolve over several years. The sulfate reduction chemistry for this amendment is the same as described above, but sulfate will be introduced as a solid form. Gypsum is commonly used as construction wallboard, plaster, and is a fertilizer and soil additive. The solubility of gypsum is approximately 2 to 2.5 g/L, which corresponds to a maximum sulfate concentration of approximately 1.1 to 1.4 g/L in groundwater. These levels of sulfate in groundwater would be effective in stimulating natural populations of sulfate-reducing bacteria (Cuthbertson, 2007). The microbially-mediated sulfate reduction coupled with petroleum hydrocarbons (represented by octane) oxidation is represented by the following reaction:

$$C_8H_{18} + 6.25\, SO_4^{2-} \rightarrow 8\, CO_2 + 9\, H_2O +\ 6.25\, S^{2-},$$

where sulfate is reduced to sulfide and the hydrocarbons are oxidized to carbon dioxide and water.

Since the treatment depths are up to 40 feet below the existing ground surface, the most feasible way to add gypsum to the subsurface would be drilling boreholes and backfilling them with a mixture of gypsum pellets and sand, then grouting the unsaturated portion of the borehole. The sand will provide structural support and improve the likelihood that there is higher permeability within the borings to cause groundwater to flow through. The strategy is to emplace gypsum in the upgradient (northwestern) portions of the upper and lower benzene plumes and allow the dissolved sulfate to flow downgradient with the natural groundwater gradient (Figure 8).

5.3.3 Treatment Dosage

To determine the amount of sulfate to be introduced into the subsurface, the stoichiometric sulfate demand was calculated from the dissolved, sorbed and residual LNAPL contaminant mass within the targeted treatment area. The mass of TPHg, which includes the shorter chain hydrocarbons that are more readily degradable, was calculated to be approximately 10,000 pounds. The mass calculations and assumptions are included in Appendix B. Assuming that the TPHg can be represented by octane (C_8H_{18}), the corresponding sulfate demand is approximately 54,000 pounds. The amount of sulfate in various granular gypsum products range from 17% to 50% and it is currently assumed that gypsum will be purchased with the higher sulfate content.

The full-scale remedy is designed to emplace approximately 25% of the required sulfate mass. This will be a sufficient amount to enhance bioremediation and see significant reductions in the areas near and directly downgradient of the remediation borings. The dosage was selected such that sulfate would be completely consumed within the treatment area and the added sulfate would not migrate offsite. It is expected that the sulfate will dissolve and be completely consumed over a period of 2 to 4 years.

5.3.4 Remediation Boring Construction and Layout

The remediation borings will be drilled with 8" diameter hollow-stem augers to fifteen feet below the water table (approximately 25 feet MSL, in the Service Bay area). As shown on the remediation boring construction detail on Figure 7, the bottom 15 feet of the boring will be filled with a mixture of 50% #2/12 sand and 50% gypsum pellets by volume. The higher permeability of the sand and gypsum mix will allow for more groundwater flow through this biostimulation media and will reduce the impacts of potential clogging from metal sulfides precipitation. Two feet of hydrated bentonite will be placed above the biostimulation media and the borehole will be finished with neat cement grout. During the future site excavation activities, the neat cement grout columns may be encountered and will be addressed in the Soil Management Plan (SMP) described in Section 6.3.

The borings will be installed in rows perpendicular to the direction of groundwater flow to create a bioremediation treatment zone. As shown on the conceptual remediation boring layout on Figure 8, the rows of remediation borings will be positioned at the upgradient portions of the two 1,000 µg/L benzene areas and upgradient of the SV-10 location. A total of 40 remediation borings are currently planned, but the number and placement of borings are subject to change based on the geotechnical foundation design plans, drilling rig accessibility in the existing buildings, field conditions encountered, and the results of additional sampling pursuant to this FS/CAP. The remediation boring locations located near SV-10 may be changed or removed based on the pre-design investigation groundwater data.

The majority of the borings will be placed in two offset rows of barriers spanning the width of the 1,000 µg/L benzene plumes. Within each row, the borings will be drilled with an on-center spacing of approximately 10 feet. The second row will be located approximately 20 feet downgradient of the first row, so the groundwater travel time is approximately one year between the two rows based on the upper range of the estimated groundwater seepage velocity of 20 feet per year. The locations of the borings may be adjusted based on the building foundation design and location of the structural elements. The downgradient portions of the benzene plume will be addressed as dissolved sulfate migrates downgradient with the natural groundwater flow, which is roughly estimated to be approximately 4 years for the upper benzene plume and 2 to 3 years for the lower benzene plume (Figure 5).

5.3.5 Short-Term Impacts to Groundwater

To introduce sufficient sulfate to stimulate bioremediation of petroleum hydrocarbons, the sulfate concentrations within the treatment area will temporarily increase above the secondary MCL of 250 mg/L. Sulfate concentrations can be as high as 1.4 g/L, but will decrease over time as the sulfate-reducing bacteria utilize it to degrade the hydrocarbons. Because the targeted dosage is less than the calculated contaminant demand, the sulfate is projected to be consumed within the treatment area and will not run off-site.

In the bioremediation process, sulfate will be reduced to sulfide, which will likely precipitate out of the groundwater as metal sulfides. Under acidic conditions, sulfide can combine with hydrogen ions to generate hydrogen sulfide gas, which at low concentrations can be an irritating, flammable gas with a characteristic rotten-egg-like odor. Due to the neutral groundwater pH at the site and the abundance of naturally-occurring metals in the site soils, metal sulfides precipitation is expected to be the dominant sulfide removal process. Low levels of hydrogen sulfide may be generated, but are unlikely to pose a concern due to dilution within the vadose zone, ventilation within the parking garage, and the VMS proposed for the retail portions of the development. To monitor the potential for hydrogen sulfide generation, sulfide will be analyzed in groundwater samples and the headspace of monitoring wells will be screened with a portable hydrogen sulfide gas meter during routine sampling events. In the unlikely event that the sulfide concentrations and geochemical parameters indicate a risk for hydrogen sulfide intrusion into the building, options to address the issue include adjustment of pH or injection of an iron solution to precipitate sulfide.

6.0 IMPLEMENTATION OF CORRECTIVE ACTION ALTERNATIVES

The following sections detail the implementation of the selected corrective actions for soil, soil vapor, and groundwater.

6.1 Permitting, Utility Clearance, and Health and Safety

Prior to implementation of pre-design investigations and corrective actions at the site, the following permits will be obtained from the Alameda County Public Works Agency, Water Resources Department:

- A permit to construct groundwater monitoring wells,
- A permit to bore exploratory borings for soil sampling, and
- A permit to construct remediation borings.

The permit approval process can take up to 10 business days. The proposed locations of groundwater monitoring wells, borings, and remediation wells will be outlined for utility clearance and a private utility locator and Underground Service Alert will be contacted to locate and mark subsurface utilities in the vicinity. A site-specific Health and Safety Plan will be prepared and this document will be adhered to by Langan personnel performing work at the site. Contractors involved with the installation of the remedial measures will be required to prepare and follow Health & Safety Plans prepared specifically for them.

6.2 Pre-Design Investigations

Pre-design investigations include:

- Sampling of soil in the Service Bay area for excavation and disposal of shallow soils during development and management of petroleum-impacted soil that may be left in place after development,
- Site-wide soil sampling for excavation and disposal during construction.
- Pre-remediation groundwater sampling.
- Pilot testing of the selected groundwater corrective action.

6.2.1 Soil Investigation in the Service Bay Area

Additional soil sampling beneath the Service Bay is intended to assess the potential presence and, if petroleum is detected, delineate the extent, of petroleum impacts to soil in the onsite vicinity the former USTs and beneath UST lines that likely remain beneath the Service Bay floor slab.

The elevation of the Service Bay is approximately 62 feet MSL. Excavation during development is anticipated to extend to 52 feet MSL, or approximately 10 feet bgs at the Service Bay. Grid-based soil samples will be collected in the Service Bay at a frequency of one boring location per 625 square feet, as shown on Figure 9. At each sample location, four discrete soil samples will be collected at five-foot intervals from zero to 20 feet bgs. The analytical results for shallow soil samples (e.g., samples collected at 2.5 and 7.5 feet bgs) will be used to profile soil for offsite disposal. Deep soil samples (e.g., samples collected at 12.5 and 17.5 feet bgs) will be used to assess petroleum impacts, if any, that will remain in-place post-development. A state-licensed drilling contractor will advance approximately 35 soil borings, and up to 78 soil samples will be collected beneath the Service Bay. Samples will be collected at each of the sample locations using dual-tube direct push technology. Soil sampling equipment will be decontaminated between each sample location. Soil samples will be collected into new acetate liners, sealed with Teflon™ tape and capped, and stored on ice pending submittal to a State of California-certified laboratory for analysis. Soil samples will be transported under chain-of-custody protocol.

Soil samples will be analyzed for the following petroleum compounds:

- TPHd and TPHmo using United States Environmental Protection Agency (EPA) Method 8015B,
- TPHg and BTEX using EPA Method 8021B/8015B, and
- PAHs (including naphthalene) using EPA Method 8270C.

Select shallow soil samples (SS-1, SS-10, SS-20 and SS-30) collected at 2.5 and 7.5 feet bgs will be analyzed for the following constituents to profile soil for offsite disposal:

- VOCs (including BTEX) using EPA Method 8260B,
- semivolatile organic compounds (SVOCs) using EPA Method 8270C,
- polychlorinated biphenyls (PCBs) and pesticides using EPA Method 8081A/8082,
- CAM17 metals using EPA Method 3050B, and
- pH by 9045D.

The proposed sampling and analysis schedule is included in Table 7.

Concentrations of petroleum constituents in soil will be compared to depth-specific concentration limits for residential, commercial, and utility workers as specified in Table 1 of the LTCP (Appendix G). If results are less than concentration limits, then no corrective action for soil will be conducted other than the excavations already planned for the site development, and soil will be left in place. If results exceed concentration limits, then data will be further evaluated to determine the vertical and lateral extents of contamination so that soil can be managed in place through use of mitigation measures or the use of institutional or engineering controls. Soil analytical results will be reported to ACEH in a written report that will include description of the sampling methods, a scaled figure showing sampling locations, and a summary of the analytical results. The recommended corrective action or mitigation measures, if any, will be presented in the SMP for construction.

6.2.2 Soil Sampling for Excavation and Disposal

In addition to the discrete soil sampling planned in the Service Bay, additional soil sampling will be completed throughout the remainder of the property to support soil profiling for offsite disposal during site development. Sampling locations are shown on Figure 10. The elevation of the site varies from approximately 52 to 70 feet MSL. Excavation during development is anticipated to extend to 52 feet MSL, or approximately 0 to 18 feet bgs. Soil samples will be collected at approximately 2.5 feet bgs and every 5 feet thereafter. Proposed soil sampling depths are provided in Table 7. At least one soil sample in each location will be collected below the future bottom of foundation elevation, which is projected to be 47 feet above MSL.

Soil sample locations and the analysis plan are based on the area method for determining sampling frequency as specified in Department of Toxic Substances Control's (DTSC's) Information Advisory Clean Imported Fill Materials, dated October 2001.

A state-licensed drilling contractor will advance eight soil borings, and approximately 28 soil samples will be collected. Samples will be collected at each of the sample locations using dual-tube direct push technology or hand-driven sampling sleeve into a hand-augered bore hole. Soil sampling equipment will be decontaminated between each sample location. Soil samples will be collected into new stainless steel or acetate liners, sealed with Teflon™ tape and capped, and stored on ice pending submittal to a State of California-certified laboratory for analysis. Soil samples will be transported under chain-of-custody protocol.

Soil samples will be analyzed for the following constituents:

- TPHd and TPHmo using EPA Method 8015B,
- TPHg using EPA Method 8015B,
- VOCs (including BTEX) using EPA Method 8260B,
- SVOCs (including PAHs) using EPA Method 8270C,
- PCBs and pesticides using EPA Method 8081A/8082
- CAM17 metals using EPA Method 3050B, and
- pH by 9045D.

The proposed sampling and analysis schedule is included in Table 7.

Soil analytical results will be reported to ACEH in a written report that will include description of the sampling methods, a scaled figure showing sampling locations, and a summary of the analytical results. The recommended corrective action or mitigation measures, if any, will be presented in the SMP for construction.

6.2.3 Well Installation

As a component of the pre-design investigation for the groundwater corrective action, two groundwater wells (MW-18 and MW-19) are proposed to provide additional groundwater data under the showroom. Groundwater monitoring well installation and development specifications and procedures are outlined in the Groundwater Sampling and Enhanced Bioremediation Pilot Study Work Plan in Appendix A.

Monitoring well MW-18 will be installed in the vicinity of soil vapor point SV-10, where petroleum compounds were detected in soil vapor. Monitoring well MW-19 will be installed approximately 50 feet east-southeast of MW-18 to evaluate the extent of groundwater impacts downgradient of this location. These wells located within the showroom will confirm the northeastern plume extent, downgradient of wells MW-16A and MW-16B. During drilling of the well borings, soil will be continuously logged and screened using a photoionization detector (PID). The depths of the well screen will be determined based on the observed depth to groundwater, soil characteristics and PID readings, but is anticipated to be from approximately 20 to 30 feet bgs. As noted in Section 3.1.2, the groundwater levels on the far eastern portion of the site, near Broadway, are on the order of 10 feet lower than the upgradient portion of the site. This will be considered and evaluated in selection of the screened interval for MW-19 (Figure 11).

Due to the dimensions of the doorways into the showroom portion of the building, it is anticipated that a limited access rig will be used for the installation of wells MW-18 and MW-19. If feasible, replacement downgradient wells along Broadway (Figure 8) will be concurrently installed.

An application for a permit to construct water monitoring wells will be completed and submitted to the Alameda County Public Works Agency, Water Resources Department, for approval.

The proposed groundwater monitoring well installation locations will be outlined for utility clearance and Underground Service Alert will be contacted to locate and mark subsurface utilities in the vicinity. A state-licensed drilling contractor will install and develop the groundwater monitoring wells. The wells will be installed in accordance with the provisions outlined by Alameda County Public Works Agency, Water Resources Department. Waste generated during well development will be stored onsite, chemically tested, and disposed off-site. Within 60 days of the completion of the well installation activities, the State of California Department of Water Resources (DWR) Form 188 will be submitted to the DWR, as required.

6.2.4 Pre-Remediation Groundwater Sampling

One round of pre-remediation groundwater monitoring will be performed prior to performing the pilot test for enhanced bioremediation described in Section 6.2.5. The groundwater sampling procedures, analyses, and rationale are presented in further detail in the Groundwater Sampling and Enhanced Bioremediation Pilot Test Work Plan in Appendix A. The groundwater sampling analysis schedule summarizing the monitoring wells to be sampled, sample parameters, and analytical methods, is presented in Table 8. Figure 11 shows the locations of the monitoring wells prior to site construction activities.

At least 48 hours following well development, groundwater samples will be collected from the following wells and analyzed for BTEX, MTBE, TPHg, TPHd, 1,2-DCA and naphthalene in groundwater prior to implementing the corrective action:

- Existing wells within the groundwater plume: MW-1, MW-4, MW-6, MW-14, RW-3A, and RW-3B;
- An existing well located cross-gradient to the plume: MW-3;

- Existing downgradient delineation wells: MW-5, MW-7, and MW-8 (or the replacement wells shown on Figure 8, if feasible);
- Proposed wells at the showroom: MW-18 and MW-19.

In addition to analysis of petroleum-related compounds, the following wells will also be analyzed for additional compounds for remedial design. Groundwater from monitoring wells MW-1, MW-3, MW-6, MW-8, and MW-18 will be analyzed for:

- Electron acceptors (nitrate, nitrite, total manganese, total iron, ferrous iron, sulfate, sulfite, sulfide, and dissolved methane),
- Nutrients (total nitrogen and total phosphorus),
- Water quality parameters (total organic carbon, total dissolved solids, and alkalinity), and
- Sulfate-reducing bacteria populations.

These wells were selected to assess the different portions of the groundwater plume, and also include one cross-gradient and one downgradient location for comparison as background. Additionally, groundwater samples from MW-1, MW-6, and MW-18 will be analyzed for California Title 22 (CAM17) metals to evaluate the potential for metal sulfides precipitation in the area proposed for enhance bioremediation.

Since remediation wells RW-3A and RW-3B have not been used for extraction since January 2012 and June 2011, respectively, we propose to redevelop these wells during the MW-18 and MW-19 well installation event prior to pre-remediation sampling.

EPA low-flow well sampling procedures will be followed, and water quality parameters (temperature, pH, specific conductance, and turbidity, ORP, and dissolved oxygen [DO]) will be monitored and recorded on groundwater sampling forms. Groundwater samples for metals analyses will be field-filtered using 0.45-micron filters to remove sediment and turbidity. The groundwater data will support bioremediation design, monitoring, and evaluation efforts. Should the groundwater data support modification of the groundwater corrective action presented in Section 5.3, Langan will document those changes in a memorandum for ACEH approval.

6.2.5 Pilot Study for Enhanced Bioremediation

An enhanced bioremediation pilot study is planned prior to full-scale implementation of the groundwater corrective action to evaluate and refine the process of drilling and installing the gypsum borings inside the existing buildings. Specifically, the objectives of the pilot test include establishing the boring installation workflow within the existing Service Bay, including concrete coring, drilling, and mixing and emplacement of biostimulation media.

The scope of the pilot study will include installation of seven borings in a row south of the location of the former USTs, as shown on Figure 8. These borings are located in the far upgradient portion of the contaminant plume and are within the former source area, near the USTs and potential UST piping. These boring locations were selected for the pilot test to provide the most remedial benefit and to anticipate the worst-case challenges of working inside buildings, such as clearance issues or potential presence of underground utilities or structures.

The lessons learned from the pilot test will be used to plan and scale up the full-scale remediation scope. A detailed Groundwater Sampling and Enhanced Bioremediation Pilot Test Work Plan is included as Appendix A.

6.3 Soil Corrective Action

Components of the soil corrective action serve the dual purpose of preparing the site for the proposed development and meeting soil correction action goals. Portions of former product lines that may remain within the Service Bay area will require removal as part of demolition of the existing building and building slab. Grading will remove soil to depths ranging from zero to 18 feet bgs, which correspond to an approximate excavation bottom elevation of 52 feet above MSL. The deepest excavation areas will occur in the northwestern portion of the site adjacent to Hawthorne Street. A conceptual grading plan is included as Appendix C.

The proposed site development will include construction of a building that will cover nearly the entire footprint of the Site. The building and building slab would also serve as an engineered cover that reduces the probability of an exposure pathway between soil and residential receptors, as described in Section 3.2.3. The engineered cover does not necessarily eliminate the exposure pathway between soils and future construction or utility workers, and this future risk is addressed by proposed institutional controls described in Section 7.6.

This section describes in more detail the portion of the soil corrective action to be performed during site development.

6.3.1 Soil Management Plan

Soil excavation and demolition activities will proceed under a SMP. The SMP will be prepared and submitted to ACEH after collection of additional soil data, as described in Sections 6.2.1 and 6.2.2, and prior to commencing earth work activities (e.g., soil handling, excavation, grading). Protective measures during site development will include, but are not limited to specific protocols and requirements related to:

- soil management,
- petroleum product line removal (see Section 6.3.2),
- soil vapor management,
- groundwater management (if necessary),
- stormwater management,
- soil stockpile management,
- dust control,
- odor control,
- construction worker health and safety,
- off-site disposal of soil and wastes,
- traffic control and off-haul for disposal,
- access control during construction and maintenance activities, and
- unknown/unexpected conditions.

An Unknown Conditions Response Plan will be prepared as part of the SMP to address unforeseen environmental conditions that may be encountered during development. The Unknown Conditions Response Plan will contain specific protocols and requirements related to removal of unknown product lines in the Service Bay, as further detailed in Section 6.3.2.

6.3.2 Product Line Removal in the Service Bay

According to SCI's Work Plan for Ongoing and Additional Investigation Tasks (1997), a fuel dispenser island located within the existing building was removed sometime prior to 1997. The Work Plan referred to leak testing conducted on the UST system and product lines in September 1985 by Comer Petroleum Equipment Company, which indicated that both the UST system and lines were apparently leaking. The potential for petroleum impacts to soil beneath the former product pipelines in the Service Bay area has not been fully assessed. It is anticipated that former product pipelines may remain in place and will require removal following demolition of the existing building slab. Procedures for removal of unknown product lines will be outlined in the SMP's Unknown Conditions Response Plan. Removal of the product lines in the Service Bay will occur concurrently with site demolition and/or excavation activities.

6.4 Soil Vapor Corrective Action

The purpose of the soil vapor corrective action at the site is to mitigate the potential for intrusion of petroleum compounds that have been detected in soil gas into future buildings at the site. The soil vapor corrective action for the proposed development will consist of natural or engineered ventilation within the future garage. In addition, a soil vapor mitigation system beneath the future ground-floor commercial area, use of utility cut-off trenches, and additional mitigative measures such as conduit seals will be applied.

6.4.1 Conceptual Passive Ventilation within Future Development

The future development will cover approximately 133,505 square feet, of which approximately 105,130 square feet is proposed podium garage and approximately 28,375 square feet is proposed retail space. Residential units will be located on the second floor above two garage levels and retail. Based on current soil vapor concentrations, a VMS is selected as a preemptive measure to address potential vapor intrusion in the retail portion of the proposed building, as described in more detail in Section 6.4.2.

DTSC's Vapor Intrusion Mitigation Advisory considers podium construction to be an intrinsically safe design, where the ground level of a building is maintained as a well-ventilated space not intended for human occupation; therefore, VMS is not needed for the podium garage area.

The negative determination for VMS beneath the podium garage is demonstrated by calculated indoor air concentration estimates for benzene and 1,2-DCA based on an assumed 0.75 cubic feet per minute exhaust rate within the garage, as presented in Appendix D. According to the California Mechanical Code, enclosed garages must be designed to supply a minimum of exhaust rate of 0.75 cubic feet per minute per square foot (or 3.75 air exchanges per hour, assuming a 12 foot ceiling height). To estimate the indoor air concentration for benzene and 1,2-DCA, the diffusion coefficient was calculated for each compound (i) in air. The diffusion coefficient [length^2/time] describes the rate of movement of compound (i) in a specific medium (i.e., air) due to random motions. The effective diffusion coefficient was then calculated to account for diffusion in porous media and tortuosity (a factor that accounts for diffusion in a tortuous or not straight, porous medium). Conservative calculation assumptions included, (1) the total fraction of soil porosity is air-filled (rather than water filled), (2) no chemical sorption occurs, and (3) the effect of potential bioattenuation was not included in the calculation. It was also assumed that the system is diffusion controlled. Flux for each compound (i) through the vadose zone into the atmosphere was calculated based on the effective diffusion coefficient and the concentration gradient across the vadose zone. Flux [mass/length^2 time] is the rate of movement of compound (i) per unit area within a specific media (i.e., soil gas) into the atmosphere. The concentration of compound (i) in indoor air was then calculated based on the flux of the compound (i), air exchange rate between indoor air and atmosphere, and room height. Finally, the concrete slab was accounted for using a slab attenuation factor of 0.1. The calculated indoor air concentrations of benzene and 1,2-dicloroethane are projected to be one to two orders of magnitude less than commercial RWQCB ESLs for indoor air, which supports the determination that no VMS is needed beneath the garage. It is also important to note that bioattenuation will likely further reduce soil vapor concentrations. A 1,000-fold reduction is assumed in the State's Low Threat Closure Policy.

6.4.2 Vapor Mitigation System

This section presents the retail area VMS and serves as a basis for a contingency VMS should the development plans change.

The retail portions of the development will be constructed with a sub-slab VMS designed to preemptively mitigate against potential soil vapor intrusion from the subsurface into indoor air. A VMS will be installed in the garage area if the current development plan for the lowest building level (i.e., garage) is modified and further evaluation demonstrates that risk posed by vapor intrusion will not be effectively managed with passive ventilation. The VMS will consist of a continuous, spray-applied, vapor barrier membrane, located immediately beneath the building slab, combined with a horizontal vapor collection and venting system, which will be installed below the vapor barrier membrane so that soil vapors that would otherwise collect beneath the slab can migrate, and vent, to the atmosphere, outside the building.

This section provides the basis of design for the VMS, including several sketches depicting the major system components, and describes the general construction quality control/quality assurance (QA/QC) program. The basis of design incorporates Langan's design experience on similar projects completed over the course of the past 10 years, and is intended to generally conform to the DTSC's Vapor Intrusion Mitigation Advisory (2011). The conceptual VMS design is described in greater detail in the following paragraphs. Conceptual VMS design details are provided in Appendix E.

6.4.2.1 Vapor Barrier Membrane

A typical cross-section, showing the vapor barrier membrane beneath the structural slab, is shown in Figure E1 (Appendix E). The foundation for the proposed building is anticipated to consist of a spread-footing supported structural slab system. Typically, the footings, grade beams, and pile caps will be poured before the structural slab. After these foundation members are constructed, a carrier fabric will be placed on the soil subgrade and overlap onto the foundation units. The spray-applied membrane will then be applied onto the carrier fabric; the membrane will have a dry cured minimum thickness of 60 mils. The membrane will then be covered by a protection course layer (fabric), so that the membrane is not damaged during the laying of the reinforcing steel for the slab. As it cures, the concrete of the structural slab will form a bond with the protection course fabric, causing the membrane system to adhere to the underside of the slab. In the event that voids are created beneath the slab due to settlement of the subgrade, the integrity of the membrane would not be compromised.

Proper sealing of slab penetrations is essential to maintaining the integrity of the vapor barrier. A typical detail showing a penetration through the structural slab is shown in Figure E2. The penetrations must be fully prepared prior to the spray application of the membrane.

The spray-applied membrane product will be either Liquid Boot, manufactured by CETCO, or Geo-Seal, manufactured by Regenesis. Standard manufacturer's specifications for both products are included in Appendix E. QA/QC procedures will be performed during and following installation of the spray-applied membrane product (e.g., smoke testing).

6.4.2.2 Passive Vapor Collection and Venting System

A passive, horizontal, collection and venting system will be installed beneath the vapor barrier, described above, to collect soil vapor from beneath the building slab and vent it to atmosphere outside the building. The system will include an interconnected network of 4-inch perforated PVC or HDPE piping embedded within a 6-inch "blanket" of open-graded material such as gravel, crushed rock, or pea gravel. The piping network will be connected to vertical riser pipes, constructed of cast iron or ductile iron pipe, which will trend vertically (typically through utility pipe chases) to the roof level, where the riser pipes will each be capped with a wind turbine that will generate a vacuum on the piping network to enhance collection and venting of the vapors. The precise location of the collection and venting system is dependent on the foundation design, and below-grade utility line locations, and will be coordinated with other members of the design team, particularly the structural engineers and architects. In general, sub-slab vapor collection piping will be spaced no further than 50 feet apart, and no less than one riser will be installed per 10,000 square feet of building footprint potentially affected by vapor intrusion. Each vertical riser will include a test port above the roof to allow for VMS performance monitoring. The VMS is intended to be entirely passive.

6.4.2.3 Exterior Grade Beam Inlet Vents

The purpose of the exterior grade beam vents, shown in Figure E3, is to facilitate convective airflow up the vertical riser pipe of the collection and venting system, by allowing fresh air to enter the space beneath the building slab. The vent is constructed of solid PVC or cast iron pipe, and is placed through the formwork prior to pouring the concrete. The precise location of the exterior grade beam vents, and the details of how they will be incorporated into the exterior walls, or surrounding landscaping, will be coordinated with other members of the design team, particularly the structural engineer and architect.

6.4.2.4 Construction Observation during VMS Installation

Construction and installation of the various components of the VMS will be observed and documented. Each site visit will be documented in a Construction Observation Daily Report, which may include photographs, drawing mark-ups, and other supporting information as attachments. An initial site visit will be performed to observe the installation of the gravel blanket and the horizontal vent piping network. Additional site visits will be performed to observe the installation of the spray-applied vapor barrier membrane, and a site visit will be performed each time that a portion of the membrane is scheduled to be smoke tested by the installer. A final site visit will be performed when installation of the VMS is comlete, including hook-up of the wind turbines. A completion letter that is stamped and signed by a professional engineer (PE) registered in the State of California will be provided after the installation of the VMS is complete.

The membrane installer will be required to adhere to the QA/QC procedures established by the membrane manufacturer, and the manufacturer and installer will typically warranty the product and workmanship, respectively.

6.4.3 Utility Trench Cutoffs

Various utilities, such as water, sanitary sewer, electrical, and telecommunications services, will enter and exit the building in covered trenches. Typically, the trenches are at least partially backfilled with gravel or other bedding material that is more porous than the surrounding soil, which could create a preferential pathway for vapor migration. To mitigate such migration, the utility trenches will be "plugged" where they enter or exit the building, as shown in Figure E4. The plug will consist of either a 50/50 mixture of soil from the trench excavation and bentonite pellets or a lean cement mix (commonly referred to as "controlled density fill" or "CDF").

6.4.4 Additional Mitigative Measures

The VMS design engineer will assist the project design team to identify potential, preferential pathways for vapor migration into, and through, the building, and to devise suitable mitigative measures. These may include conduit seals for electrical and communications lines and/or other design elements. Vapor barrier membrane may need to be installed beneath ground-level elevator pits and stairwells to reduce the potential for these areas to act as preferential pathways for vapor intrusion.

6.5 Groundwater Corrective Action

The groundwater corrective action will introduce calcium sulfate, or gypsum, into the groundwater to stimulate the biodegradation of petroleum hydrocarbons. The corrective action design and approach are presented in Section 5.3. This section describes the field procedures for implementation of the corrective action.

Following the pilot test activities described in Section 6.2.5 and Appendix A, the implementation procedures and plans for the full-scale implementation may be updated. A total of 40 remediation borings filled with sand and gypsum will be installed within the treatment area (Figure 8), seven of which are included in the pilot study scope of work. As noted in previous sections, the remediation boring locations may be subject to change based on the geotechnical foundation design plans, drilling rig accessibility in the existing buildings, and field conditions encountered. A conceptual construction detail of the gypsum-filled remediation boring is presented on Figure 7.

6.5.1 Remediation Boring Drilling

The remediation borings will be installed by advancing 8-inch diameter hollow stem augers to approximately 25 feet MSL, or 15 feet below the water table. Prior to drilling, the water levels at nearby wells will be gauged to verify that the gypsum will be emplaced within the saturated zone. The water levels at the borings close to the eastern portion of the property boundary, near MW-6, will be closely evaluated to determine where there may be a drop in water levels.

Drilling will be performed by a California-licensed driller. The full-scale implementation is planned to be performed prior to building demolition. Therefore, the drilling will be performed inside the Service Bay and showroom, and outside in the asphalt parking lot. It is anticipated that a limited access drill rig will be required for entering the showroom area. Within the Service Bay and showroom, concrete coring will be required through the approximately 6-inch thick concrete slab. Each concrete core will be 10- to 12-inches in diameter to allow for sufficient spacing for the 8-inch augers. Waste generated during drilling will be placed into 55-gallon drums, chemically tested, and disposed of properly.

6.5.2 Mixing and Emplacement

The biostimulation media to be placed into the borehole consists of 50% #2/12 sand and 50% gypsum pellets by volume. These granular materials will be mixed above-ground in a mixing tank or hopper until the materials are evenly mixed. Each borehole will require approximately 600 pounds of gypsum and 1,000 pounds of sand. The total amount of gypsum and sand for the 40 planned borings are approximately 24,000 pounds and 40,000 pounds, respectively.

After the borehole is drilled to the design depth, the sand-gypsum mixture will be poured into the borehole through the hollow-stem auger as the augers are slowly lifted out of the borehole. This will avoid the collapse of the borehole prior to material emplacement. Care will be taken to check that the mixture is not getting stuck, or bridging, within the augers. As shown on Figure 7, the remainder of the borehole will be sealed with two feet of hydrated bentonite and neat cement grout up to the ground surface. The amount of materials used for each borehole will be estimated and recorded in field implementation logs.

During site development, soil will be excavated to match the grade at Broadway Street, approximately 52 feet MSL. The future excavation will expose the upper grouted portion of the remediation boring but will not affect the biostimulation media. The handling of soil and grout columns remaining from former borings and wells on the site will be detailed in the SMP described in Section 6.3.1, above.

6.5.3 Field Modifications

Field modifications to the groundwater corrective action plan may be required due to unforeseen circumstances. If an obstruction is encountered, the boring will be sealed with neat cement grout and reinstalled at an adjacent location that is southeast (downgradient) of the intended location. The remediation boring locations will be selected with consideration of the foundation drawings to minimize conflict with the proposed footings. Deviations to the proposed corrective action plan will be noted in the corrective action completion report to be submitted following implementation of the soil, soil vapor, and groundwater corrective actions.

7.0 POST-CORRECTIVE ACTION ACTIVITIES

Post-corrective action activities will include removal of the existing AS/DPE system, destruction of remediation wells, destruction of groundwater and soil vapor monitoring wells, groundwater monitoring well installation and development, groundwater monitoring and evaluation of the progress of ongoing enhanced bioremediation, VMS operation and maintenance (contingency in the area of proposed residential development), preparation of a SMP for future site work post-development, and implementation of institutional controls.

7.1 Removal of AS/DPE System, Destruction of Remediation Wells, and Destruction of Groundwater and Soil Vapor Monitoring Wells

Following completion of the groundwater corrective actions at the site and prior to development, the existing AS/DPE system will be removed, onsite remediation wells will be destroyed, and groundwater and soil vapor monitoring wells will be destroyed. Removal and abandonment procedures will be detailed in a Work Plan for Removal of AS/DPE System, Destruction of Remediation Wells, and Destruction of Groundwater and Soil Vapor Monitoring Wells, to be prepared at a later date and submitted to ACEH. Upon receiving approval of the Work Plan, an application for a permit to destroy wells will be completed and submitted to the Alameda County Public Works Agency, Water Resources Department, for approval. The permit approval process can take up to 10 business days. A state-licensed drilling contractor will destroy the remediation wells, and the groundwater and soil vapor monitoring wells. The wells will be destroyed in accordance with the provisions outlined by Alameda County Public Works Agency, Water Resources Department. A state-licensed contractor will excavate and remove horizontal AS/DPE pipes; removal of the horizontal AS/DPE pipes may occur concurrently with site demolition, grading, and/or excavation activities under the protocols outlined in the SMP. Wastes will be temporarily stored onsite, pending offsite disposal. Within 60 days of the completion of the well destruction activities, the State of California DWR Form 188 will be submitted to the DWR as required.

7.2 Groundwater Monitoring Well Installation and Development

The onsite monitoring wells will be removed prior to site development, so replacement monitoring wells will be installed for groundwater verification sampling. Eight groundwater monitoring wells (MW-20 through MW-27) are proposed in the treatment areas and downgradient locations. The well locations depicted on Figure 8 have been selected to roughly correspond with existing well locations. The existing wells will be sampled prior to implementation of the corrective action. The locations are conceptual and may be modified based on future site considerations. Groundwater monitoring well construction specifications and procedures are described in Appendix A.

Proposed wells MW-20 and MW-21 will be installed in the former service bay area, in the approximate locations of existing wells MW-1 and MW-14, respectively. Well MW-22 will be installed in the former showroom area, in the approximate location of proposed well MW-18. Wells MW-23 and MW-24 will be installed near existing wells MW-4 and RW-3A, respectively. These wells will serve to monitor the progress of the groundwater corrective action. Downgradient wells MW-5, MW-7 and MW-8, located along Broadway, will be replaced by wells MW-25, MW-26, and MW-27. These wells will continue to monitor for the potential off-site migration of groundwater impacts. The downgradient replacement wells will be installed onsite, if possible. Alternatively, the downgradient replacement wells will be installed in the public right-of-way, pending permitting by the City of Oakland.

The monitoring well installation in the garage footprint will be performed after site grading activities and framing of the slab. If feasible, the wells will be installed prior to pouring of the foundations and concrete slab. The monitoring wells along Broadway will be installed concurrent with installation of monitoring wells MW-18 and MW-19 and implementation of the pilot test.

7.3 Post-Development Verification Sampling

Groundwater monitoring will be performed following site development at the well locations proposed in Section 7.2 and shown on Figure 8 to monitor the progress of the bioremediation corrective action. Four quarterly rounds of groundwater monitoring will be conducted to support site closure. The post-construction sampling analysis plan is summarized in Table 8.

During the quarterly sampling events, groundwater from eight monitoring wells (MW-20 through MW-27) will be sampled and analyzed for BTEX, MTBE, TPHg, TPHd, 1,2-DCA, naphthalene, sulfate, sulfite, sulfide, and dissolved hydrogen sulfide gas to evaluate the remediation progress. Based on the analytical results, additional parameters may be added to the post-development sampling as needed, to compare to pre-remediation conditions.

Wells will be sampled using EPA low-flow well sampling procedures, and water quality parameters (temperature, pH, specific conductance, and turbidity, ORP, and DO) will be monitored and recorded on groundwater sampling forms.

7.4 Vapor Mitigation System Operation and Maintenance

Following completion of the VMS installation, an Operation and Maintenance Plan will be prepared to describe post-construction inspection and maintenance of the VMS. The Operation and Maintenance Plan will include a description and record drawings of the VMS, an inspection and maintenance schedule for visible components of the VMS, and provide repair details for use in the event that the VMS is disrupted during future building modifications.

7.5 Post-Construction Soil Management Plan

A Post-Construction SMP will be prepared for use during future soil handling or excavation work (e.g., utility repairs) following site development. The Post-Construction SMP will (1) document residual petroleum impacts to soil, following implementation of the soil corrective action, and (2) identify protocols for activities listed in Section 7.6, Institutional Controls. Protective measures described in the SMP will include, but are not limited to specific protocols and requirements related to:

- soil management,
- soil vapor management,
- groundwater management (if necessary),
- stormwater management,
- soil stockpile management,
- dust control,
- odor control,
- construction worker health and safety,
- off-site disposal of soil and wastes,
- traffic control and off-haul for disposal,
- access control during construction and maintenance activities; and
- unknown/unexpected conditions.

The Post-Construction SMP will be prepared and submitted to ACEH after implementation of the soil, groundwater and soil vapor corrective actions.

7.6 Institutional Controls

Institutional controls may be required at the site following site development as a mitigative measure to further reduce the potential for exposure to residual petroleum concentrations likely to be left in place beneath the development. The following institutional controls are anticipated:

1. Installation of shallow groundwater wells for domestic supply will be prohibited.

2. Excavation of soil, construction or repair of subsurface utilities, facilities, structures, and appurtenances will be performed in accordance with the post-construction SMP.

3. The ground-floor garage will be maintained in accordance with the City of Oakland permit requirements.

Areas of the site subject to these institutional controls may be refined based on the results of additional soil sampling (i.e., Sections 6.2.1 and 6.2.2 of this FS/CAP). These restrictions on future site activities will be temporary, pending further evaluation of residual petroleum impacts.

8.0 DOCUMENTATION AND SITE EVALUATION FOR CASE CLOSURE

Implementation of the corrective action plan and verification sampling are scheduled to be complete by October 2017, at which time case closure will be requested. Groundwater results will be compared to the LTCP criteria and concentration trends will be evaluated. The rationale for the case closure request is anticipated to be: (1) petroleum constituents in soil will have been reduced to maximum concentrations listed in Table 1 of the LTCP (Appendix G) or human exposure potential will be limited by engineering controls, (2) groundwater monitoring results will demonstrate that concentrations of petroleum constituents are stable or declining and are expected to attain WQOs in a reasonable time frame, (3) soil vapor mitigation measures will be installed and operating, and (4) institutional controls will be in place.

9.0 PROPOSED SCHEDULE

The following schedule for remedial planning and design, pre-design investigations, corrective action implementation, and case closure is proposed:

- Remedial Planning and Design: January 2015 through October 2015
  - Soil Management Plan For Construction
  - Work Plan for Removal of AS/DPE System, Destruction of Remediation Wells, and Destruction of Groundwater and Soil Vapor Monitoring Wells
  - VMS Design Drawings
- Pre-Design Investigations: March 2015 through August 2015
  - Soil Investigation Report
  - Technical Memorandum for Groundwater Sampling and Enhanced Bioremediation Pilot Test
- Corrective Action Implementation: July 2015 through December 2016
  - Letter Report for Removal of AS/DPE System, Destruction of Remediation Wells, and Destruction of Groundwater and Soil Vapor Monitoring Wells
  - VMS Operation and Maintenance Plan
  - Corrective Action Completion Report
- Case Closure: First Quarter 2018
  - Post-Construction Soil Management Plan
  - Case Closure Documentation
  - Monitoring Well Destruction Report

A detailed Gantt chart is provided in Appendix F.

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TABLES

Table 1
Future Use Risk Screening: Soil[1]
Post-Remedial Action
3093 Broadway
Oakland, California

Sample ID[2]	Date Sampled	Ground Elevation	Sample Elevation	Sample Depth	Future Grade Elevation	Sample Depth Based on Future Grade Elevation	TPHd	TPHg	TPHmo	Benzene	Toluene	Ethyl benzene	Xylenes	MTBE	Naphthalene	PAHs
		feet a-msl	feet a-msl	feet bgs	feet a-msl	feet bgs	(mg/kg)									
SV-1-20	11/17/14	67.00	47.00	20	52.00	5.00	<1.0	<1.0	<5.0	<0.005	<0.005	<0.005	<0.005	<0.05	-	-
SV-2-16	11/19/14	62.00	46.00	16	52.00	6.00	**610**	6.8	**1200**	<0.005	<0.005	0.009	0.023	<0.05	-	-
SV-3-10.25	11/18/14	57.00	46.75	10.25	52.00	5.25	<1.0	<1.0	<5.0	<0.005	<0.005	<0.005	<0.005	<0.05	-	-
SV-4-7.25	11/18/14	54.00	46.75	7.25	52.00	5.25	<1.0	<1.0	<5.0	<0.005	<0.005	<0.005	<0.005	<0.05	-	-
SV-5-17.25	11/18/14	64.00	46.75	17.25	52.00	5.25	1.1	<1.0	6.2	<0.005	<0.005	<0.005	<0.005	<0.05	-	-
SV-6-13.25	11/17/14	61.00	47.75	13.25	52.00	4.25	<1.0	<1.0	<5.0	<0.005	<0.005	<0.005	<0.005	<0.05	-	-
SV-7-7.25	11/18/14	54.00	46.75	7.25	52.00	5.25	<1.0	<1.0	<5.0	<0.005	<0.005	<0.005	<0.005	<0.05	-	-
SV-8-9	11/17/14	56.00	47.00	9	52.00	5.00	2.3	<1.0	8.0	<0.005	<0.005	<0.005	<0.005	<0.05	-	-
SV-9-14	11/17/14	61.00	47.00	14	52.00	5.00	1.4	<1.0	<5.0	<0.005	<0.005	<0.005	<0.005	<0.05	-	-
SV-11-23	11/19/14	53.00	30.00	23	52.00	22.00	<1.0	<1.0	<5.0	<0.005	<0.005	<0.005	<0.005	<0.05	-	-
SV-12-9.25	11/18/14	56.00	46.75	9.25	52.00	5.25	2.7	<1.0	<5.0	<0.005	<0.005	<0.005	<0.005	<0.05	-	-
Residential LTCP, 0 to 5 feet bgs[3]							-	-	-	1.9	-	21	-	-	9.7	0.063
Residential ESL, <3 meters bgs[4]							100	100	100	0.044	2.9	3.3	2.3	0.023	1.2	-
Construction Worker ESL, >3 meters bgs[5]							900	2700	28000	71	4300	490	2500	3800	370	-
LTCP Bioattenuation Zone Requirements[6]							100	100	-	-	-	-	-	-	-	-

Notes:
Bolded values exceed residential ESLs
[1]Soil data collected for the site in November 2014 (Langan, 2014) after the air sparging and dual phase extraction (AS/DPE) system shutdown in June 2013
[2]Sample locations are presented on Figure 4 - Future Use Risk Screening: Soil
[3]Residential LTCP = Table 1 - Concentrations of Petroleum Constituents in Soil That Will Have No Significant Risk of Adversely Affecting Human Health, State Water Resources Control Board, May 2012; the 0 to 5 feet bgs depth interval protects potential receptors from ingestion, dermal contact and inhalation of potentially contaminated soil.
[4]Residential ESL = Table A-1 - Environmental Screening Levels for Shallow Soil (<3 meters), Residential Land Use, where groundwater is a current or potential drinking water resource, as established by the San Francisco Regional Water Quality Control Board, December 2013.
[5]Construction Worker ESL = Table K-3 - Direct Exposure Soil Screening Levels, Construction/Trench Worker Exposure Scenario, as established by the San Francisco Regional Water Quality Control Board, December 2013. ESLs presented in Table K-3 were developed to address human health/direct exposure concerns in deep soils (>3 meters) for the construction/utility trench worker exposure scenario.
[6]The LTCP requires certain characteristics for a Bioattenuation Zone scenario. If the total amount of TPH (the sum of TPHg and TPHd) throughout the entire depth of a bioattenuation zone is less than 100 mg/kg, a bioattenuation factor of 1,000 is assumed. The determination of a bioattenuation zone is relevant to soil vapor risk screening and is not intended for use in soil risk screening.
Benzene, toluene, ethylbenzene, and xylenes by EPA Method 8021B; by 8021B/ 8015Bm during 2014 investigation
– = Not collected, not analyzed, or not applicable.
<1.0 = Analyte was not detected at or above the laboratory reporting limit (1.0 mg/kg)
a-msl = above mean sea level ft bgs = feet below ground surface. mg/kg = milligrams per kilogram.
ESL = Environmental Screening Level
LTCP = Low Threat Underground Storage Tank Case Closure Policy, State Water Resources Control Board, May 2012
MTBE = Methyl tertiary butyl ether by EPA Method 8260.
TPHd = Total petroleum hydrocarbons as diesel by EPA Method 8015C; by EPA Method 8015B during 2014 investigation
TPHg = Total petroleum hydrocarbons as gasoline by modified EPA Method 8015C; by EPA Method 8021B/ 8015B during 2014 investigation
TPHmo = Total petroleum hydrocarbons as motor oil by modified EPA Method 8015C; by EPA Method 8015B during 2014 investigation

Table 2a
Future Use Risk Screening: Groundwater[1]
3093 Broadway
Oakland, California

Well ID	Date Sampled	TPHg	TPHd	Benzene	Toluene	Ethyl-benzene	Xylenes	MTBE	t-Butyl alcohol (TBA)	1,2-DCA	Naphthalene	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	n-Propyl-benzene	Isopropyl-benzene	2-Buta-none	n-Butyl-benzene	2-Hexa-none	Other VOCs	DO
		µg/L																		mg/L
AS-1B	5/22/2014	170	--	4.9	4.0	< 2.5	6.5	< 2.5	460	< 2.5	< 2.5	2.7	-	-	-	-	-	-	ND[3]	--
MW-1	6/21/2013	51,000	--	2,300	3,500	340	8,100	<120	--	--	--	-	-	-	-	-	-	-	--	0.78
MW-1	5/21/2014	60,000	--	4,300	6,400	660	10,000	< 250	< 1,000	< 250	780	2400	690	-	-	-	-	-	ND[3]	--
MW-1[a]	11/19/2014	68,000	9900	5,700	4,100	680	13,000	< 250	-	-	--	-	-	-	-	-	-	-	-	-
MW-2[b]	5/22/2014	< 50	--	< 0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 2.0	< 0.50	< 0.50	-	-	-	-	-	-	-	ND[2]	--
MW-3	5/22/2014	< 50	--	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 2.0	< 0.50	< 0.50	-	-	-	-	-	-	-	ND[2]	--
MW-3[a]	11/19/2014	< 50	52	0.63	< 0.50	< 0.50	1.0	< 5.0	--	--	--	-	-	-	-	-	-	-	--	--
MW-4	6/21/2013	110,000	--	4,400	15,000	1,700	13,000	<1,200	--	--	--	-	-	-	-	-	-	-	--	0.85
MW-4	5/20/2014	72,000	--	1,900	7,300	1,400	9,400	< 250	< 1,000	< 250	1,100	4200	1100	270	-	-	-	-	ND[3]	--
MW-5[c]	5/22/2014	< 50	--	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 2.0	< 0.50	< 0.50	-	-	-	-	-	-	-	ND[2]	--
MW-6[c]	6/21/2013	15,000	--	2,400	300	370	680	<250	--	--	--	-	-	-	-	-	-	-	--	0.81
MW-6[c]	5/20/2014	17,000	--	3,700	530	830	840	< 50	490	< 50	200	1000	96	110	50	-	-	-	ND[3]	--
MW-6[a,c]	11/19/2014	20,000	3,200	3,500	400	900	970	< 250	--	--	--	-	-	-	-	-	-	-	--	--
MW-7[c]	5/20/2014	< 50	--	< 0.50	< 0.50	< 0.50	0.64	< 0.50	< 2.0	< 0.50	< 0.50	0.51	-	-	-	-	-	-	ND[2]	--
MW-8[c]	5/21/2014	70	--	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	310	9.7	< 2.5	-	-	-	-	-	-	-	ND[3]	--
MW-9	5/20/2014	< 50	--	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	640	100	< 2.5	-	-	-	-	-	-	-	ND[3]	--
MW-9[a]	11/19/2014	240	83	4.5	2.2	< 0.5	6.2	< 5.0	--	--	--	-	-	-	-	-	-	-	--	--
MW-10	5/20/2014	88,000	--	5,600	18,000	1,700	9,900	< 500	< 2,000	< 500	770	3500	890	-	-	-	-	-	ND[3]	--
MW-13[c]	5/22/2014	< 50	--	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	6.2	< 0.50	< 0.50	-	-	-	-	-	-	-	ND[2]	--
MW-14	6/21/2013	36,000	--	1,100	4,000	550	6,400	<250	--	--	--	-	-	-	-	-	-	-	--	0.95
MW-15	6/21/2013	11,000	--	390	710	120	2,200	<50	--	--	--	-	-	-	-	-	-	-	--	1.12
MW-15	5/21/2014	4,100	--	430	19	220	250	< 17	< 67	< 17	--	230	75	28	20	-	-	-	ND[3]	--
MW-16A	5/21/2014	3,700	--	5.3	3.7	7.4	31	< 2.5	27	< 2.5	11	120	45	4.1	-	17	15	2.7	ND[3]	--
MW-16B[b]	6/21/2013	5,400	--	1,600	350	56	170	<50	--	--	--	-	-	-	-	-	-	-	--	1.74
MW-16B[b]	5/21/2014	15,000	--	11,000	710	1,000	2,000	< 250	3,400	< 250	< 250	400	-	-	-	-	-	-	ND[3]	--
MW-17A	6/21/2013	20,000	--	1,300	1,500	73	3,400	<250	--	--	--	-	-	-	-	-	-	-	--	1.31
MW-17A	5/21/2014	52,000	--	1,900	3,500	970	10,000	< 50	< 200	< 50	830	2200	570	130	70	-	-	-	ND[3]	--
MW-17B	5/21/2014	< 50	--	< 0.50	< 0.50	< 0.50	1.1	< 0.50	< 2.0	< 0.50	< 0.50	-	-	-	-	-	-	-	ND[2]	--
RW-2	5/20/2014	3,600	--	220	330	140	780	< 10	49	< 10	38	130	41	10	-	-	-	-	ND[3]	--
RW-2	6/21/2013	4,000	--	180	350	65	530	<50	--	--	-	-	-	-	-	-	-	-	--	1.81
RW-4	5/21/2014	11,000	--	200	670	310	1,700	< 17	< 67	< 17	170	610	140	71	27	-	20		ND[3]	--
RW-5	5/21/2014	14,000	--	880	440	520	2,200	< 50	< 200	< 50	250	690	120	120	57	-	-	-	ND[3]	--
Drinking Water ESLs[4]		100	100	1.0	150	300	1800	5.0	12	0.5	6.1	-	-	-	-	4900	-	-	-	-

Notes:

Shaded values exceed drinking water ESLs

[1]Compilation of groundwater data collected for the site, June 2013 through November 2014. Well locations are shown on Figure 5 - Future Use Risk Screening: Groundwater. Data References: Groundwater Monitoring & Remediation Report, Pangea Environmental Services, August 2013; and Additional Investigation Results, Langan Treadwell Rollo, 5 December 2013

[2]Non-detect laboratory reporting limits are at or below application screening criteria (drinking water ESLs) using EPA Method 5030B/8260B

[3]Non-detect laboratory reporting limits are above applicable screening criteria (drinking water ESLs) using EPA Method 5030B/8260B

[4]Drinking Water ESLs = Table F-3 - Summary of Drinking Water Screening Levels, as established by the San Francisco Regional Water Quality Control Board, December 2013.

[a]TPHg, benzene, toluene, ethylbenzene, xylenes, and MTBE using EPA Method 8021B/ 8015Bm

[b]Wells with groundwater located at depths of 10 feet or greater below the proposed future site grade. Groundwater elevation data was collected in September 2014 and is presented in Table 5 of the Conceptual Site Model (Langan, 2014). Well located in an area proposed for residential development as shown in Figure 5 - Future Use Risk Screening: Groundwater.

Table 2a
Future Use Risk Screening: Groundwater[1]
3093 Broadway
Oakland, California

Notes (Continued):

[c]Wells with groundwater located at depths of 10 feet or greater below the proposed future site grade. Groundwater elevation data was collected in September 2014 and is presented in Table 5 of the Conceptual Site Model (Langan, 2014). Well located in an area proposed for commercial development as shown in Figure 5 - Future Use Risk Screening: Groundwater.

1,2-DCA - 1,2-Dichloroethane
-- = Not analyzed
MTBE - Methyl-t-butyl ether
ESLs - Environmental Screening Criteria
VOCs = Volatile organic compounds by EPA Method 8260 unless otherwise indicated
Other VOCs = Volatile organic compounds that were not detected above the laboratory reporting limit
< 50 - Analyte was not detected at or above the laboratory reporting limit (50 µg/L)
ESL = Environmental Screening Level
ND - Not detected at or above the laboratory reporting limit
µg/L = micrograms per liter
mg/L = milligrams per liter
TPHg = Total petroleum hydrocarbons as gasoline by modified EPA Method 8015C unless otherwise indicated
TPHd = Total petroleum hydrocarbons as diesel by modified EPA Method 8015C
DO = Dissolved oxygen

Table 2b
Future Use Risk Screening: Groundwater for Evaluation of Potential Vapor Intrusion[1]
3093 Broadway
Oakland, California

Well ID	Date Sampled	TPHg	TPHd	Benzene	Toluene	Ethyl-benzene	Xylenes	MTBE	t-Butyl alcohol (TBA)	1,2-DCA	Naphthalene	1,2,4-Trimethyl-benzene	1,3,5-Trimethyl-benzene	n-Propyl-benzene	Isopropyl-benzene	2-Buta-none	n-Butyl-benzene	2-Hexa-none	Other VOCs	DO
		µg/L																		mg/L
AS-1B	5/22/2014	170	--	4.9	4.0	< 2.5	6.5	< 2.5	460	< 2.5	< 2.5	2.7	-	-	-	-	-	-	ND	--
MW-1	6/21/2013	51,000	--	2,300	3,500	340	8,100	<120	--	--	--	-	-	-	-	-	-	-	--	0.78
MW-1	5/21/2014	60,000	--	4,300	6,400	660	10,000	< 250	< 1,000	< 250	780	2400	690	-	-	-	-	-	ND	--
MW-1[a]	11/19/2014	68,000	9900	5,700	4,100	680	13,000	< 250	-	-	--	-	-	-	-	-	-	-	-	-
MW-2	5/22/2014	< 50	--	< 0.5	< 0.50	< 0.50	< 0.50	< 0.50	< 2.0	< 0.50	< 0.50	-	-	-	-	-	-	-	ND	--
MW-3	5/22/2014	< 50	--	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 2.0	< 0.50	< 0.50	-	-	-	-	-	-	-	ND	--
MW-3[a]	11/19/2014	< 50	52	0.63	< 0.50	< 0.50	1.0	< 5.0	--	--	--	-	-	-	-	-	-	-	--	--
MW-4	6/21/2013	110,000	--	4,400	15,000	1,700	13,000	<1,200	--	--	--	-	-	-	-	-	-	-	--	0.85
MW-4	5/20/2014	72,000	--	1,900	7,300	1,400	9,400	< 250	< 1,000	< 250	1,100	4,200	1,100	270	-	-	-	-	ND	--
MW-5	5/22/2014	< 50	--	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	< 2.0	< 0.50	< 0.50	-	-	-	-	-	-	-	ND	--
MW-6	6/21/2013	15,000	--	2,400	300	370	680	<250	--	--	--	-	-	-	-	-	-	-	--	0.81
MW-6	5/20/2014	17,000	--	3,700	530	830	840	< 50	490	< 50	200	1,000	96	110	50	-	-	-	ND	--
MW-6[a]	11/19/2014	20,000	3200	3,500	400	900	970	< 250	--	--	--	-	-	-	-	-	-	-	--	--
MW-7	5/20/2014	< 50	--	< 0.50	< 0.50	< 0.50	0.64	< 0.50	< 2.0	< 0.50	< 0.50	0.51	-	-	-	-	-	-	ND	--
MW-8	5/21/2014	70	--	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	310	9.7	< 2.5	-	-	-	-	-	-	-	ND	--
MW-9	5/20/2014	< 50	--	< 2.5	< 2.5	< 2.5	< 2.5	< 2.5	640	100	< 2.5	-	-	-	-	-	-	-	ND	--
MW-9[a]	11/19/2014	240	83	4.5	2.2	< 0.5	6.2	< 5.0	--	--	--	-	-	-	-	-	-	-	--	--
MW-10	5/20/2014	88,000	--	5,600	18,000	1,700	9,900	< 500	< 2,000	< 500	770	3500	890	-	-	-	-	-	ND	--
MW-13	5/22/2014	< 50	--	< 0.50	< 0.50	< 0.50	< 0.50	< 0.50	6.2	< 0.50	< 0.50	-	-	-	-	-	-	-	ND	--
MW-14	6/21/2013	36,000	--	1,100	4,000	550	6,400	<250	--	--	--	-	-	-	-	-	-	-	--	0.95
MW-15	6/21/2013	11,000	--	390	710	120	2,200	<50	--	--	--	-	-	-	-	-	-	-	--	1.12
MW-15	5/21/2014	4,100	--	430	19	220	250	< 17	< 67	< 17	--	230	75	28	20	-	-	-	ND	--
MW-16A	5/21/2014	3,700	--	5.3	3.7	7.4	31	< 2.5	27	< 2.5	11	120	45	4.1	-	17	15	2.7	ND	--
MW-16B	6/21/2013	5,400	--	1,600	350	56	170	<50	--	--	--	-	-	-	-	-	-	-	--	1.74
MW-16B	5/21/2014	15,000	--	11,000	710	1,000	2,000	< 250	3,400	< 250	< 250	400	-	-	-	-	-	-	ND	--
MW-17A	6/21/2013	20,000	--	1,300	1,500	73	3,400	<250	--	--	--	-	-	-	-	-	-	-	--	1.31
MW-17A	5/21/2014	52,000	--	1,900	3,500	970	10,000	< 50	< 200	< 50	830	2200	570	130	70	-	-	-	ND	--
MW-17B	5/21/2014	< 50	--	< 0.50	< 0.50	< 0.50	1.1	< 0.50	< 2.0	< 0.50	< 0.50	-	-	-	-	-	-	-	ND	--
RW-2	5/20/2014	3,600	--	220	330	140	780	< 10	49	< 10	38	130	41	10	-	-	-	-	ND	--
RW-2	6/21/2013	4,000	--	180	350	65	530	<50	--	--	-	-	-	-	-	-	-	-	--	1.81
RW-4	5/21/2014	11,000	--	200	670	310	1,700	< 17	< 67	< 17	170	610	140	71	27	-	20		ND	--
RW-5	5/21/2014	14,000	--	880	440	520	2,200	< 50	< 200	< 50	250	690	120	120	57	-	-	-	ND	--
Potential Vapor Intrusion ESLs[3], Residential		-	-	27	95,000	310	37,000	9,900	-	100	160	-	-	-	-	23,000,000	-	-	-	-
Potential Vapor Intrusion ESLs[3], Commercial		-	-	270	-	3,100	-	100,000	-	1,000	1,600	-	-	-	-	200,000,000	-	-	-	-

Notes:

Shaded values exceed potential vapor intrusion ESLs for residential site use

[1]Compilation of groundwater data collected for the site, June 2013 through November 2014. Well locations are shown on Figure 5 - Future Use Risk Screening: Groundwater. Data References: Groundwater Monitoring & Remediation Report, Pangea Environmental Services, August 2013; and Additional Investigation Results, Langan Treadwell Rollo, 5 December 2013

[3]Potential Vapor Intrusion ESLs = Table E-1 Groundwater Screening Levels for Evaluation of Potential Vapor Intrusion (volatile chemicals only), Fine - Coarse Mix, as established by the San Francisco Regional Water Quality Control Board, December 2013.

[a]TPHg, benzene, toluene, ethylbenzene, xylenes, and MTBE using EPA Method 8021B/ 8015B modified

1,2-DCA - 1,2-Dichloroethane

-- = Not analyzed

Table 2b
Future Use Risk Screening: Groundwater for Evaluation of Potential Vapor Intrusion[1]
3093 Broadway
Oakland, California

Notes (Continued):
MTBE - Methyl-t-butyl ether
ESLs - Environmental Screening Criteria
VOCs = Volatile organic compounds by EPA Method 8260 unless otherwise indicated
Other VOCs = Volatile organic compounds that were not detected above the laboratory reporting limit
< 50 - Analyte was not detected at or above the laboratory reporting limit (50 µg/L)
ESL = Environmental Screening Level
ND - Not detected at or above the laboratory reporting limit
µg/L = micrograms per liter
mg/L = milligrams per liter
TPHg = Total petroleum hydrocarbons as gasoline by modified EPA Method 8015C unless otherwise indicated
TPHd = Total petroleum hydrocarbons as diesel by modified EPA Method 8015C
DO = Dissolved oxygen

Table 3
Future-Use Risk Screening: Soil Vapor[1]
Volatile Organic Compounds - Part 1 of 2
3093 Broadway
Oakland, California

Sample ID	Date Sampled	Ground Elevation	Sample Elevation	Sample Depth	Future Grade Elevation	Sample Depth Based on Future Grade Elevation	Benzene	Toluene	Ethylbenzene	Naphthalene	MTBE	Helium	Oxygen[2]	Carbon Dioxide	Methane[3]
		feet a-msl	feet a-msl	feet bgs	feet a-msl	feet bgs	$\mu g/m^3$					%v			
Samples with a Bioattenuation zone *(1- there is a minimum of five feet of soil between the sample and the proposed building foundation, 2 - concentration of TPH is less than 100 mg/kg, AND 3 - Oxygen is greater than 4%)*															
SV-1-111814	11/18/14	67	60.0	7.0	52	-8.0[a]	7.8	39	<2.2	<26	<7.2	0.0566	13.2	5.06	0.00028
SV-3-111814	11/18/14	57	45.5	11.5	52	6.5	72	89	<17	<210	<58	<0.01	14.2	1.21	0.0160
SV-3-111814DUP	11/18/14	57	45.5	11.5	52	6.5	69	89	<17	<210	<58	<0.01	13.3	1.44	0.0170
SV-4-111814	11/18/14	54	46.0	8.0	52	6.0	94	64	<17	<210	<58	<0.01	17.8	<0.5	0.0068
SV-6-111814	11/18/14	61	54.0	7.0	52	-2.0[a]	38	130	5.4	<26	<7.2	<0.01	17	1.05	0.0071
SV-7-111814	11/18/14	54	47.5	6.5	52	4.5[b]	65	68	7.1	<47	<13	<0.01	15.3	<0.5	-
SV-8-111814	11/18/14	56	47.0	9.0	52	5.0	<1.6	36	<2.2	<26	<7.2	4.41	21	<0.5	-
SV-9-111714	11/17/14	61	46.5	14.5	52	5.5	53	76	3.7	<30	<8.3	<0.01	18.6	1.18	0.0067
SV-9-111914	11/19/14	61	46.5	14.5	52	5.5	-	-	-	<17[c]	-	-	-	-	-
SV-10-111914	11/19/14	53	47.0	6.0	52	5.0	4,300	110	390	<160	<45	<0.01	11.6	<0.5	0.00049
SV-11-111914	11/19/14	53	46.0	7.0	52	6.0	6.8	23	<6.3	<76	<21	<0.01	8.97	<0.5	0.00046
SV-12-111814	11/18/14	56	43.5	12.5	52	8.5	30	41	<8.4	<100	<28	<0.01	18.5	<0.5	0.0130
Screening Criteria for Samples with a Bioattenuation zone															
Residential ESL, Soil Gas x bioattenuation zone factor (1,000)							42,000	160,000,000	490,000	36,000	4,700	-	-	-	-
LTCP Criteria, residential with a bioattenuation zone							85,000	-	1,100,000	93,000	-	-	-	-	-
Samples without a Bioattenuation Zone[4] *(The concentration of TPH between the sample and the proposed building foundation may be greater than 100 mg/kg)*															
SV-2-111914	11/19/14	62	46.0	16.0	51	5.0	**130**	71	120	<260	<72	<0.01	19.4	<0.5	0.0240
Screening Criteria for Samples without a Bioattenuation zone															
Residential ESL, Soil Gas							42	160,000	490	36	4,700	-	-	-	-
LTCP Criteria, residential without a bioattenuation zone							85	-	1,100	93	-	-	-	-	-

Notes:

Bolded values exceed residential screening criteria

[1]Soil vapor data collected for the site November 2014 (Langan, 2014). Soil vapor locations are shown on Figure 6 - Future Use Risk Screening: Soil Vapor.

[2]Oxygen soil gas results are compared to the minimum four percent (where a bioattenuation zone is present) as presented in Appendix 4 - Direct Measurement of Soil Gas Concentrations Low-Threat Underground Storage Tank Case Closure Policy, as established by the State Water Resources Control Board, May 2012

[3]Methane soil gas results are compared to California State Regulations (Title 27) limit for protection of indoor air quality in overlying structures (1.25%)

[4]Total petroleum hydrocarbons were detected at concentrations greater than 100 milligrams per kilogram in soil collected from SV-2. Based on LTCP bioattenuation zone criteria, this risk screening evaluation does not apply a bioattenuation factor to sample SV-2.

[a]Elevation of soil vapor sample is above the expected future grade. A bioattenuation factor was applied because (i) there is a minimum of ten feet of soil between groundwater and the proposed building foundation and (ii) concentrations of petroleum compounds in soil and groundwater in the vicinity do not indicate a potential vapor intrusion concern.

[b]Soil vapor results collected less than five feet below expected future grade. A bioattenuation factor was applied because (i) there is a minimum of ten feet of soil between groundwater and the proposed building foundation and (ii) concentrations of petroleum compounds in soil and groundwater in the vicinity do not indicate a potential vapor intrusion concern.

[c]Naphthalene by EPA Method TO-17

Definition of Bioattenuation zone - Appendix 3, Scenario 3 - Dissolved Phase Benzene Concentrations in Groundwater

Residential Soil Gas Criteria - Appendix 4 - Direct Measurement of Soil Gas Concentrations Low-Threat Underground Storage Tank Case Closure Policy, as established by the State Water Resources Control Board, May 2012.

Residential ESLs = Table E-2 - Soil Gas Screening Levels for Evaluation of Potential Vapor Intrusion (volatile chemicals only), as established by the RWQCB-SFBR, Dec 2013.

Benzene, toluene, ethylbenzene, naphthalene, and MTBE by EPA Method TO-15, unless otherwise indicated

Helium, oxygen and carbon dioxide by American Society for Testing and Materials (ASTM) Method D-1946

Methane by EPA TO-3M

a-msl = above mean sea level
bgs = below ground surface.
ESL = Environmental screening level
LTCP = Low-Threat Underground Storage Tank Case Closure Policy
MTBE = Methyl tert-butyl ether

%v = percent by volume
$\mu g/m^3$ = micrograms per cubic meter
-- = Not collected, not analyzed, or not applicable.
<17 = Not detected above laboratory reporting limits.

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Table 4
Future-Use Risk Screening: Soil Vapor[1]
Volatile Organic Compounds - Part 2 of 2
3093 Broadway
Oakland, California

Sample ID	Date Sampled	Ground Elevation	Sample Elevation	Sample Depth	Future Grade Elevation	Sample Depth based on Future Grade Elevation	1,1,1-Trichloroethane	1,1,2-Trichloro-1,2,2-Trifluoroethane	1,2,4-Trimethyl-benzene	1,2-Dichloro-ethane	1,3,5-Trimethyl-benzene	2-Butanone	4-Ethyltoluene	Acetone	Bromom-ethane
		feet a-msl	feet a-msl	feet bgs	feet a-msl	feet bgs	µg/m^3								
Samples with a Bioattenuation zone[2]															
SV-1-111814	11/18/14	67	60.0	7.0	52	-8.0[a]	5.5	< 11.0	< 7.4	< 2.0	< 2.5	14	< 2.5	110	< 1.9
SV-3-111814	11/18/14	57	45.5	11.5	52	6.5	< 22.0	< 92.0	< 59.0	< 16.0	< 20.0	67	< 20.0	140	< 16.0
SV-3-111814DUP	11/18/14	57	45.5	11.5	52	6.5	< 22.0	< 92.0	< 59.0	< 16.0	< 20.0	60	< 20.0	110	< 16.0
SV-4-111814	11/18/14	54	46.0	8.0	52	6.0	< 22.0	< 92.0	< 59.0	< 16.0	< 20.0	84	< 20.0	140	< 16.0
SV-6-111814	11/18/14	61	54.0	7.0	52	-2.0[a]	< 2.7	< 11.0	< 7.4	< 2.0	< 2.5	13	< 2.5	210	< 1.9
SV-7-111814	11/18/14	54	47.5	6.5	52	4.5[b]	< 4.9	< 21.0	< 13.0	< 3.6	< 4.4	56	< 4.4	160	< 3.5
SV-8-111814	11/18/14	56	47.0	9.0	52	5.0	< 2.7	< 11.0	< 7.4	< 2.0	< 2.5	8.3	< 2.5	58	< 1.9
SV-9-111714	11/17/14	61	46.5	14.5	52	5.5	< 3.1	< 13.0	< 8.5	< 2.3	< 2.8	27	< 2.8	86	< 2.2
SV-9-111914	11/19/14	61	46.5	14.5	52	5.5	-	-	-	-	-	-	-	-	-
SV-10-111914	11/19/14	53	47.0	6.0	52	5.0	< 17.0	< 72.0	94	**290**	51	270	43	330	< 12.0
SV-11-111914	11/19/14	53	46.0	7.0	52	6.0	< 7.9	< 33.0	< 21.0	< 5.9	< 7.1	23	< 7.1	100	< 5.6
SV-12-111814	11/18/14	56	43.5	12.5	52	8.5	< 10.0	< 44.0	< 28.0	< 7.8	< 9.5	20	< 9.5	86	< 7.5
Samples without a Bioattenuation Zone[2]															
SV-2-111914	11/19/14	62	46.0	16.0	52	6.0	< 27.0	< 110.0	< 74.0	< 20.0	33	45	44	57	< 19.0
Residential ESL, Soil Gas							2600000	-	-	58	-	2600000	-	16000000	2600
Commercial ESL, Soil Gas							2.2E+07	-	-	5.8E+02	-	2.20E+07	-	1.4E+08	2.2E+04

Table 4
Future-Use Risk Screening: Soil Vapor[1]
Volatile Organic Compounds - Part 2 of 2
3093 Broadway
Oakland, California

Sample ID	Date Sampled	Ground Elevation	Sample Elevation	Sample Depth	Future Grade Elevation	Sample Depth based on Future Grade Elevation	Carbon Disulfide	Carbon Tetrachloride	Chloroform	Chloro-methane	Dichlorodifluoromethane	Ethanol	Methylene Chloride	o-Xylene	p/m-Xylene	Styrene	Tert-Butyl Alcohol	Tetrachloro-ethene	Trichlorofluoro-methane
		feet a-msl	feet a-msl	feet bgs	feet a-msl	feet bgs	µg/m³												
Samples with a Bioattenuation zone[2]																			
SV-1-111814	11/18/14	67	60.0	7.0	52	-8.0[a]	< 6.2	< 3.1	190	2.4	3.1	18	< 17.0	< 2.2	< 8.7	< 6.4	< 6.1	87	6.0
SV-3-111814	11/18/14	57	45.5	11.5	52	6.5	< 50.0	< 25.0	< 20.0	< 8.3	< 110	< 75.0	< 140.0	< 17.0	< 69.0	< 51.0	< 49.0	< 27.0	< 45.0
SV-3-111814DUP	11/18/14	57	45.5	11.5	52	6.5	< 50.0	< 25.0	< 20.0	< 8.3	< 110.0	< 75.0	< 140.0	< 17.0	< 69.0	< 51.0	< 49.0	< 27.0	< 45.0
SV-4-111814	11/18/14	54	46.0	8.0	52	6.0	< 50.0	< 25.0	< 20.0	< 8.3	< 20.0	< 75.0	< 140.0	< 17.0	< 69.0	< 51.0	< 49.0	< 21.0	< 45.0
SV-6-111814	11/18/14	61	54.0	7.0	52	-2.0[a]	66	< 3.1	5.7	6.9	< 14.0	37	< 17.0	4.4	15	< 6.4	< 6.1	< 3.4	< 5.6
SV-7-111814	11/18/14	54	47.5	6.5	52	4.5[b]	18	< 5.6	< 4.4	< 1.8	< 4.4	23	< 31.0	< 3.9	< 16.0	< 11.0	< 11.0	< 6.1	< 10.0
SV-8-111814	11/18/14	56	47.0	9.0	52	5.0	< 6.2	< 3.1	< 2.4	1.2	< 14.0	17	< 17.0	< 2.2	< 8.7	< 6.4	< 6.1	< 3.4	< 5.6
SV-9-111714	11/17/14	61	46.5	14.5	52	5.5	8.7	< 3.6	< 2.8	6.8	< 16.0	34	< 20.0	2.9	< 10.0	< 7.3	< 7.0	11	< 6.5
SV-9-111914	11/19/14	61	46.5	14.5	52	5.5	-	-	-	-	-	-	-	-	-	-	-	-	-
SV-10-111914	11/19/14	53	47.0	6.0	52	5.0	< 39.0	< 20.0	< 15.0	< 6.5	< 15.0	< 59.0	< 110.0	< 14.0	360	< 40.0	120	< 21.0	< 35.0
SV-11-111914	11/19/14	53	46.0	7.0	52	6.0	< 18.0	< 9.1	< 7.1	< 3.0	< 7.2	< 27	< 50.0	< 6.3	< 25.0	< 19.0	< 18.0	< 9.8	< 16.0
SV-12-111814	11/18/14	56	43.5	12.5	52	8.5	< 24.0	< 12.0	< 9.4	7.7	< 16.0	< 36.0	< 67.0	< 8.4	< 33.0	< 25.0	< 23.0	< 13.0	< 22.0
Samples without a Bioattenuation Zone[2]																			
SV-2-111914	11/19/14	62	46.0	16.0	52	6.0	< 62.0	< 31.0	< 24.0	< 10.0	< 25.0	< 94.0	< 170.0	220	460	< 64.0	< 61.0	< 34.0	< 27.0
Residential ESL, Soil Gas							-	29	230	47000	-	-	2600	-	-	470000	-	210	-
Commercial ESL, Soil Gas							-	2.9E+02	2.3E+03	3.9E+05	-	-	2.6E+04	-	-	3.9E+06		2.1E+03	-

Notes:
Bolded values exceed residential ESLs
[1]Soil vapor data collected for the site November 2014 (Langan, 2014). Soil vapor locations are shown on Figure 6 - Future Use Risk Screening: Soil Vapor.
[2]See Table 3, Future-Use Risk Screening: Soil Vapor, Volatile Organic Compounds - Part 1 of 2
[a]Elevation of soil vapor sample is above the expected future grade.
[b]Soil vapor results collected less than five feet below expected future grade.

Residential and Commercial ESLs = Table E-2 - Soil Gas Screening Levels for Evaluation of Potential Vapor Intrusion (volatile chemicals only), as established by the RWQCB-SFBR, Dec 2013.

Definition of Bioattenuation zone - Appendix 3, Scenario 3 - Dissolved Phase Benzene Concentrations in Groundwater
a-msl = above mean sea level
bgs = below ground surface.
LTCP = Low-Threat Underground Storage Tank Case Closure Policy
µg/m³ = micrograms per cubic meter
VOCs = volatile organic compounds using EPA Method TO-15
-- = Not collected, not analyzed, or not applicable.
ND = Not detected above laboratory reporting limits, see laboratory analytical report for reporting limit

Table 5
Screening of Remediation Technologies
3093 Broadway
Oakland, California

	Target Media	Remedial Action/Technology	Technology Description	Technical Effectiveness	Implementability	Remediation Timeframe	Relative Cost Range	Retained for Additional Evaluation (Yes/No)
1	Soil Groundwater Soil Vapor	No Action	No Action	**Low** The groundwater plume is stable and the impacts to soil, soil vapor, and groundwater are decreasing over time. An extended time period is expected necessary to reduce concentrations in groundwater to Water Quality Objectives.	**N/A**	**N/A**	**No Cost**	**No**
2	Saturated Soils & Groundwater	Natural Source Zone Depletion/ Natural Attenuation	Groundwater monitoring to verify natural source zone depletion of LNAPL and natural attenuation of COCs in groundwater.	**Low** This monitoring-only approach will monitor the gradual degradation of LNAPL and dissolved COCs due to natural processes such as volatilization, dissolution, and degradation due to natural influx of oxygen.	**High** Only monitoring is required. Existing monitoring well network is likely sufficient for monitoring.	**Very Long (20+ Years)** Remediation timeframe is very long because no active remediation is performed.	**Very Low (up to $100,000)** Costs include periodic monitoring and reporting.	**Yes**
3	LNAPL	LNAPL Skimming	LNAPL is hydraulically recovered from the top of the groundwater column within Site wells.	**Low** Technology is capable of removing mobile LNAPL, but is not capable of removing immobile LNAPL that will not flow towards a wells. Previous monitoring at the site indicates LNAPL remaining is primarily immobile with limited potential for additional LNAPL removal by skimming alone. ACEH has indicated LNAPL skimming alone is not a sufficient remedial approach.	**High** Technology could use existing wells screened across the water table. A mechanical skimmer can be placed into site wells, or wells can be manually bailed periodically.	**Very Long (20+ Years)** Remediation timeframe is very long because no active remediation is performed to address immobile LNAPL and groundwater COCs.	**Low ($100,000-$250,000)** Costs include mechanical skimmers or periodic mechanical bailing, and monitoring costs.	**No**
4	Saturated Soils & Groundwater	Surfactant or Cosolvent Flushing	A surfactant or cosolvent is injected to increase LNAPL and COC solubility and LNAPL mobility. LNAPL and dissolved COCs are then removed by hydraulic recovery.	**Low-Medium** Technology is capable of increasing COC solubility and mobility, however hydraulic recovery is limited by low-permeability formation. Low permeability will likely slow the rate of LNAPL recovery and also present a challenge for achieving full contact of surfactant or cosolvent with impacted soils.	**Medium-High** Technology may be able to make use of some existing wells screened across the water table, however additional wells may be required. Technology could make use of existing dual phase extraction system for groundwater and LNAPL removal. Additional piping may be required for injection of surfactant or cosolvent.	**Medium (5-10 Years)** Several rounds of surfactant or cosolvent flushing are typically required. The timeframe is fairly long because low permeability soils would limit the rate of COC recovery via hydraulic means.	**Medium ($250,000-$500,000)** Costs may include additional remediation wells, surfactant or cosolvent reagent, injection of reagent into wells, and operation and maintenance of dual phase extraction system.	**Yes**
5	Saturated Soils & Groundwater	Enhanced Bioremediation	Introduction of an electron acceptor (may be oxygen, nitrate, or sulfate) into the remediation zone to promote biodegradation of dissolved COCs. Certain microbes utilize electron acceptors along with electron donors (in this case the COCs) as part of the microbial respiration process that is the basis for their metabolism.	**Medium - High** This technology stimulates naturally-occurring microbial degradation of dissolved COCs, which are likely currently limited by presence of electron acceptors. Site COCs are biodegradable. The low permeability of site soils present a challenge in delivering electron acceptor to all portions of impacted media; however, placement of electron acceptor directly into soil (by boring or mixing injection technologies) overcomes this limitation.	**Medium - High** Technology will require adding electron acceptors into the subsurface by injection through wells or temporary points or by emplacement in a trench or borings. Additional electron acceptors may need to be replenished periodically over the duration of remediation. Given that the site is currently not in use, installation prior to development has no negative impact on current site use.	**Long (10-20 Years)** Bioremediation is generally a slow process, and is even slower for sites with relatively high mass associated with residual LNAPL. The timeframe is shorter than for natural attenuation, but longer than more active remediation technologies. Slow release of electron acceptor reagents are available that can have a long effect with relatively short initial installation time.	**Medium ($250,000-$500,000)** Costs include installation of remediation wells or borings, electron acceptor reagent, monitoring, and potential periodic replenishment of reagents.	**Yes**
6	Unsaturated & Saturated Soils & Groundwater	Air Sparging with Dual Phase Extraction	Continued operation of the existing air sparge/dual phase extraction system. Air sparge wells introduce atmospheric air into groundwater to volatilize LNAPL and groundwater COCs into vadose zone. Dual phase Extraction captures volatilized COCs along with groundwater and mobile LNAPL, if present.	**Medium** Technology is capable of volatilizing mobile and immobile LNAPL through phase change from liquid to vapor phase. Additional remediation wells may be required to remediate all impacted areas of the Site. Low permeability soils may limit the radius of influence of air sparge effectiveness. Current monitoring data cannot confirm the radius of influence from the existing system.	**Medium - Low** Technology uses existing system already installed. Some components of the system may require upgrade and installation of remediation wells would be needed inside the site building. System would need to operate longer than available within development schedule to be effective.	**Low (1-5 Years)** Typical remediation timeframes for air sparging are up to several years. This assumes that a remediation well network is in place to provide appropriate coverage of the treatment area.	**Medium ($250,000-$500,000)** Costs include additional remediation wells and system upgrades, and operation and maintenance costs.	**No**
7	Groundwater	Physical, Hydraulic, or Treatment Barrier for Containment	Installation of a physical, hydraulic, or treatment barrier to prevent migration of COCs in groundwater. Typically installed at site boundary to prevent migration off-site. Physical options may include slurry wall or sheet piles. Hydraulic options may include groundwater extraction. Treatment options may include a line of remediation wells at the site boundary for placement of chemical or biological treatment reagents.	**Low for Remediation, High for Containment** This technology would not address the source of COCs at the Site, but would prevent migration of those COCs from flowing off Site towards Broadway Street. COCs are not migrating offsite, so this technology would have little to no current effects.	**Medium** Technology will require infrastructure along the Broadway side of the Site, potentially including trenching or sheet pile placement (for physical option), groundwater extraction wells, piping and treatment (for hydraulic option), or remediation wells (for treatment option).	**Very Long (20+ Years)** Monitoring of the effectiveness of containment may be required on a long-term basis. Because this technology does not address the source of COCs, containment is assumed indefinite.	**Low ($100,000-$250,000)** Costs will depend on the containment approach taken.	**No**
8	Soil	In Situ Soil Stabilization	In Situ mechanical mixing of impacted soils with low-permeability materials such as clay or stabilizing media such as Portland cement.	**Medium-High (LNAPL only)** This technology does not remove or degrade COCs, however it manages the COCs mass by limiting the flux of COCs into surrounding media. Technology is typically applied for LNAPL stabilization with a separate treatment technology to address dissolved COCs, if needed.	**Medium** This technology cannot be applied until/unless building is removed. After building removal, cement mixing can be performed from the surface using soil mixing equipment, however some excavation will be required to reach deeper depths. Heavy equipment would be on-site for duration of mixing process. Dewatering will be required to target saturated soils.	**Very Short (less than 1 Year)** Stabilization field effort would likely required several months, but less than 1 year. Timeframe does not include monitoring.	**High ($500,000 to $1,000,000)** Costs include excavation equipment, soil mixing equipment, earthwork support, and cement slurry.	**No**

Table 5
Screening of Remediation Technologies
3093 Broadway
Oakland, California

	Target Media	Remedial Action/Technology	Technology Description	Technical Effectiveness	Implementability	Remediation Timeframe	Relative Cost Range	Retained for Additional Evaluation (Yes/No)
9	Saturated Soils & Groundwater	In Situ Chemical Oxidation (ISCO)	ISCO involves injecting an oxidant to react with and destroy organic compounds such as petroleum hydrocarbons. Oxidants can be injected via wells or via direct push injection. ISCO can be used to target LNAPL and dissolved COCs, however the oxidation reaction occurs in the dissolved phase.	**Medium** This technology is effective for destruction of dissolved COCs. This technology is somewhat effective LNAPL in that remediation of dissolved COCs increases the dissolution of LNAPL into the groundwater. Effective oxidation requires delivery and contact between oxidant and target media in the proper dosage. The low permeability of site soils present a challenge in achieving adequate oxidant to all portions of impacted media. If oxidant is applied by soil mixing, the effectiveness would be increased due to better oxidant contact.	**Medium** This technology requires installation of oxidant injection wells or direct push injection of oxidant reagents. If the building is removed, oxidant can also be applied by soil mixing, although some earthwork may be required for the soil mixer to reach the desired depth. Multiple rounds of oxidant injection will be required. Fracturing of soils may be required to achieve adequate contact between oxidant and impacted media. Heavy equipment would be on-site during injection or soil mixing events.	**Short (1-5 Years)** Oxidant injection events can be performed in a matter or weeks or months, however several rounds of injections events would be required and spaced months apart.	**High ($500,000 to $1,000,000)** Costs include direct push injection or soil mixing equipment, oxidant reagent and monitoring over the course of several injection events.	No
10	Soil & Groundwater	Thermal Remediation	Placement of conductive heating wells or electrical resistance heating electrodes to heat subsurface to volatilize LNAPL and dissolved COCs. Placement of vapor recovery wells in the vadose zone for COC capture.	**High** This technology is very effective for removal of petroleum impacts. Heating increases the mobility of LNAPL, potentially resulting in additional hydraulic recovery. Heating will also volatilize and vaporize LNAPL and dissolved COCs. At higher temperatures, COCs may degrade in situ.	**Medium** This technology requires a significant network of heating wells, vapor recovery wells, and associated piping and above-ground treatment. It is possible to install within the a building, however the building will not be usable for another purpose until the remediation is complete due to the heavy piping and infrastructure needed inside the building for this technology. On-going monitoring and maintenance of the ventilation system and vapor barrier is required. Nearby utilities would need to be protected.	**Short (1-5 Years)** Timeframe includes estimated 3 months for thermal system construction followed by approximately 6 to 12 months of operations.	**Very High (greater than $1,000,000)** Costs include heater and recovery well installation, extraction piping, above-ground vapor treatment, electrical systems installation, daily operation and maintenance, and large energy costs associated with this technology.	No
11	Soil	Excavation	Excavation and disposal of impacted soils and backfill with clean fill.	**High** This technology is very effective for direct removal of soils containing LNAPL or adsorbed COCs. Excavation removes soils, but does not remove groundwater, which may require some additional treatment.	**Medium** This technology cannot be applied until/unless building is removed. After building removal, excavation can be performed to the target remediation depth. Addition of oxygen-releasing compound powder is often used upon backfill of excavation to treat remaining groundwater impacts. Heavy equipment would be on-site for duration of excavation and backfill process. Dewatering will be required to target saturated soils. Shoring and/or sloping will likely be required.	**Very Short (less than 1 Year)** Excavation field effort would likely require several months, but less than 1 year. Timeframe does not include monitoring.	**Very High (greater than $1,000,000)** Costs include excavation equipment, earthwork support, characterization and disposal of excavated soils, and backfill materials.	Yes
12	Soil	Engineered Cover	Placement of an engineered cover to prevent direct contact with soil, including physical barriers such as a concrete slab, pavement, or a clean fill cap.	**Medium** These controls will limit direct contact to impacted soil, but will not remove, degrade, or reduce the toxicity of COCs in soil.	**High** This technology is highly implementable, because the approved development plans include hardscape across the extent of the site.	**Very Short (less than 1 Year)** Remediation timeframe is very short because remediation technology would be installed during site development.	**Very Low (up to $100,000)** It is anticipated that no additional effort is necessary for this alternative beyond what is already proposed for the site development.	Yes
13	Soil & Groundwater	Institutional Controls	Institutional controls are administrative or legal controls to minimize the potential for human exposure to contamination. Examples include a Soil Management Plan to limit exposure to construction workers and limitations on well installation for drinking water.	**Medium** Establishment of controls to manage soil and restrict groundwater usage will limit human exposure to impacted media. However, this alternative alone will not remediate, reduce mobility, or prevent migration of COCs.	**High** This technology is very implementable, as Soil Management Plans are typical for construction projects. Agreements to limit installation of water supply wells can be formally put into place.	**Very Long (20+ Years)** Institutional controls would remain in place over a long duration.	**Very Low (up to $100,000)** Costs include report preparation, monitoring and sampling during construction, and notification of groundwater use restrictions.	Yes
14	Sub-slab Soil Vapor	Vapor Mitigation System (VMS)	VMS is used to mitigate potential intrusion of impacted soil vapors into indoor spaces of a constructed building. VMS involves installation of a continuous, spray-applied, vapor barrier membrane, located sub-slab (below building slab foundations). A horizontal vapor collection and venting system is installed beneath the membrane so that chemical vapors from impacted soil and groundwater can migrate and vent to the atmosphere.	**High** This technology is very effective for mitigating soil vapor COCs from intrusion into indoor spaces to prevent inhalation risk to site users in enclosed buildings.	**High** Installation of a VMS requires construction of building components that are not typically included in construction on non-impacted sites, however these components can be readily installed during the building construction process.	**Very Short (less than 1 Year)** The VMS can be installed during the process of building construction.	**Low ($100,000-$250,000)** Typical costs for VMS is approximately $7 per square foot (sq. ft) for membrane application, materials, and vapor venting system installation.	Yes
15	Sub-slab Soil Vapor	Natural or Engineered Building Ventilation	Natural building ventilation relies on HVAC or natural ventilation within a building for dilution and flushing of potential intrusion of soil vapors into the building. Air exchange within the building must be sufficient to keep indoor air concentrations within acceptable health limits.	**Medium** No action is taken to prevent potential indoor air intrusion, however natural ventilation or HVAC may be sufficient to protect indoor air in cases with high ventilation or low rates of vapor intrusion.	**High** No action is required other that HVAC and ventilation that is already performed to meet the California Building Code.	**Very Short (less than 1 Year)** No action is required other that HVAC and ventilation that is already performed to meet the California Building Code. HVAC is constructed in the process of building construction.	**Very Low (less than $100,000)** There are no costs above those ventilation requirements already performed to meet the California Building Code.	Yes

Notes:
COC - Contaminant of Concern
LNAPL - Light Non Aqueous Phase Liquid (free product)
N/A - Not Applicable

Table 6
Natural Attenuation Parameters in Groundwater
3093 Broadway Street
Oakland, California

Well ID	Sampling Date	Dissolved Methane	TOC	TDS	Alkalinity	Nitrate	Sulfate	Total Iron	Total Manganese	pH	Dissolved Oxygen	Oxidation Reducton Potential
		µg/L	mg/L	mg/L	mg $CaCO_3$/L	mg/L	mg/L	µg/L	µg/L	-	mg/L	mV
MW-1	11/19/14	4,300	73	660	501	< 0.45	0.73	16,000	9,800	6.11	2.21	-121.6
MW-3	11/19/14	0.37	3.0	534	220	5.6	140	3,000	59	6.03	6.81	58.7
MW-6	11/19/14	510	21	570	462	< 0.45	9.1	6,000	4,400	6.33	5.62	-260.4
MW-9	11/19/14	47	6.0	497	234	< 0.45	110	1,300	580	5.67	-	58.7

Notes:
Reference: Additional Investigation Results, Langan Treadwell Rollo, 5 Dec 2014.
µg/L - micrograms per liter
mg/L - milligrams per liter
MCLs - maximum contaminant levels
mg $CaCO_3$/L - milligrams calcium carbonate per liter
TOC - total organic carbon
TDS - total dissolved solids
< 0.45 - non-detected at or above the laboratory reporting limit

Table 7
Proposed Soil Sampling and Analysis Schedule
3093 Broadway
Oakland, California

Sample ID	Sampling Location	Sample Depth	Approximate Ground Elevation	Future Grade Elevation	Approximate Sample Elevation	Analytes							
						TPH-gasoline, diesel, motor oil	BTEX	PAHs (Including, naphthalene)	VOCs	SVOCs	PCBs and Pesticides	CAM-17 metals	pH
		feet bgs	feet a-msl	feet a-msl		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
SS-1	Service Bay	2.5	62	52	59.5	X			X	X	X	X	X
		7.5	62	52	54.5	X			X	X	X	X	X
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-2	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-3	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-4	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-5	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-6	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-7	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-8	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-9	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					

Table 7
Proposed Soil Sampling and Analysis Schedule
3093 Broadway
Oakland, California

Sample ID	Sampling Location	Sample Depth	Approximate Ground Elevation	Future Grade Elevation	Approximate Sample Elevation	Analytes							
						TPH-gasoline, diesel, motor oil	BTEX	PAHs (Including, naphthalene)	VOCs	SVOCs	PCBs and Pesticides	CAM-17 metals	pH
		feet bgs	feet a-msl	feet a-msl		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
SS-10	Service Bay	2.5	62	52	59.5	X			X	X	X	X	X
		7.5	62	52	54.5	X			X	X	X	X	X
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-11	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-12	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-13	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-14	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-15	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-16	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-17	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-18	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					

Table 7
Proposed Soil Sampling and Analysis Schedule
3093 Broadway
Oakland, California

Sample ID	Sampling Location	Sample Depth	Approximate Ground Elevation	Future Grade Elevation	Approximate Sample Elevation	Analytes							
						TPH-gasoline, diesel, motor oil	BTEX	PAHs (Including, naphthalene)	VOCs	SVOCs	PCBs and Pesticides	CAM-17 metals	pH
		feet bgs	feet a-msl	feet a-msl		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
SS-19	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-20	Service Bay	2.5	62	52	59.5	X	X		X	X	X	X	X
		7.5	62	52	54.5	X	X		X	X	X	X	X
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-21	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-22	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-23	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-24	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-25	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-26	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-27	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					

Table 7
Proposed Soil Sampling and Analysis Schedule
3093 Broadway
Oakland, California

Sample ID	Sampling Location	Sample Depth	Approximate Ground Elevation	Future Grade Elevation	Approximate Sample Elevation	Analytes							
						TPH-gasoline, diesel, motor oil	BTEX	PAHs (Including, naphthalene)	VOCs	SVOCs	PCBs and Pesticides	CAM-17 metals	pH
		feet bgs	feet a-msl	feet a-msl		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
SS-28	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-29	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-30	Service Bay	2.5	62	52	59.5	X	X		X	X	X	X	X
		7.5	62	52	54.5	X	X		X	X	X	X	X
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-31	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-32	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-33	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-34	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-35	Service Bay	2.5	62	52	59.5								
		7.5	62	52	54.5								
		12.5	62	52	49.5	X	X	X					
		17.5	62	52	44.5	X	X	X					
SS-36	Site - NW Quadrant	2.5	65	52	62.5	X			X	X	X	X	X
		7.5	65	52	57.5	X			X	X	X	X	X
		12.5	65	52	52.5	X			X	X	X	X	X
		17.5	65	52	47.5	X			X	X	X	X	X

Table 7
Proposed Soil Sampling and Analysis Schedule
3093 Broadway
Oakland, California

Sample ID	Sampling Location	Sample Depth	Approximate Ground Elevation	Future Grade Elevation	Approximate Sample Elevation	Analytes							
						TPH-gasoline, diesel, motor oil	BTEX	PAHs (Including, naphthalene)	VOCs	SVOCs	PCBs and Pesticides	CAM-17 metals	pH
		feet bgs	feet a-msl	feet a-msl		mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	mg/kg	
		22.5	65	52	42.5	X			X	X	X	X	X
SS-37	Site - Center	2.5	65	52	62.5	X			X	X	X	X	X
		7.5	65	52	57.5	X			X	X	X	X	X
		12.5	65	52	52.5	X			X	X	X	X	X
		17.5	65	52	47.5	X			X	X	X	X	X
		22.5	65	52	42.5	X			X	X	X	X	X
SS-38	Site - Center North	2.5	59	52	56.5	X			X	X	X	X	X
		7.5	59	52	51.5	X			X	X	X	X	X
		12.5	59	52	46.5	X			X	X	X	X	X
SS-39	Site - Center South	2.5	57	52	54.5	X			X	X	X	X	X
		7.5	57	52	49.5	X			X	X	X	X	X
		12.5	57	52	44.5	X			X	X	X	X	X
SS-40	Site - Show Room	2.5	55	52	52.5	X			X	X	X	X	X
		7.5	55	52	47.5	X			X	X	X	X	X
		12.5	55	52	42.5	X			X	X	X	X	X
SS-41	Site - NE Quadrant	2.5	55	52	52.5	X			X	X	X	X	X
		7.5	55	52	47.5	X			X	X	X	X	X
		12.5	55	52	42.5	X			X	X	X	X	X
SS-42	Site - Center East	2.5	55	52	52.5	X			X	X	X	X	X
		7.5	55	52	47.5	X			X	X	X	X	X
		12.5	55	52	42.5	X			X	X	X	X	X
SS-43	Site - SE Quadrant	2.5	54	52	51.5	X			X	X	X	X	X
		7.5	54	52	46.5	X			X	X	X	X	X

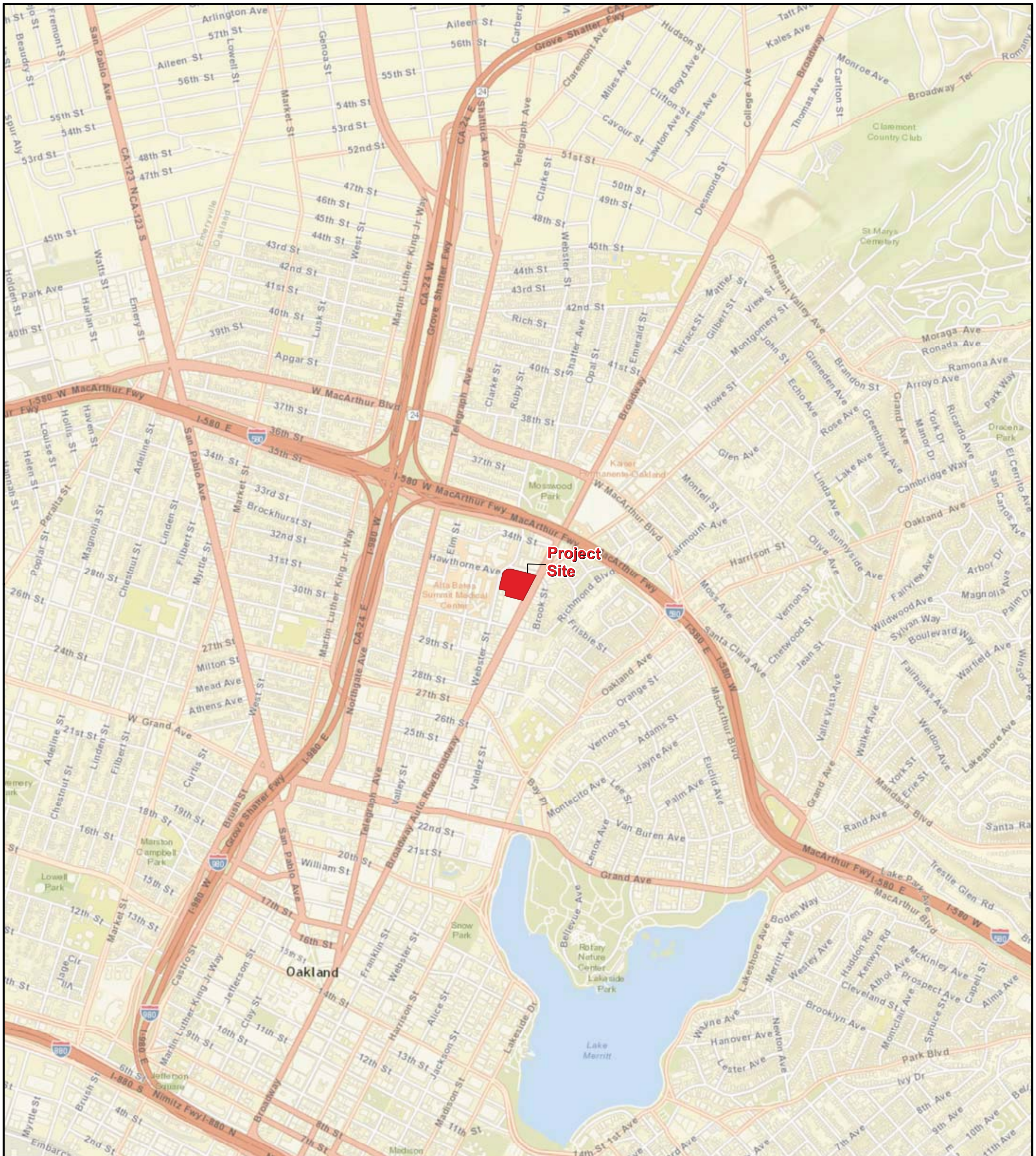
Notes:
a-msl = above mean sea level
bgs = below ground surface
FOC = Fraction organic carbon in soil
BTEX/MTBE = benzene, toluene, ethylbenzene, xylenes, methyl tertiary butyl ethe %v = percent volume
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds, including naphthalene and fuel oxygenates
mg/kg = milligrams/kilogram
$\mu g/m^3$ = micrograms per cubic meter
-- not applicable

Table 8
Proposed Groundwater Sampling and Analysis Schedule
3093 Broadway
Oakland, California

Sampling Location	Location	TOC Elevation	Casing Diameter	Screened Interval	Depth to Groundwater (May 2014)	Contaminants				Electron Acceptors/Reduced Electron Acceptors					Nutrients		Metals	Water Quality Parameters			Microbial
						BTEX/ MTBE	TPH-Gasoline and Diesel	1,2-DCA	Naphthalene	Nitrate/ Nitrite	Total Manganese	Total Iron/ Ferrous Iron	Sulfate/ Sulfite/ Sulfide	Dissolved Methane	Total Nitrogen	Total Phosphorus	CAM17 Metals	Total Organic Carbon (TOC)	Total Dissolved Solids (TDS)	Alkalinity	Sulfate Reducing Bacteria
Analytical Methods						**8260B**	**8015B**	**8260B**	**8260B**	**E300.1**	**E200.8**	**E200.8 SM 3500Fe**	**E300.1**	**RSK175**	**SM4500-N**	**SM4500-P**	**E200.8**	**E415.3**	**SM2540C**	**SM2320B**	**CENSUS APS**
		feet a-msl	inches	feet bgs	feet bgs	μg/L	μg/L	μg/L	μg/L	mg/L	μg/L	μg/L	mg/L	μg/L	mg/L	mg/L	μg/L	mg/L	mg/L	mg/L $CaCO_3$	cells/mL
Pre-Construction Sampling - once at pre-remediation event (2015)																					
MW-1	In plume	60.57	2	19 to 35	22.13	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW-3	Cross-gradient	56.87	2	20 to 35	19.51	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
MW-4	In plume	55.67	2	15 to 30	18.15	X	X	X	X				X								
MW-5	Downgradient	51.7	2	15 to 35	25.97	X	X	X	X				X								
MW-6	In plume	51.65	2	15 to 35	22.93	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW-7	Downgradient	52.25	2	13.5 to 33.5	16.99	X	X	X	X				X								
MW-8	Downgradient	52.30	6	19.5 to 40	26.14	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
MW-14	In plume	61.5[b]	--	10 to 40	--	X	X	X	X				X								
MW-18	Assumed in plume	52[a]	2	20 to 30[a]	--	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW-19	Downgradient	52[a]	2	20 to 30[a]	--	X	X	X	X				X								
RW-3A	In plume	54[b]	4	16 to 26	--	X	X	X	X				X								
RW-3B	In plume	54[b]	4	32 to 37	--	X	X	X	X				X								
MW-25	Downgradient	52[a]	2	20 to 30[a]	--	X	X	X	X				X								
MW-26	Downgradient	52[a]	2	13 to 23[a]	--	X	X	X	X				X								
MW-27	Downgradient	52[a]	2	15 to 25[a]	--	X	X	X	X				X								
Post-Development Sampling - quarterly for one year (estimated 2017)																					
MW-20	In plume	52[a]	2	10 to 20[a]	--	X	X	X	X				X								
MW-21	In plume	52[a]	2	10 to 20[a]	--	X	X	X	X				X								
MW-22	In plume	52[a]	2	20 to 30[a]	--	X	X	X	X				X								
MW-23	In plume	52[a]	2	10 to 20[a]	--	X	X	X	X				X								
MW-24	In plume	52[a]	2	15 to 25[a]	--	X	X	X	X				X								
MW-25	Downgradient	52[a]	2	20 to 30[a]	--	X	X	X	X				X								
MW-26	Downgradient	52[a]	2	13 to 23[a]	--	X	X	X	X				X								
MW-27	Downgradient	52[a]	2	15 to 25[a]	--	X	X	X	X				X								

Notes:
a. Estimated value for proposed well, screened interval selected be 10 feet long and intersecting the top of the water table.
b. Estimated value based on topographic contour
a-msl = above mean sea level
bgs = below ground surface
BTEX/MTBE = benzene, toluene, ethylbenzene, xylenes, methyl tertiary butyl ether
TPH = total petroleum hydrocarbons
μg/L = micrograms per liter
-- not applicable
Wells are to be sampled using low-flow sampling methodology and field parameters will be collected: including turbidity, pH, dissolved oxygen, oxidation-reduction potential, specific conductivity and temperature.
Additional parameters may be added to the post-development sampling as needed based on remediation progress.

FIGURES



Notes:

1. World street basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online. Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN.
2. Map displayed in California State Plane Coordinate System, Zone III, North American Datum of 1983 (NAD83), US Survey Feet.

0 1,000 2,000 4,000
Feet

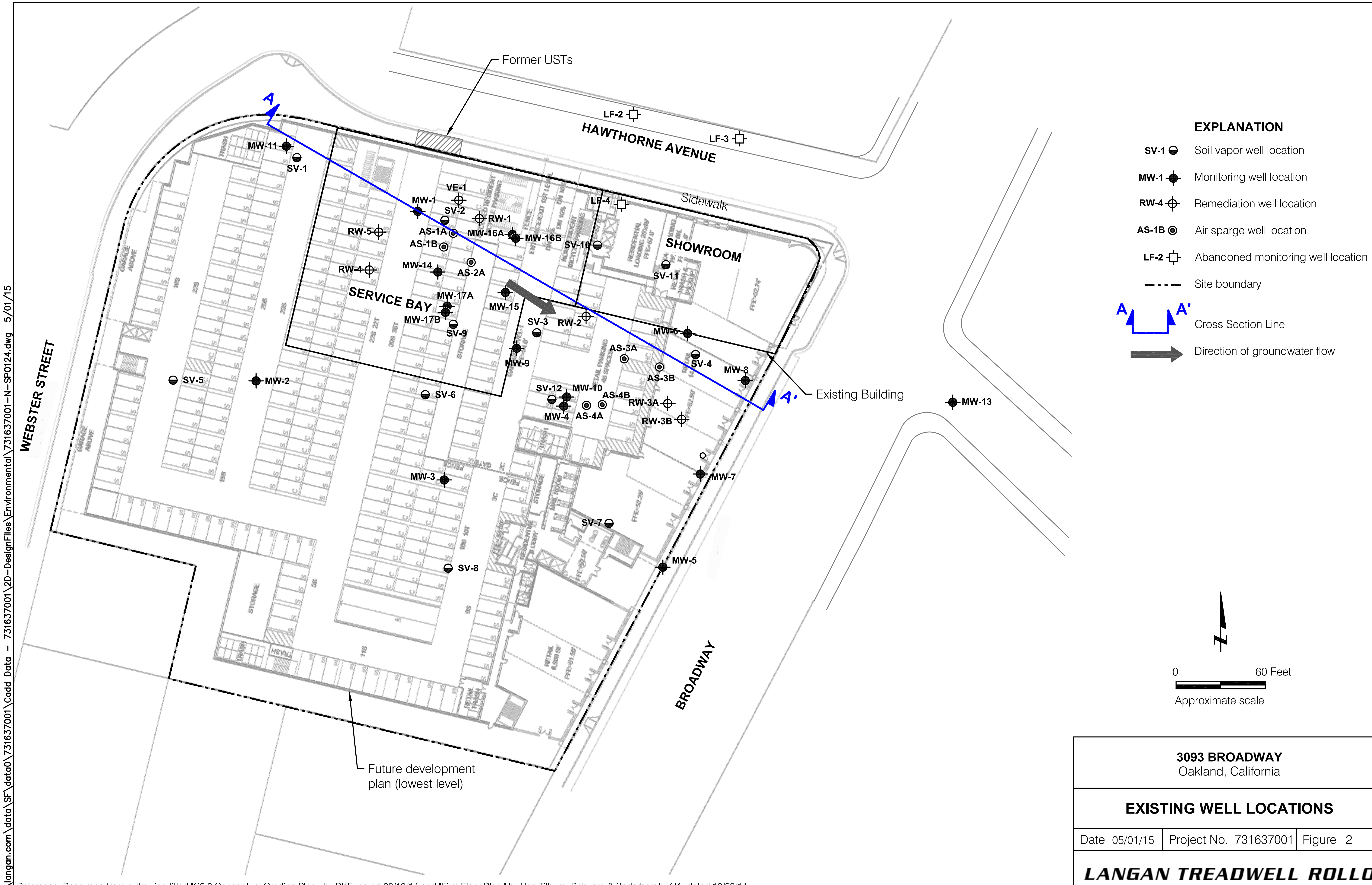
N

3093 BROADWAY
Oakland, California

LANGAN TREADWELL ROLLO

SITE LOCATION MAP

Date 05/01/15	Project 7316317001	Figure 1



Reference: Base map from a drawing titled "C2.0 Conceptual Grading Plan," by BKF, dated 08/19/14 and "First Floor Plan," by Van Tilburg, Babvard & Soderbergh, AIA, dated 10/03/14.

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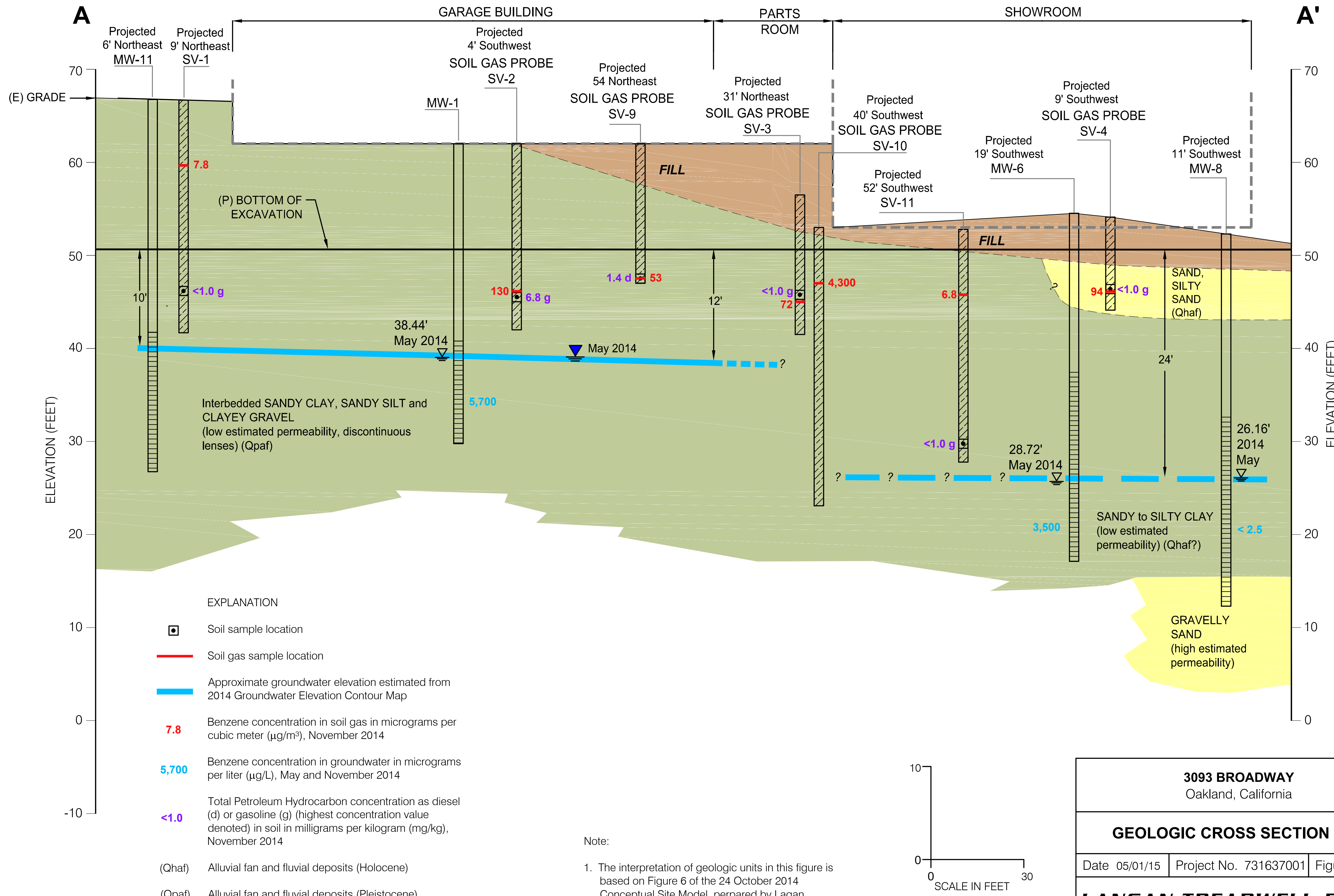
3093 BROADWAY
Oakland, California

EXISTING WELL LOCATIONS

Date 05/01/15	Project No. 731637001	Figure 2

LANGAN TREADWELL ROLLO



EXPLANATION

- Soil sample location
- Soil gas sample location
- Approximate groundwater elevation estimated from 2014 Groundwater Elevation Contour Map
- 7.8 — Benzene concentration in soil gas in micrograms per cubic meter (µg/m³), November 2014
- 5,700 — Benzene concentration in groundwater in micrograms per liter (µg/L), May and November 2014
- <1.0 — Total Petroleum Hydrocarbon concentration as diesel (d) or gasoline (g) (highest concentration value denoted) in soil in milligrams per kilogram (mg/kg), November 2014
- (Qhaf) Alluvial fan and fluvial deposits (Holocene)
- (Qpaf) Alluvial fan and fluvial deposits (Pleistocene)

Note:

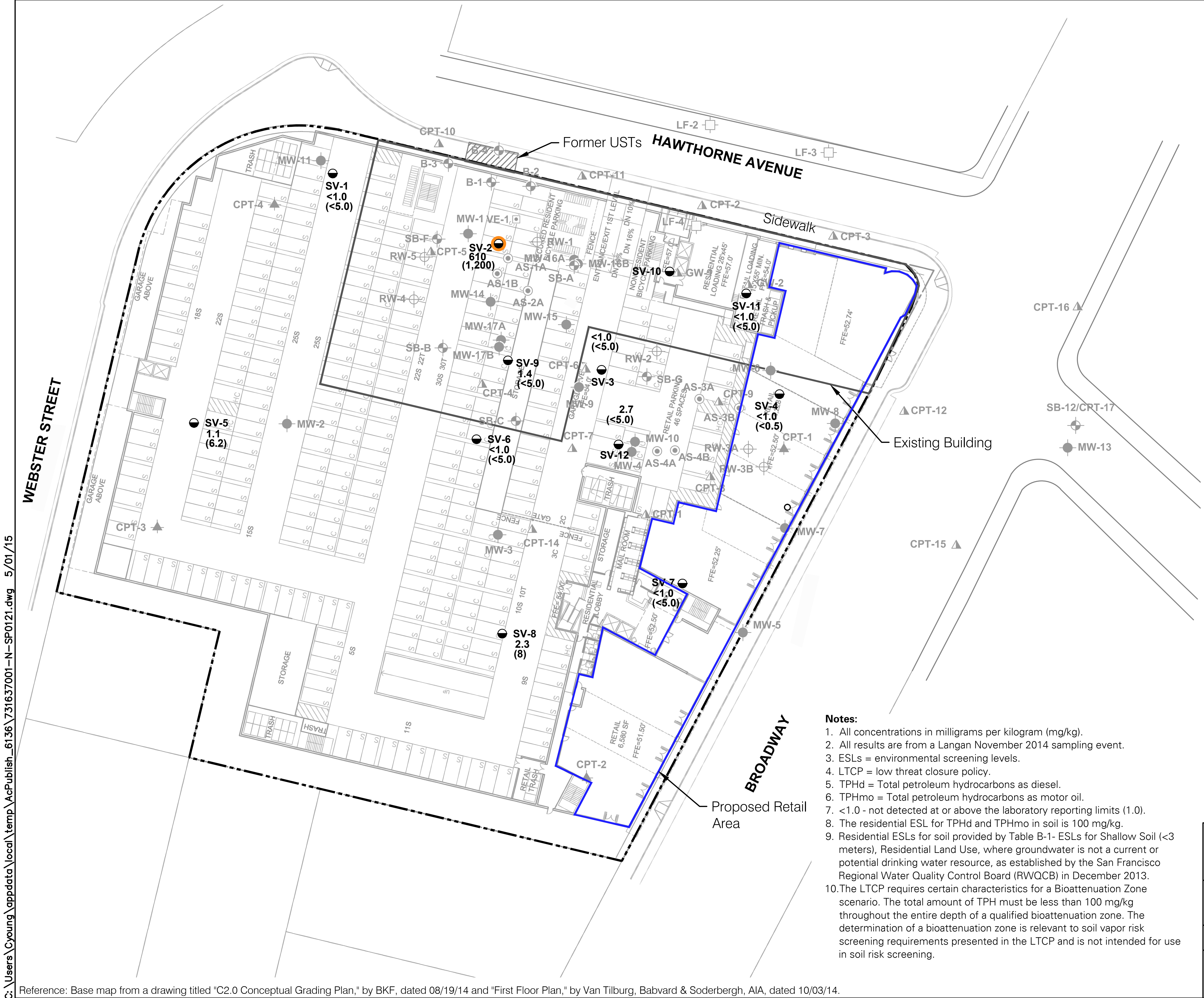
1. The interpretation of geologic units in this figure is based on Figure 6 of the 24 October 2014 Conceptual Site Model, perpared by Lagan.

3093 BROADWAY
Oakland, California

GEOLOGIC CROSS SECTION A-A'

Date 05/01/15 | Project No. 731637001 | Figure 3

LANGAN TREADWELL ROLLO



EXPLANATION

SV-1	Soil sample location
MW-1	Monitoring well location
RW-4	Remediation monitoring well location
AS-1B	Air sparge well location
VE-1	Vapor extraction well location
SB-A	Soil boring
CPT-6	Penetration test boring - 1992
CPT-4	Penetration test boring - 2014
LF-2	Abandoned monitoring well location
<1.0	TPHd (diesel)
(<5.0)	TPHmo (motor oil)
○	Sample in exceedance of Residential ESLs and LTCP Bioattenuation zone requirements
— · —	Site boundary

Notes:

1. All concentrations in milligrams per kilogram (mg/kg).
2. All results are from a Langan November 2014 sampling event.
3. ESLs = environmental screening levels.
4. LTCP = low threat closure policy.
5. TPHd = Total petroleum hydrocarbons as diesel.
6. TPHmo = Total petroleum hydrocarbons as motor oil.
7. <1.0 - not detected at or above the laboratory reporting limits (1.0).
8. The residential ESL for TPHd and TPHmo in soil is 100 mg/kg.
9. Residential ESLs for soil provided by Table B-1- ESLs for Shallow Soil (<3 meters), Residential Land Use, where groundwater is not a current or potential drinking water resource, as established by the San Francisco Regional Water Quality Control Board (RWQCB) in December 2013.
10. The LTCP requires certain characteristics for a Bioattenuation Zone scenario. The total amount of TPH must be less than 100 mg/kg throughout the entire depth of a qualified bioattenuation zone. The determination of a bioattenuation zone is relevant to soil vapor risk screening requirements presented in the LTCP and is not intended for use in soil risk screening.

Reference: Base map from a drawing titled "C2.0 Conceptual Grading Plan," by BKF, dated 08/19/14 and "First Floor Plan," by Van Tilburg, Babvard & Soderbergh, AIA, dated 10/03/14.

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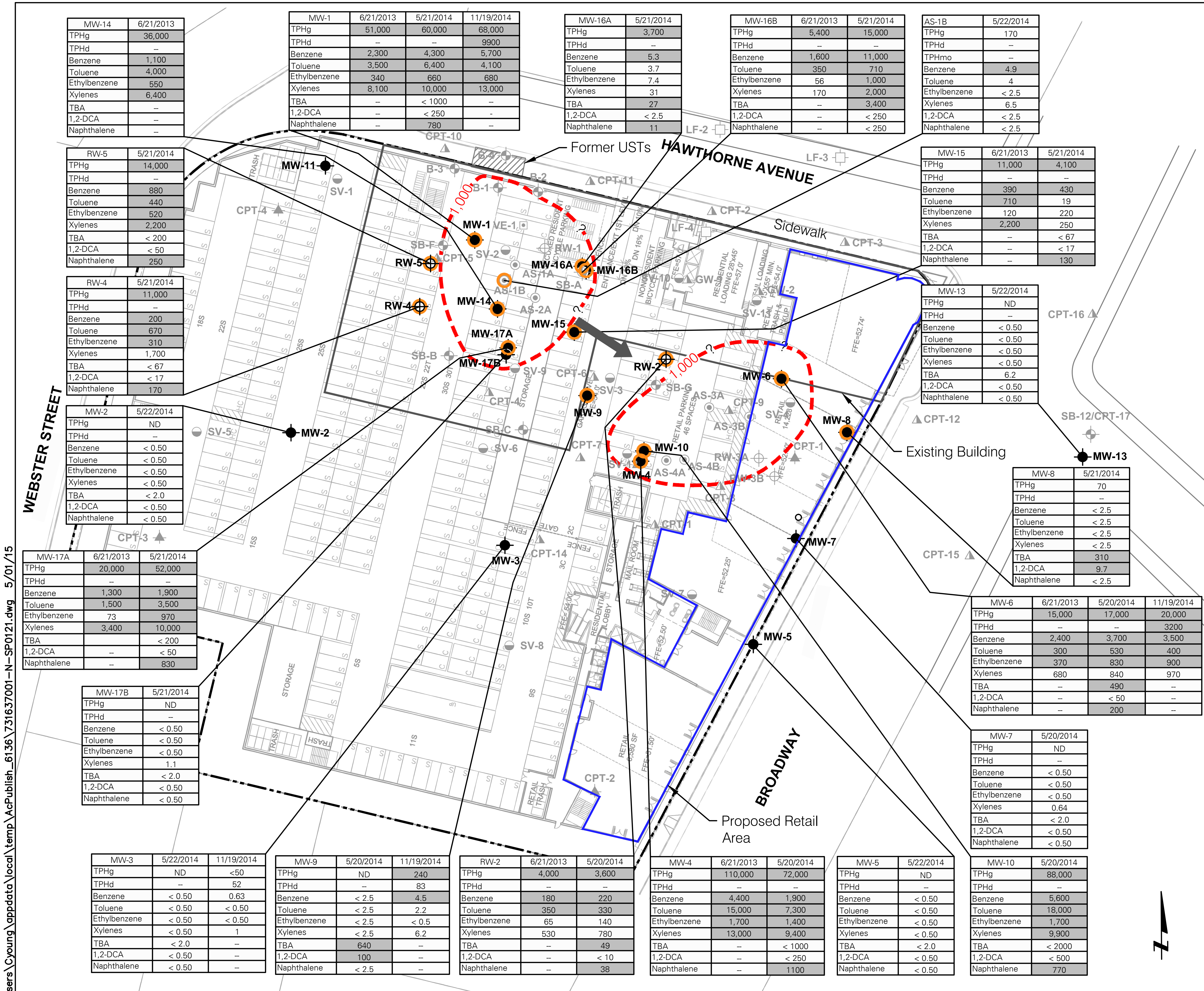
3093 BROADWAY
Oakland, California

FUTURE USE RISK SCREENING: SOIL

Date 05/01/15	Project No. 731637001	Figure 4

LANGAN TREADWELL ROLLO



MW-14	6/21/2013
TPHg	36,000
TPHd	--
Benzene	1,100
Toluene	4,000
Ethylbenzene	550
Xylenes	6,400
TBA	--
1,2-DCA	--
Naphthalene	--

MW-1	6/21/2013	5/21/2014	11/19/2014
TPHg	51,000	60,000	68,000
TPHd	--	--	9900
Benzene	2,300	4,300	5,700
Toluene	3,500	6,400	4,100
Ethylbenzene	340	660	680
Xylenes	8,100	10,000	13,000
TBA	--	< 1000	--
1,2-DCA	--	< 250	-
Naphthalene	--	780	--

MW-16A	5/21/2014
TPHg	3,700
TPHd	--
Benzene	5.3
Toluene	3.7
Ethylbenzene	7.4
Xylenes	31
TBA	27
1,2-DCA	< 2.5
Naphthalene	11

MW-16B	6/21/2013	5/21/2014
TPHg	5,400	15,000
TPHd	--	--
Benzene	1,600	11,000
Toluene	350	710
Ethylbenzene	56	1,000
Xylenes	170	2,000
TBA	--	3,400
1,2-DCA	--	< 250
Naphthalene	--	< 250

AS-1B	5/22/2014
TPHg	170
TPHd	--
TPHmo	--
Benzene	4.9
Toluene	4
Ethylbenzene	< 2.5
Xylenes	6.5
1,2-DCA	< 2.5
Naphthalene	< 2.5

RW-5	5/21/2014
TPHg	14,000
TPHd	--
Benzene	880
Toluene	440
Ethylbenzene	520
Xylenes	2,200
TBA	< 200
1,2-DCA	< 50
Naphthalene	250

MW-15	6/21/2013	5/21/2014
TPHg	11,000	4,100
TPHd	--	--
Benzene	390	430
Toluene	710	19
Ethylbenzene	120	220
Xylenes	2,200	250
TBA	--	< 67
1,2-DCA	--	< 17
Naphthalene	--	130

RW-4	5/21/2014
TPHg	11,000
TPHd	--
Benzene	200
Toluene	670
Ethylbenzene	310
Xylenes	1,700
TBA	< 67
1,2-DCA	< 17
Naphthalene	170

MW-13	5/22/2014
TPHg	ND
TPHd	--
Benzene	< 0.50
Toluene	< 0.50
Ethylbenzene	< 0.50
Xylenes	< 0.50
TBA	6.2
1,2-DCA	< 0.50
Naphthalene	< 0.50

MW-2	5/22/2014
TPHg	ND
TPHd	--
Benzene	< 0.50
Toluene	< 0.50
Ethylbenzene	< 0.50
Xylenes	< 0.50
TBA	< 2.0
1,2-DCA	< 0.50
Naphthalene	< 0.50

MW-8	5/21/2014
TPHg	70
TPHd	--
Benzene	< 2.5
Toluene	< 2.5
Ethylbenzene	< 2.5
Xylenes	< 2.5
TBA	310
1,2-DCA	9.7
Naphthalene	< 2.5

MW-17A	6/21/2013	5/21/2014
TPHg	20,000	52,000
TPHd	--	--
Benzene	1,300	1,900
Toluene	1,500	3,500
Ethylbenzene	73	970
Xylenes	3,400	10,000
TBA		< 200
1,2-DCA	--	< 50
Naphthalene	--	830

MW-6	6/21/2013	5/20/2014	11/19/2014
TPHg	15,000	17,000	20,000
TPHd	--	--	3200
Benzene	2,400	3,700	3,500
Toluene	300	530	400
Ethylbenzene	370	830	900
Xylenes	680	840	970
TBA	--	490	--
1,2-DCA	--	< 50	--
Naphthalene	--	200	--

MW-17B	5/21/2014
TPHg	ND
TPHd	--
Benzene	< 0.50
Toluene	< 0.50
Ethylbenzene	< 0.50
Xylenes	1.1
TBA	< 2.0
1,2-DCA	< 0.50
Naphthalene	< 0.50

MW-7	5/20/2014
TPHg	ND
TPHd	--
Benzene	< 0.50
Toluene	< 0.50
Ethylbenzene	< 0.50
Xylenes	0.64
TBA	< 2.0
1,2-DCA	< 0.50
Naphthalene	< 0.50

MW-3	5/22/2014	11/19/2014
TPHg	ND	<50
TPHd	--	52
Benzene	< 0.50	0.63
Toluene	< 0.50	< 0.50
Ethylbenzene	< 0.50	< 0.50
Xylenes	< 0.50	1
TBA	< 2.0	--
1,2-DCA	< 0.50	--
Naphthalene	< 0.50	--

MW-9	5/20/2014	11/19/2014
TPHg	ND	240
TPHd	--	83
Benzene	< 2.5	4.5
Toluene	< 2.5	2.2
Ethylbenzene	< 2.5	< 0.5
Xylenes	< 2.5	6.2
TBA	640	--
1,2-DCA	100	--
Naphthalene	< 2.5	--

RW-2	6/21/2013	5/20/2014
TPHg	4,000	3,600
TPHd	--	--
Benzene	180	220
Toluene	350	330
Ethylbenzene	65	140
Xylenes	530	780
TBA	--	49
1,2-DCA	--	< 10
Naphthalene	--	38

MW-4	6/21/2013	5/20/2014
TPHg	110,000	72,000
TPHd	--	--
Benzene	4,400	1,900
Toluene	15,000	7,300
Ethylbenzene	1,700	1,400
Xylenes	13,000	9,400
TBA	--	< 1000
1,2-DCA	--	< 250
Naphthalene	--	1100

MW-5	5/22/2014
TPHg	ND
TPHd	--
Benzene	< 0.50
Toluene	< 0.50
Ethylbenzene	< 0.50
Xylenes	< 0.50
TBA	< 2.0
1,2-DCA	< 0.50
Naphthalene	< 0.50

MW-10	5/20/2014
TPHg	88,000
TPHd	--
Benzene	5,600
Toluene	18,000
Ethylbenzene	1,700
Xylenes	9,900
TBA	< 2000
1,2-DCA	< 500
Naphthalene	770

EXPLANATION

- SV-1 — Soil sample location
- MW-1 — Monitoring well location
- RW-4 — Remediation monitoring well location
- AS-1B — Air sparge well location
- VE-1 — Vapor extraction well location
- SB-A — Soil boring
- CPT-6 — Penetration test boring - 1992
- CPT-4 — Penetration test boring - 2014
- LF-2 — Abandoned monitoring well location
- 1,000 — Benzene Isoconcentration in water, queried where uncertain (May 2014)
- Sample concentration exceeds drinking water ESL
- Site boundary
- Direction of groundwater flow

Notes:

1. All concentrations in micrograms per liter (µg/L).
2. 1,2-DCA = 1,2- Dichloroethane.
3. ESLs = environmental screening levels.
4. ND = non-detect at or above laboratory reporting limits.
5. TBA = t-Butyl alcohol
6. TPHg = Total petroleum hydrocarbons as gasoline.
7. TPHd = Total petroleum hydrocarbons as diesel.
8. Shaded values exceed drinking water ESLs.
9. The drinking water ESLs are as follows: TPHg = 100, TPHd = 100, benzene = 1.0, toluene = 150, ethylbenzene = 300, xylenes = 1800, TBA = 12, 1,2-DCA = 0.5 and naphthalene = 6.1.
10. Drinking water ESLs provided by Table F-3 - Summary of Drinking Water Screening Levels, as established by the San Francisco Regional Water Quality Control Board, December 2013.
11. Groundwater data collected June 2013 through November 2014.
12. 12. Additional groundwater sampling downgradient of MW-16B is proposed to further delineate the boundaries of the benzene isoconcentration contours."

0 60 Feet

Approximate scale

Reference: Base map from a drawing titled "C2.0 Conceptual Grading Plan," by BKF, dated 08/19/14 and "First Floor Plan," by Van Tilburg, Babvard & Soderbergh, AIA, dated 10/03/14.

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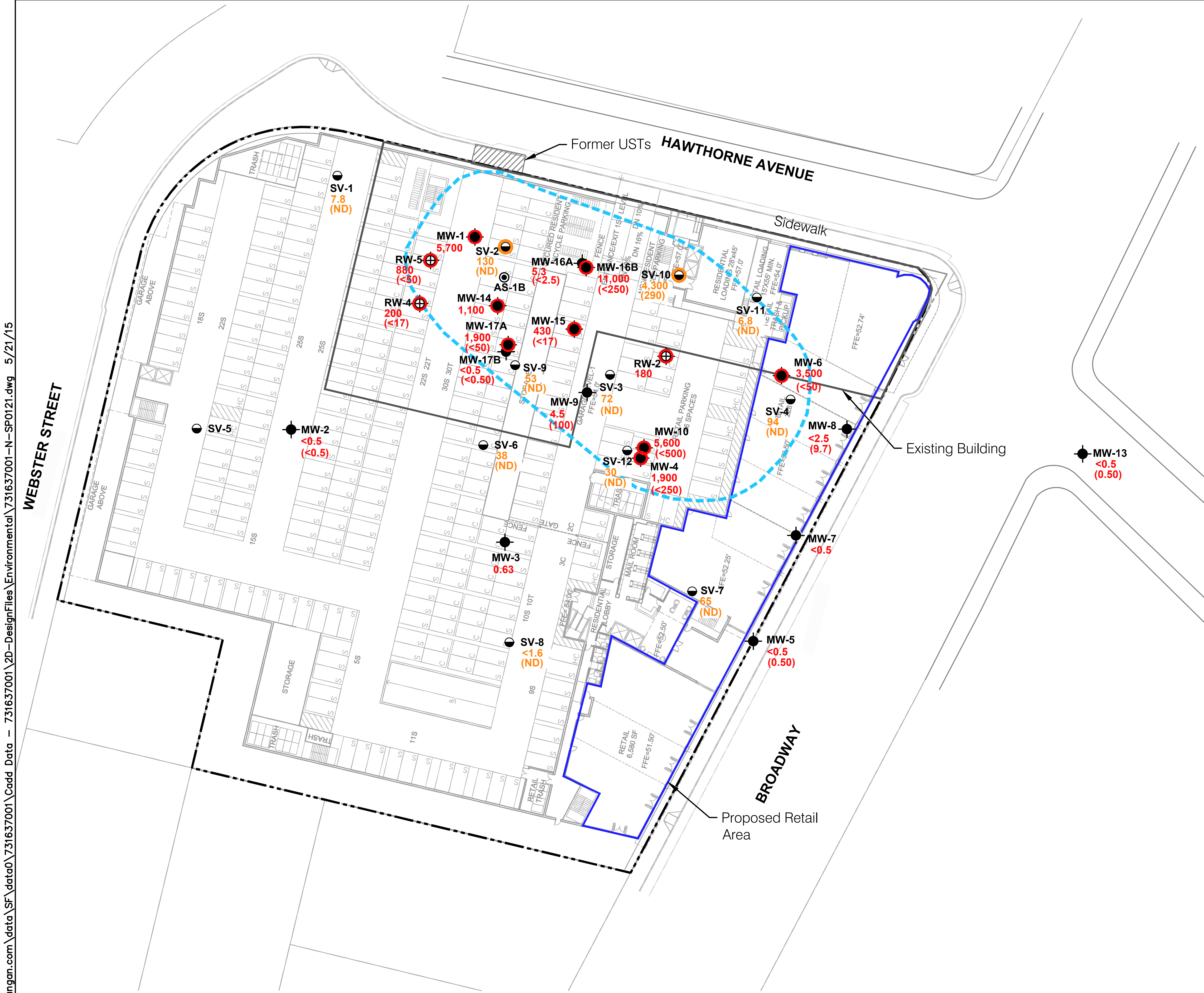
3093 BROADWAY
Oakland, California

FUTURE USE RISK SCREENING: GROUNDWATER

Date 05/01/15	Project No. 731637001	Figure 5

LANGAN TREADWELL ROLLO



Reference: Base map from a drawing titled "C2.0 Conceptual Grading Plan," by BKF, dated 08/19/14 and "First Floor Plan," by Van Tilburg, Babvard & Soderbergh, AIA, dated 10/03/14.

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EXPLANATION

- SV-1 — Soil vapor sample location
- MW-1 — Groundwater monitoring well location
- AS-1B — Air sparge well location
- RW-4 — Groundwater remediation monitoring well location
- <1.0 — Benzene
- (<5.0) — 1,2-DCA
- Detected soil vapor concentration exceeds vapor intrusion screening level
- Detected groundwater concentration exceeds potential vapor intrusion screening level for groundwater
- Approximate targeted treatment area
- Site boundary

Notes:

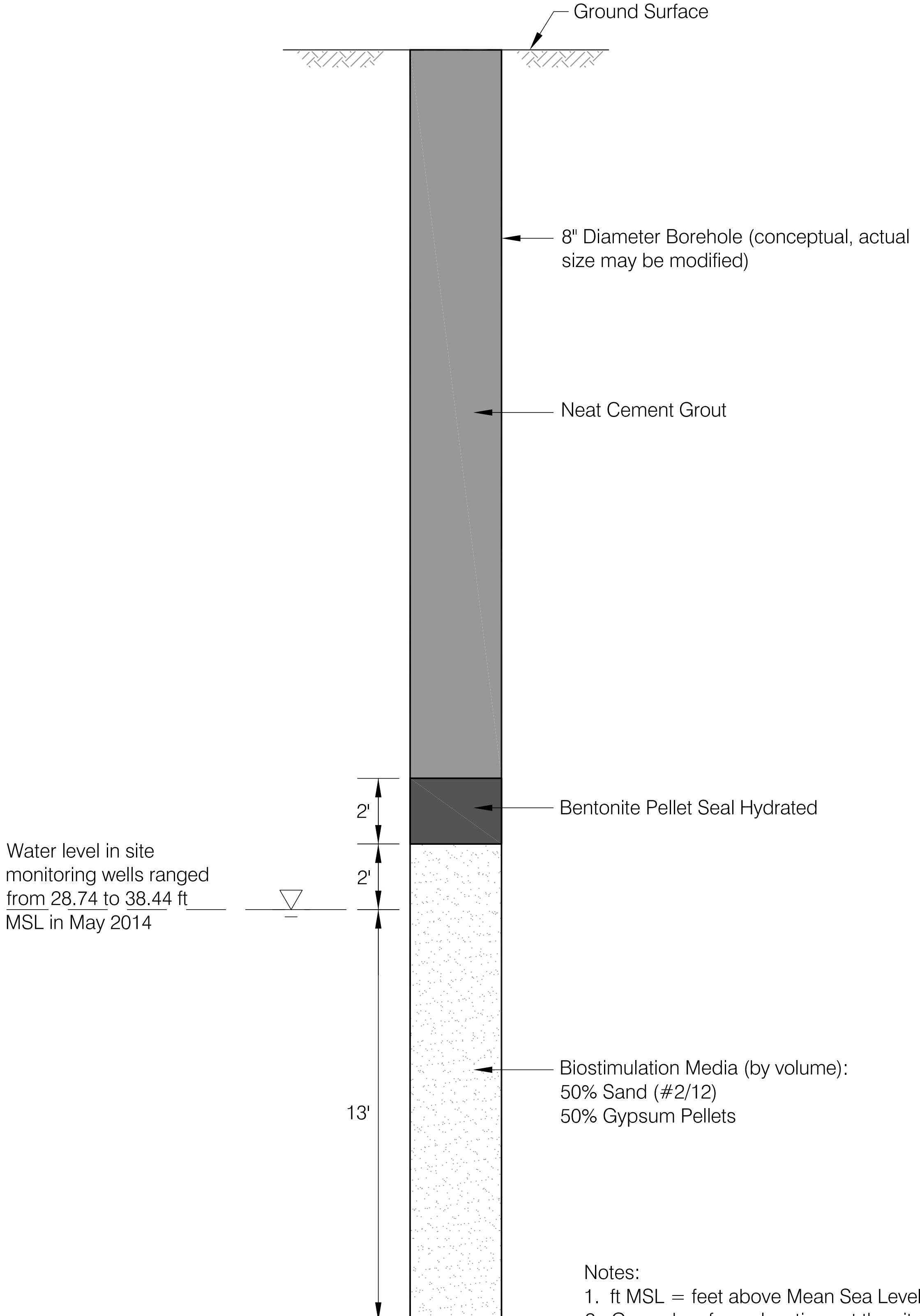
1. Groundwater concentrations in red are in micrograms per liter (μg/L).
2. Soil vapor results in orange are in micrograms per cubic meter (μg/m^3).
3. Groundwater results are from June 2013 or May 2014 or November 2014 sampling events.
4. Soil vapor results are from November 2014 sampling events.
5. Concentrations are in micrograms per cubic meter (μg/m^3).
6. ESLs = environmental screening levels.
7. ND = non-detect at or above laboratory reporting limits.
8. Vapor intrusion screening levels are listed in Tables 3 and 4.
9. Vapor intrusion screening levels are listed in Table 2b for groundwater.

3093 BROADWAY
Oakland, California

FUTURE USE RISK SCREENING EVALUATION OF POTENTIAL VAPOR INTRUSTION

Date 05/01/15	Project No. 731637001	Figure 6

LANGAN TREADWELL ROLLO



NOT TO SCALE

Notes:
1. ft MSL = feet above Mean Sea Level.
2. Ground surface elevations at the site range from 52 to 66 ft MSL.

3093 BROADWAY
Oakland, California

LANGAN TREADWELL ROLLO

REMEDIATION BORING CONSTRUCTION DETAIL

Date 05/01/15 | Project No. 731637001 | Figure 7

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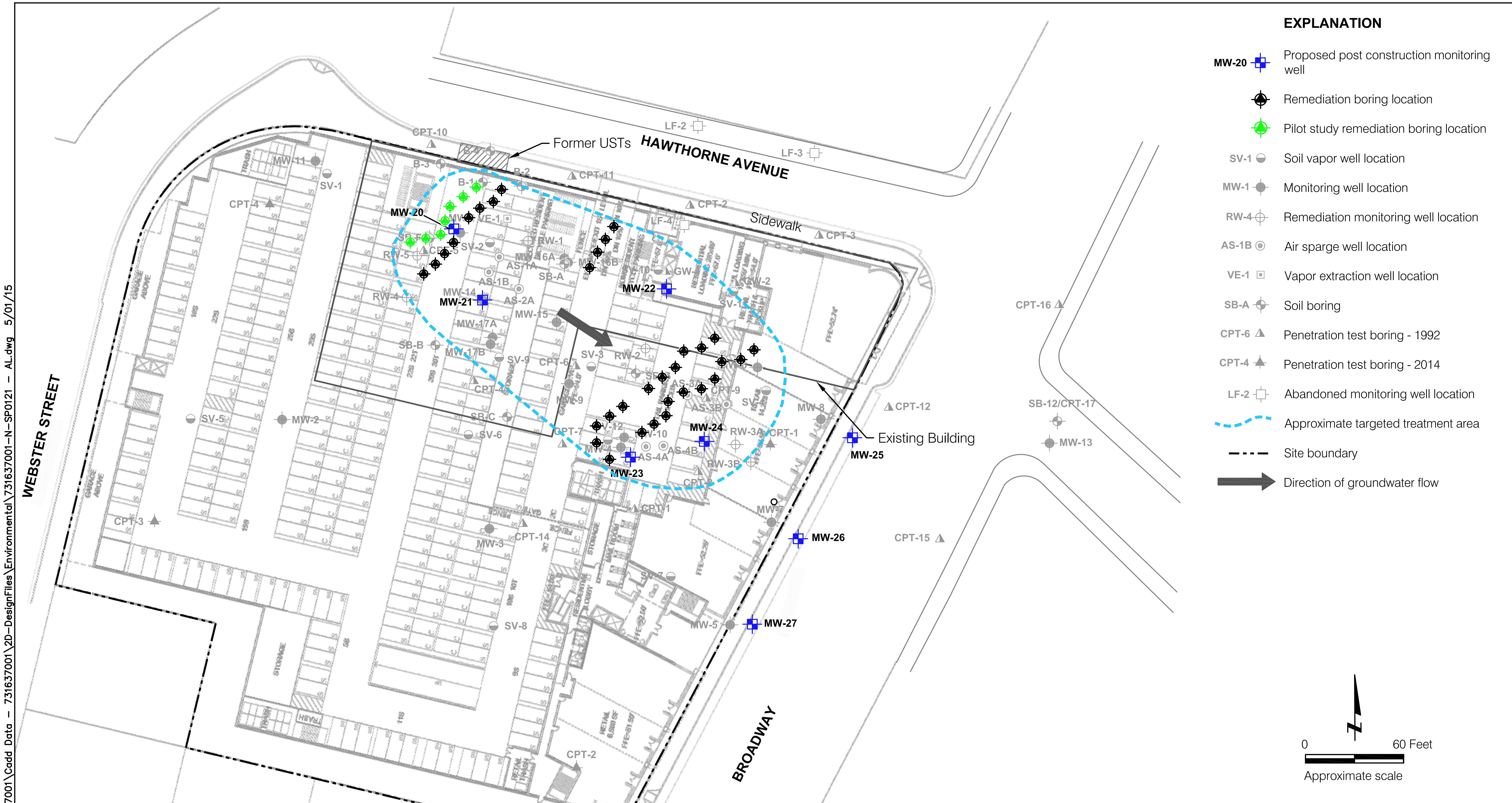

3093 BROADWAY
Oakland, California

PROPOSED REMEDIATION SITE PLAN AND MONITORING WELL NETWORK

Date 05/01/15	Project No. 731637001	Figure 8

LANGAN TREADWELL ROLLO

Reference: Base map from a drawing titled "C2.0 Conceptual Grading Plan," by BKF, dated 08/19/14 and "First Floor Plan," by Van Tilburg, Babvard & Soderbergh, AIA, dated 10/03/14.

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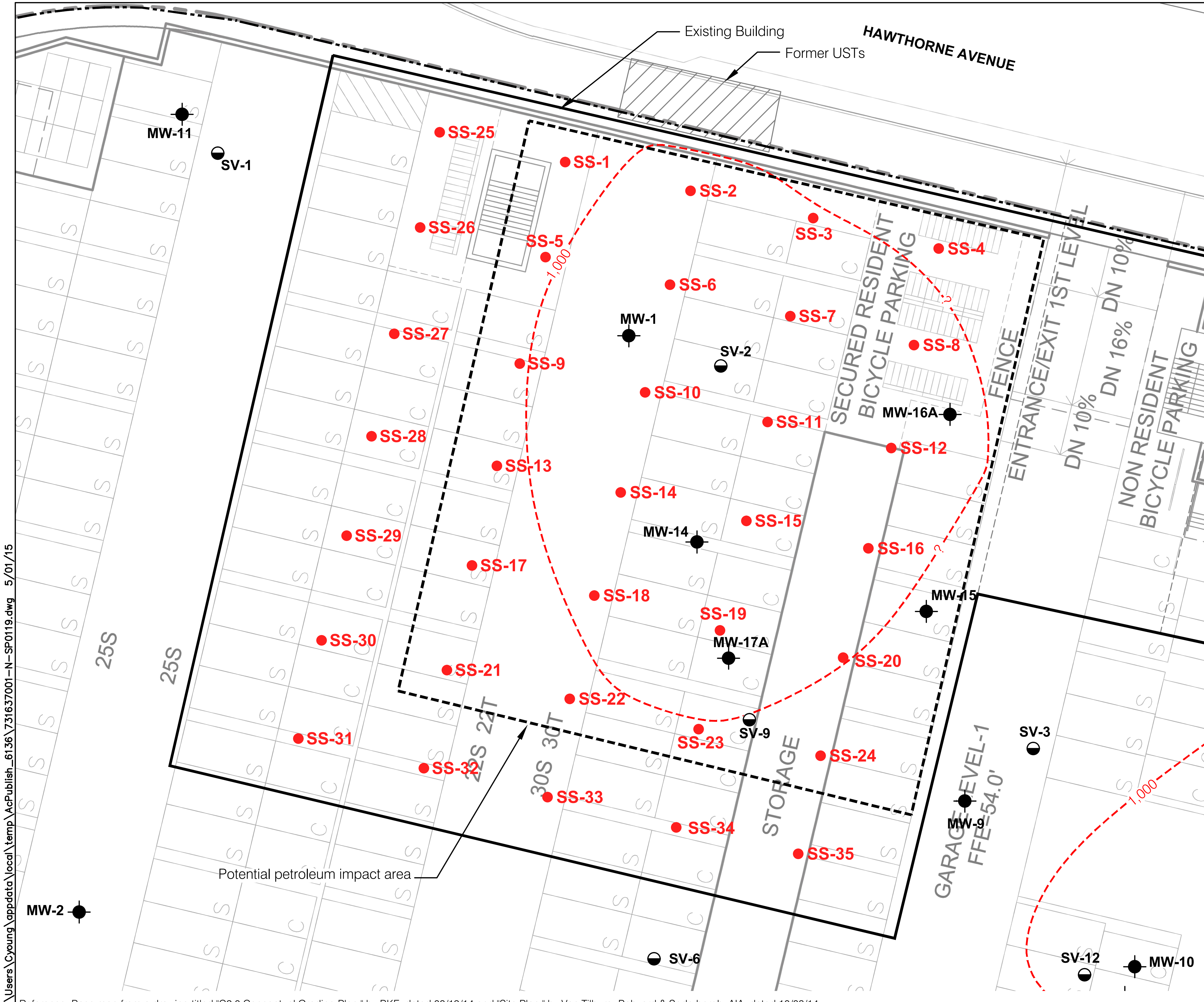

EXPLANATION

SV-1 Soil vapor well location

MW-1 Monitoring well location

Site boundary

1,000 Benzene Isoconcentration in water, queried where uncertain (May 2014)

SS-1 Proposed pre-excavation soil sampling location (625 square foot center)

0 20 Feet

Approximate scale

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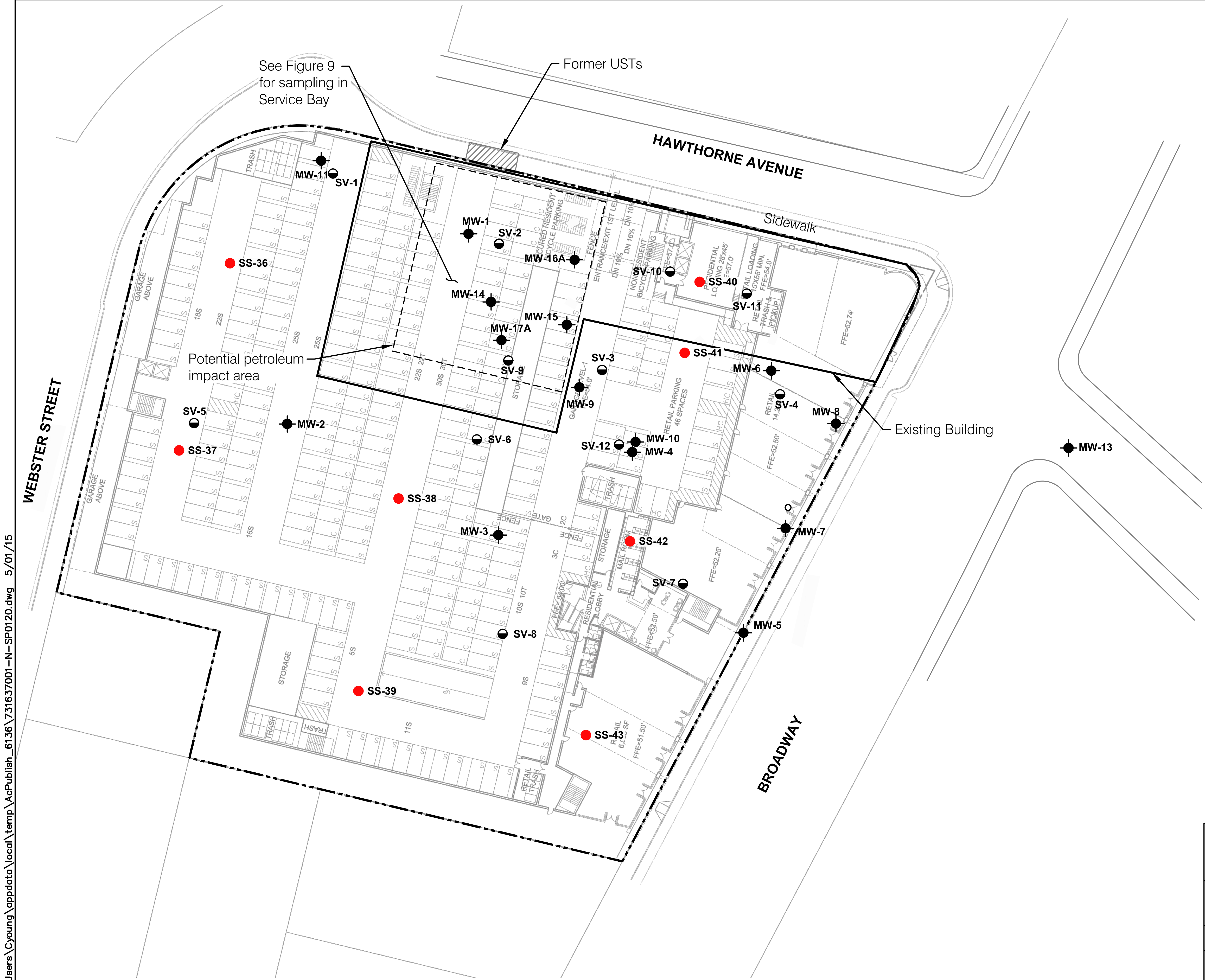
Reference: Base map from a drawing titled "C2.0 Conceptual Grading Plan," by BKF, dated 08/19/14 and "Site Plan," by Van Tilburg, Babvard & Soderbergh, AIA, dated 10/03/14.

3093 BROADWAY
Oakland, California

PROPOSED PRE-EXCAVATION SAMPLING AND CHARACTERIZATION SERVICE BAY AREA

Date 05/01/15	Project No. 731637001	Figure 9

LANGAN TREADWELL ROLLO



EXPLANATION

- SS-36 ● Soil sampling location
- SV-1 Soil vapor well location
- MW-1 Monitoring well location
- Site boundary

Note:
1. Soil sampling frequency of minimum of 1 sample every 1/2 acre in general accordance with DTSC's information advisory for clean imported fill material (2001)
2. Sampling locations and frequency may vary based on field considerations.
3. A 4-point composite soil sample is a composite sample comprised of soil collected from four discrete sample locations.

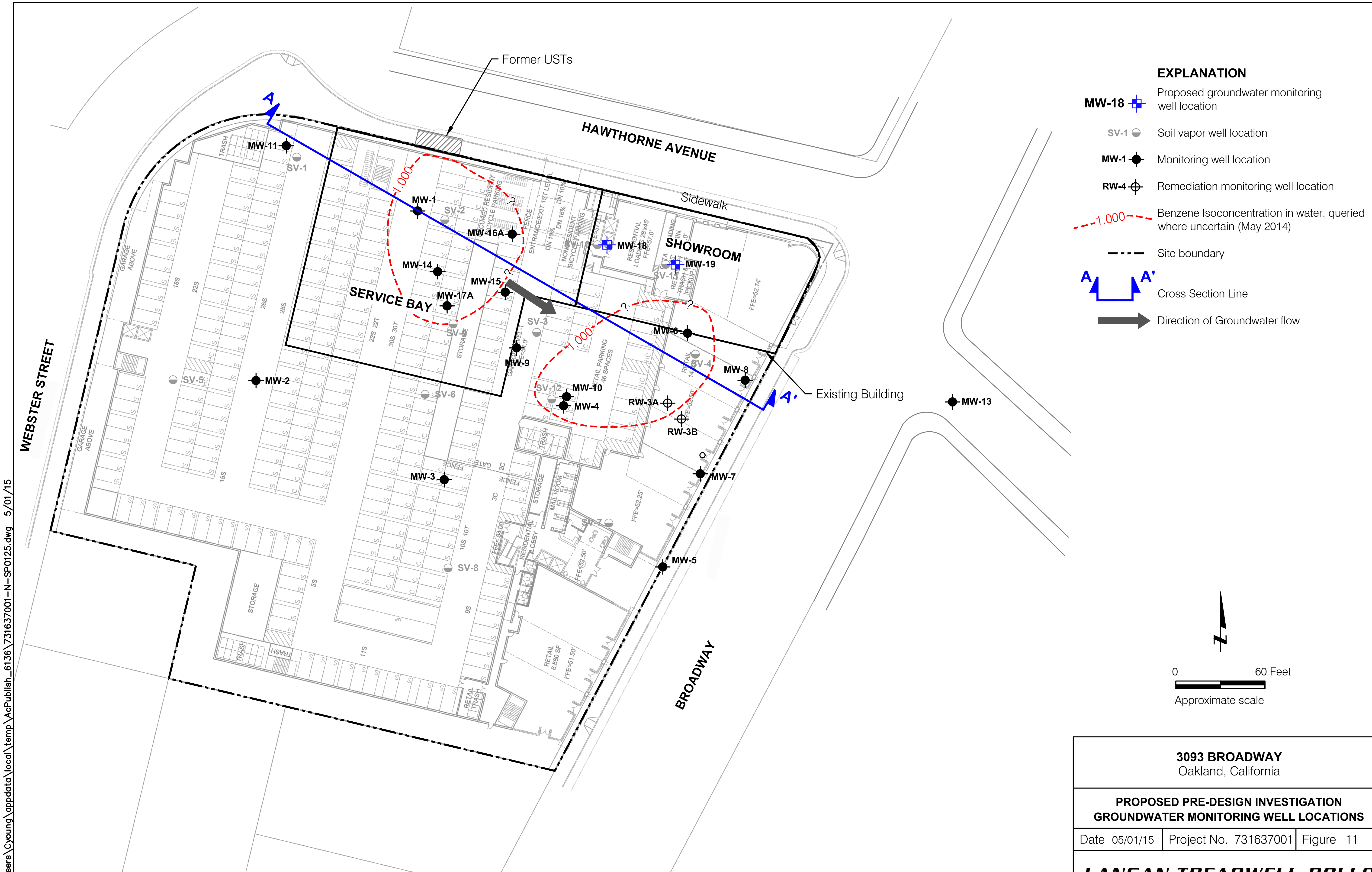
3093 BROADWAY
Oakland, California

PROPOSED PRE-EXCAVATION SAMPLING AND CHARACTERIZATION AREAS OUTSIDE OF SERVICE BAY

Date 05/01/15	Project No. 731637001	Figure 10

LANGAN TREADWELL ROLLO

Reference: Base map from a drawing titled "C2.0 Conceptual Grading Plan," by BKF, dated 08/19/14 and "First Floor Plan," by Van Tilburg, Babvard & Soderbergh, AIA, dated 10/03/14.



3093 BROADWAY
Oakland, California

PROPOSED PRE-DESIGN INVESTIGATION GROUNDWATER MONITORING WELL LOCATIONS

Date 05/01/15	Project No. 731637001	Figure 11

LANGAN TREADWELL ROLLO

Reference: Base map from a drawing titled "C2.0 Conceptual Grading Plan," by BKF, dated 08/19/14 and "First Floor Plan," by Van Tilburg, Babvard & Soderbergh, AIA, dated 10/03/14.

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APPENDIX A

GROUNDWATER SAMPLING AND ENHANCED BIOREMEDIATION PILOT STUDY WORK PLAN

17 April 2015

Ms. Karel Detterman, P.G.
Hazardous Materials Specialist
Alameda County Department of Environmental Health
1131 Harbor Bay Parkway
Alameda, CA 94502

Re: Groundwater Sampling and Enhanced Bioremediation Pilot Study Work Plan
3093 Broadway
Oakland, California
ACEH Case No.: RO0000199
Langan Project No.: 730637001

Dear Ms. Detterman,

On behalf of 3093 Broadway Holdings, L.L.C. ("Broadway Holdings"), Langan Treadwell Rollo (Langan) has prepared this *Enhanced Bioremediation Pilot Study and Groundwater Sampling Work Plan* ("Work Plan") at the Former Connell Oldsmobile site ("site"), located at 3093 Broadway in Oakland, California (Figure 1). This Work Plan has been prepared in conjunction with the Feasibility Study and Corrective Action Plan (FS/CAP), as requested in a 12 December 2014 meeting with the Alameda County Department of Environmental Health (ACEH). The objectives of the groundwater sampling and pilot study are, respectively: 1) to obtain additional design parameters and 2) to demonstrate the implementability of the proposed groundwater corrective action. This Work Plan presents the well installation, groundwater sampling, and pilot test implementation activities.

BACKGROUND

The site is located in a mixed-use area, near commercial, medical, and residential properties. The approximately 3.4-acre site is bounded by Hawthorne Street to the north, Broadway to the east, Webster Street to the west, and a surface parking lot to the south (Figure 2). Site facilities include a vacant, two-story concrete structure that was formerly a car dealership. Currently, the parking areas west and south of the site structure are used to store automobiles for other nearby dealerships.

Three underground storage tanks (USTs) that previously contained gasoline, diesel, and waste oil were removed from beneath the Hawthorne Avenue sidewalk, north of the service bay in December 1989. Soil and groundwater investigations have been ongoing since 1990. The chemicals of concern in groundwater at the site include benzene, toluene, ethylbenzene, and xylenes (BTEX), 1,2-dichloroethane, and naphthalene. Previous investigations concluded that methyl tertiary butyl ether (MTBE) is not present at the site.

We understand the existing buildings will be demolished, with the exception of a portion of the show room in the northeast corner of the Site. A multi-story mixed use building will occupy the entire property. The ground floor will consist of parking and retail space. The upper levels will include residential units. Site excavation for the development is planned to reduce existing grade by approximately 3 to 18 feet; the ground floor will be roughly level with Broadway.

Site Geology and Hydrogeology

The site elevation ranges from approximately 52 to 70 feet above mean sea level. The site slopes downward to the southeast, from Webster Street to Broadway. The site is underlain by unconsolidated sediments ranging from silty clays to sandy gravels. Based on geotechnical drilling conducted by Langan at the site, unconsolidated sediments extend to at least 50 feet below ground surface. The site surficial geology is mapped as the Temescal Formation, which consists of quaternary age alluvial fan deposits comprised of interbedded layers of silt, sand, clay, and gravel (Radbrush, 1957)[1]. Alluvial fan deposits are characterized by laterally discontinuous and heterogeneous layers of irregular thickness. The depth to groundwater (Langan, 2014)[2] beneath the site ranges from approximately 16 to 27 feet. Groundwater beneath the site flows toward the southeast (Langan, 2014)[3] at an estimated seepage velocity ranging from 0.2 to 20 feet per year.

Previous Remedial Actions

A detailed history of environmental investigations and remediation is provided in the FS/CAP. The remedial actions performed at the site are summarized below:

- December 1989: Removal of one 2,000-gallon gasoline tank, one 650-gallon diesel tank, and one 425-gallon waste oil tank beneath the Hawthorne Street sidewalk. Visually contaminated soil in the former UST area was excavated at depth up to 12 feet below grade and the excavation was backfilled with imported fill material.

- 1991 to 2010: Manual removal of separate phase hydrocarbons (SPH) from site monitoring wells.

- October 1996 to March 1998: A soil vapor extraction (SVE) remediation system was used at the site to remove volatilized contaminants from soil and soil vapor. The SVE system removed approximately 1,421 pounds (lbs) of hydrocarbons.

- September 2000: Feasibility testing for dual phase extraction (DPE) was performed.

---

1 Radbrush, Dorothy. 1957, Areal and Engineering Geology of the Oakland West Quadrangle, California.

2 Langan Treadwell Rollo, 2014. Results of May 2014 Groundwater Monitoring – Revised Transmittal, Case # RO0000199, Former Connell Oldsmobile Site, 3093 Broadway, Oakland. 30 October.

3 Langan Treadwell Rollo, Inc., 2014. Conceptual Site Model, 3093 Broadway, Oakland, California. 24 October.

- April 2011 to June 2013: An air sparging and DPE remediation system (AS/DPE) operated at the site to remove hydrocarbons through the extraction of SPH, groundwater, and soil vapor. The AS/DPE system removed approximately 8,882 lbs of gasoline-range Total Petroleum Hydrocarbons (TPHg) and 545 lbs benzene.

The remedial activities performed at the site removed mobile light non-aqueous phase liquid (LNAPL). However, the benzene concentrations in groundwater exceed the closure criteria in the State Water Resource Control Board's (State Board's) Low-Threat Underground Storage Tank Case Closure Policy (LTCP). Additional groundwater remediation has been requested by ACEH to accelerate the timeframe for restoration of groundwater quality.

MONITORING WELL INSTALLATION

Two groundwater wells (MW-18 and MW-19) are proposed to obtain additional soil and groundwater data under the showroom. The proposed monitoring well locations were selected after evaluating existing data; including past and present hydrogeologic conditions and chemical distribution patterns. During the November 2014 sampling activities, groundwater grab samples could not be collected through direct push borings at these locations due to the low-permeability formation. However, the highest soil gas concentration was detected under the showroom at soil vapor point SV-10. Currently, there are no monitoring wells under the showroom and this area was likely outside of the zone of influence of the former remediation system. The installation and sampling of these monitoring wells will provide additional chemical data, remediation parameters, and water level data for the full-scale corrective action design.

Groundwater well MW-18 will be installed in the vicinity of soil vapor point SV-10 and groundwater well MW-19 will be installed approximately 50 feet east-southeast of MW-19, to evaluate the extent of impacts underneath the showroom (Figure 2). A cross-section illustrating the lithology (based on previous borings), and existing and proposed monitoring well locations is presented in Figure 3. The monitoring well locations may be altered in the field due to subsurface utility locations or access issues.

The groundwater monitoring well installation and sampling procedures are described below.

Permitting and Utility Clearance

Prior to installing the groundwater wells, drilling permits will be obtained from the Alameda County Public Works Agency Water Resources Section (ACPWA).

A private utility locator will be subcontracted to confirm the presence/absence of subsurface utilities at the well installation locations. Prior to initiating the fieldwork, Underground Services Alert, a regional subsurface utility notification center, will be notified of the work at least 48 hours before work begins. Work will be performed in accordance with a site-specific health and safety plan.

Boring Advancement and Field Screening

A California-licensed (C-57) drilling contractor will advance the borings for groundwater wells MW-18 and MW-19 to a depth of approximately 30 to 35 feet below ground surface (bgs) within the existing showroom portion of the building. Access into the showroom is restricted by doors that are 7.5 feet wide by 6.5 feet high, so a limited access drill rig equipped with 8-inch diameter hollow-stem augers will be used. The approximately six-inch concrete slab within the showroom will be cored at each location to prepare for drilling. Continuous soil cores will be collected from each location using direct push for logging purposes prior to monitoring well drilling using hollow stem augers.

Field staff, under the direct supervision of a California Professional Geologist, will log the recovered soil cores using the visual-manual procedures of ASTM International Standard D2488 for guidance, which is based on the Unified Soil Classification System. Soil cores will be field screened for organic vapors using a photoionization detector (PID) and examined for visual staining and/or unusual odors.

Soil Sampling and Analysis

As part of the drilling effort, soil samples will be collected for laboratory analysis at a minimum frequency of one sample every 5 feet. If petroleum staining or elevated PID readings are observed, soil sampling will include, at a minimum: (1) one sample above the stained zone, (2) a sample near the top of the stained zone, (3) a sample immediately above the water table, (4) a sample near the bottom of the stained zone, and (5) a sample beneath the stained zone.

Soil samples will be analyzed by a California-certified analytical laboratory for:

- Gasoline-range Total Petroleum Hydrocarbons (TPHg) using U.S. EPA Method 8015B;
- Diesel-range TPH (TPHd) using U.S. EPA Method 8015M with silica gel cleanup; and
- BTEX, MTBE, naphthalene, and 1,2-DCA using U.S. EPA Method 8260B.

Monitoring Well Installation

After soil logging, the drilling contractor will advance a larger borehole using 8-inch hollow stem augers for monitoring well construction. The driller will use 2-inch Schedule 40 polyvinyl chloride (PVC) flush-threaded well casing with up to 10 feet of 0.020-inch factory-slotted screen. The groundwater monitoring wells will be screened from approximately 2 to 3 feet above the water table, to approximately 7 to 8 feet below the water table, which is expected to be approximately 20 to 30 feet below the ground surface within the showroom. Groundwater levels on the far eastern portion of the site have been observed to be on the order of 10 feet lower than the upgradient portion of the site, which will be taken into account in determining the well screen intervals. The annular space for the wells will be filled with #2/16 filter pack sand from total depth to approximately one foot above the top of the screen.

After construction of the well casing and filter pack, the depth to water in the casing will be measured and compared to water level measurements taken during drilling and from nearby site monitoring wells. If the groundwater has not recharged to the well casing, or if water levels have not stabilized, then installation of the well seal will be deferred until later that same day or until the following day. Once the groundwater level in the well casing has stabilized, and the screened interval is confirmed to be across the water table, then the well seal will be installed and the well construction completed.

A one-foot thick hydrated bentonite-chip seal will be placed above the filter pack. A Type I/II Portland cement seal will extend from the top of the bentonite seal to approximately 3 feet bgs in the well boring. To accommodate field conditions, the Professional Geologist may modify the well construction specifications following advancement of the soil boring and interpretation of the boring log. Well installation procedures are detailed in the Langan Treadwell Rollo Well Installation SOP (Appendix A).

The groundwater well will be encased at ground surface with a flush-mounted, traffic-rated well box set in concrete, and the well casing will be sealed with a locking expansion cap. Groundwater well construction records (California Department of Water Resources (DWR) Form 188) will be submitted to the DWR and Alameda County in accordance with the permit requirements. The groundwater well will be constructed in accordance with the California Well Standards (California Department of Water Resources Bulletins 74-81 and 74-90) and ACPWA and City of Oakland requirements.

Monitoring Well Development and Surveying

After allowing the cement well seals to cure for at least 24 hours, the groundwater wells will be developed by a combination of surging and bailing using a stainless steel bailer and pumping with a submersible pump or a peristaltic pump connected to downhole tubing. During pumping, water quality parameters (including temperature, pH, specific electrical conductance, oxidation-reduction potential [ORP], and dissolved oxygen [DO]) will be measured. The groundwater well will be developed until at least 10 casing volumes of water have been removed from the well and water quality parameters have stabilized to within 10 percent of previous readings, or until the well is dry. Field instruments for measuring water level or water quality parameters will be calibrated prior to use and calibration information will be documented. The groundwater well will not be sampled for at least 72 hours after well development. The detailed development procedures for the new monitoring wells are presented in our Monitoring Well Development SOP presented in Appendix A.

Additionally, we propose to remove the remediation-related piping from former remediation wells RW-3A and RW-3B and develop the wells before sampling in the pre-remediation event. Wells RW-3A and RW-3B have not been used for extraction since January 2012 and June 2011, respectively. This well development will be performed at the same time and using the same procedures as the development of the new monitoring wells MW-18 and MW-19.

A State of California registered surveyor will measure the horizontal location and vertical elevation of MW-18 and MW-19 following their installation, in accordance with the State of California's Geotracker (Geotracker) requirements. The survey data for new monitoring wells will be uploaded to the Geotracker system.

Investigation-Derived Waste Management

Investigation derived waste, including drill cuttings, equipment wash water, and well development water will be placed in labeled 55-gallon DOT-approved steel drums, sealed, and temporarily stored on-site pending off-site disposal.

PRE-REMEDIATION GROUNDWATER SAMPLING

A round of pre-remediation groundwater monitoring will be performed prior to implementing the selected groundwater remedy and performing the pilot test. The proposed groundwater corrective action is presented in the subsequent sections of this Work Plan. The objective of the pre-remediation sampling is to collect data describing groundwater conditions before initiating enhanced bioremediation of dissolved petroleum compounds. As presented in Table 6 of the Additional Investigation Results Letter dated 5 December 2014, semivolatile organic compounds (SVOCs) in groundwater were analyzed in monitoring wells from 1995 to 2002. Naphthalene and 2-methylnaphalene were detected at monitoring wells MW-1, MW-4, MW-14 and MW-15. Because the 2-methylnaphathalene and naphthalene results are co-located, and naphthalene is present at higher concentrations, the naphthalene results will be used to delineate the treatment area. The groundwater sampling analysis plan summarizing the monitoring wells to be sampled, sample parameters, and analytical methods, is presented in Table 1. Figure 2 shows the locations of the monitoring wells prior to site construction activities.

Sampling will be performed using U.S. EPA low-flow sampling procedures. Using a flow-through cell, during low-flow pumping, water quality parameters (including temperature, pH, specific electrical conductance, ORP, and DO) will be measured.

At least 72 hours following MW-18 and MW-19 well installation and development, groundwater samples will be collected and analyzed for BTEX, MTBE, TPHg, TPHd, 1,2-DCA, and naphthalene. The following wells will be sampled:

- Existing wells within the upper groundwater plume: MW-1 and MW-14;
- Existing wells within the lower groundwater plume: MW-4, MW-6, RW-3A, and RW-3B;
- An existing well located cross-gradient to the plume: MW-3;
- Existing downgradient delineation wells: MW-5, MW-7, and MW-8;And proposed wells at the showroom: MW-18 and MW-19.

Proposed replacement downgradient wells MW-25, MW-26 and MW-27 will also be sampled and added to the monitoring program. This selection of wells is likely to be sufficient to monitor the remediation progress, because it provides lateral coverage of the treatment area and includes the most highly impacted wells. Wells MW-1, MW-4, MW-14, MW-18, and RW-3A will be replaced after construction grading for ongoing remediation progress monitoring. Well MW-6 will not be replaced, because it will be located within the retail portion of the proposed development. It is unlikely that cross-gradient well MW-3 and downgradient well MW-19 would need to be replaced. This assumption will be confirmed following the pre-remediation monitoring event.

In addition to analysis of petroleum-related compounds, selected wells will also be analyzed for additional compounds for remedial design. These wells represent the different portions of the groundwater plume, and also include one cross-gradient and one downgradient location for comparison as background. Groundwater from monitoring wells MW-1, MW-3, MW-6, MW-8, and MW-18 will be analyzed for:

- Electron acceptors (nitrate, nitrite, total manganese, total iron, ferrous iron, sulfate, sulfite, sulfide, and dissolved methane),

- Nutrients (total nitrogen and total phosphorus),

- Water quality parameters (total organic carbon, total dissolved solids, and alkalinity), and

- Sulfate-reducing bacteria populations.

Additionally, groundwater samples from MW-1, MW-6, and MW-18 will be analyzed for California Title 22 (CAM17) metals to evaluate the potential for metal sulfides precipitation in the treatment area. Groundwater samples for metals analyses will be field-filtered using 0.45-micron filters to remove sediment and turbidity.

PROPOSED GROUNDWATER CORRECTIVE ACTION

An overview of the proposed full-scale groundwater corrective action is presented in this section to provide a context for the pilot test implementation activities. A detailed discussion of the proposed full-scale groundwater correction action alternatives and design is presented in the FS/CAP.

The biological degradation of petroleum hydrocarbons in site groundwater is limited by the availability of electron acceptors such as oxygen, nitrate, and sulfate. Bioremediation can be accelerated by introducing an electron acceptor into the subsurface. To minimize the need for periodic replenishment of electron donor, emplacement of calcium sulfate (i.e., gypsum) is proposed as a slow-release source of sulfate. The gypsum will dissolve over several years. Gypsum is commonly used as construction wallboard, plaster, and is a fertilizer and soil additive. The solubility of gypsum is approximately 2 to 2.5 g/L, which corresponds to a maximum sulfate concentration of approximately 1.1 to 1.4 g/L in groundwater. These levels of sulfate in groundwater would be effective in stimulating natural populations of sulfate-reducing bacteria (SRB). The microbially-mediated sulfate reduction coupled with petroleum hydrocarbons (represented by octane) oxidation is represented by the following reaction:

$$C_8H_{18} + 6.25\,SO_4^{2-} \rightarrow 8\,CO_2 + 9\,H_2O + 6.25\,S^{2-},$$

where sulfate is reduced to sulfide and the hydrocarbons are oxidized to carbon dioxide and water.

The strategy is to emplace gypsum in the upgradient (northwestern) portions of the two major benzene-impacted areas and allow the dissolved sulfate to flow downgradient with the natural groundwater gradient. Gypsum will be introduced into the subsurface by drilling boreholes into the saturated zone and backfilling with a mixture of gypsum pellets and sand. As shown on Figure 4, the full-scale scope will include approximately 40 borings installed in rows perpendicular to the direction of groundwater flow. The number and placement of borings are subject to change based on the geotechnical foundation design plans, drilling rig accessibility in the existing buildings, and field conditions encountered. The remediation boring locations located near SV-10 may be changed or removed based on the pre-design investigation groundwater data.

The majority of the borings will be placed in two offset rows of barriers spanning the width of the 1,000 µg/L benzene plume. Within each row, the borings will be drilled with an on center spacing of 10 feet. The second row will be located approximately 20 feet downgradient of the first row, so the groundwater travel time is approximately one year between the two rows based on the upper range of the estimated groundwater seepage velocity of 20 feet per year.

The pilot study described in this report includes installing seven of the remediation boring locations in an earlier mobilization to anticipate challenges and refine procedures prior to full-scale implementation.

PILOT TEST IMPLEMENTATION

A pilot study is planned prior to full-scale implementation to evaluate and refine the process of drilling and installing the gypsum borings inside the existing building. Specifically, the objectives of the pilot test include establishing the boring installation workflow within the service bay, including concrete coring, drilling, and mixing and emplacement of biostimulation media. The lessons learned from the pilot test will be used to plan and scale up the full-scale remediation scope.

The scope of the pilot study will include installation of seven borings in a row south of the location of the former USTs, as shown on Figure 4. These borings are located in the far upgradient portion of the contaminant plume and is within the former source area, near the USTs and potential UST piping. These boring locations were selected for the pilot test to provide the most remedial benefit and to anticipate the worst-case challenges of working inside buildings, such as clearance issues or potential presence of underground utilities or structures.

Permitting and Utility Clearance

Prior to installing the remediation borings, drilling permits will be obtained from the Alameda County Public Works Agency Water Resources Section (ACPWA).

A private utility locator will be subcontracted to confirm the presence/absence of subsurface utilities at the well installation locations. Prior to initiating the fieldwork, Underground Services Alert, a regional subsurface utility notification center, will be notified of the work at least 48 hours before work begins. Work will be performed in accordance with the site-specific health and safety plan.

Remediation Boring Drilling

The remediation borings will be installed by advancing 8-inch hollow stem augers to 15 feet below the seasonally high water table, or approximately 25 feet MSL for the majority of the treatment area (Figure 5). As presented in the FS/CAP, the May 2014 water levels are approximately 1.5 feet higher than the historical average for the monitoring period and historical levels have ranged from approximately two feet higher to six feet lower than the May 2014 levels. Therefore, the gypsum will be placed at depths approximately 13 feet below to 2 feet above the observed water level to fully target the smear zone. In the eastern portion of the site, near MW-6, the borings may be up to 10 feet deeper due to lower observed water levels. Prior to drilling, the water levels at nearby wells will be gauged to verify that the gypsum will be emplaced within the saturated zone.

Drilling will be performed by a California-licensed driller. The pilot study will be performed prior to building demolition. Therefore, the drilling will be performed inside the service bay concrete coring will be required through the approximately 6-inch thick concrete slab. Each concrete core will be 10- to 12-inches in diameter to allow for sufficient spacing for the 8-inch augers. Waste generated during drilling will be placed into 55-gallon drums, chemically tested, and disposed of properly.

Mixing and Emplacement

As shown on the remediation boring detail on Figure 5, the bottom 15 feet of the boring will be filled with a mixture of 50% #2/12 sand and 50% gypsum pellets by volume. The higher permeability of the sand and gypsum mix will allow for more groundwater flow through the biostimulation media and will reduce the impacts of potential clogging from metal sulfides precipitation. Two feet of hydrated bentonite will be placed above the biostimulation media and the borehole will be finished with neat cement grout.

The sand and gypsum will be mixed above-ground in a mixing tank or hopper until the materials are evenly mixed. Each borehole will require approximately 600 pounds of gypsum and 1,000 pounds of sand. The total amount of gypsum and sand for all seven borings are approximately 4,200 pounds and 7,000 pounds, respectively.

After the borehole is drilled to the design depth, the sand-gypsum mixture will be poured into the borehole through the hollow-stem auger as the augers are slowly lifted out of the borehole. This will avoid the collapse of the borehole prior to material emplacement. Care will be taken to check that the mixture is not getting stuck, or bridging, within the augers. The amount of materials used for each borehole will be estimated and recorded in field implementation logs.

Field Modifications

Field modifications may be required due to unforeseen circumstances. If an obstruction is encountered, the boring will be sealed with neat cement grout and reinstalled at an adjacent location that is southeast (downgradient) of the intended location.

REPORTING

A technical memorandum will be prepared to document the findings from the monitoring well installation, pre-remediation groundwater sampling, and pilot test implementation activities, and to finalize the full-scale remediation plan based on the data collected. Specifically, the memorandum will:

- Summarize the lithologic and groundwater level observations, and if necessary, update the hydrogeologic description of the site to incorporate the boring logs and water levels from the new wells;
- Summarize the analytical results and visual observations of residual LNAPL, and if necessary, update the remediation treatment area;
- Revise the design or calculations based on the groundwater remedial design parameters, if needed;
- Develop drilling and remediation boring installation procedures based on the pilot study implementation; and
- Finalize the full-scale remediation boring locations based on the updated treatment area and the foundation plans for the proposed development.

ANTICIPATED SCHEDULE

Well installation is currently planned for late May 2015, with pre-remediation sampling and the pilot study to be performed in June 2015. The anticipated implementation schedule is presented in the FS/CAP.

If you have any questions, please do not hesitate to call us at 415-955-5200.

Sincerely yours,
Langan Treadwell Rollo

Christopher Glenn, PE, LEED GA
Senior Project Manager

Robert W. Schultz, CHG
Senior Project Manager

cc: Mr. Tony Cardoza and Mr. Stephen Siri, 3093 Broadway Holdings, L.L.C.
555 California Street, 10th Floor
San Francisco, CA 94104

Enclosures
Table 1 – Groundwater Sampling Analytical Summary
Figure 1 – Site Location Map
Figure 2 – Site Plan and Proposed Monitoring Well Locations
Figure 3 – Geologic Cross Section A-A'
Figure 4 – Proposed Remediation and Monitoring Well Network
Figure 5 – Remediation Boring Construction Detail
Appendix A – Well Installation and Development Standard Operating Procedures

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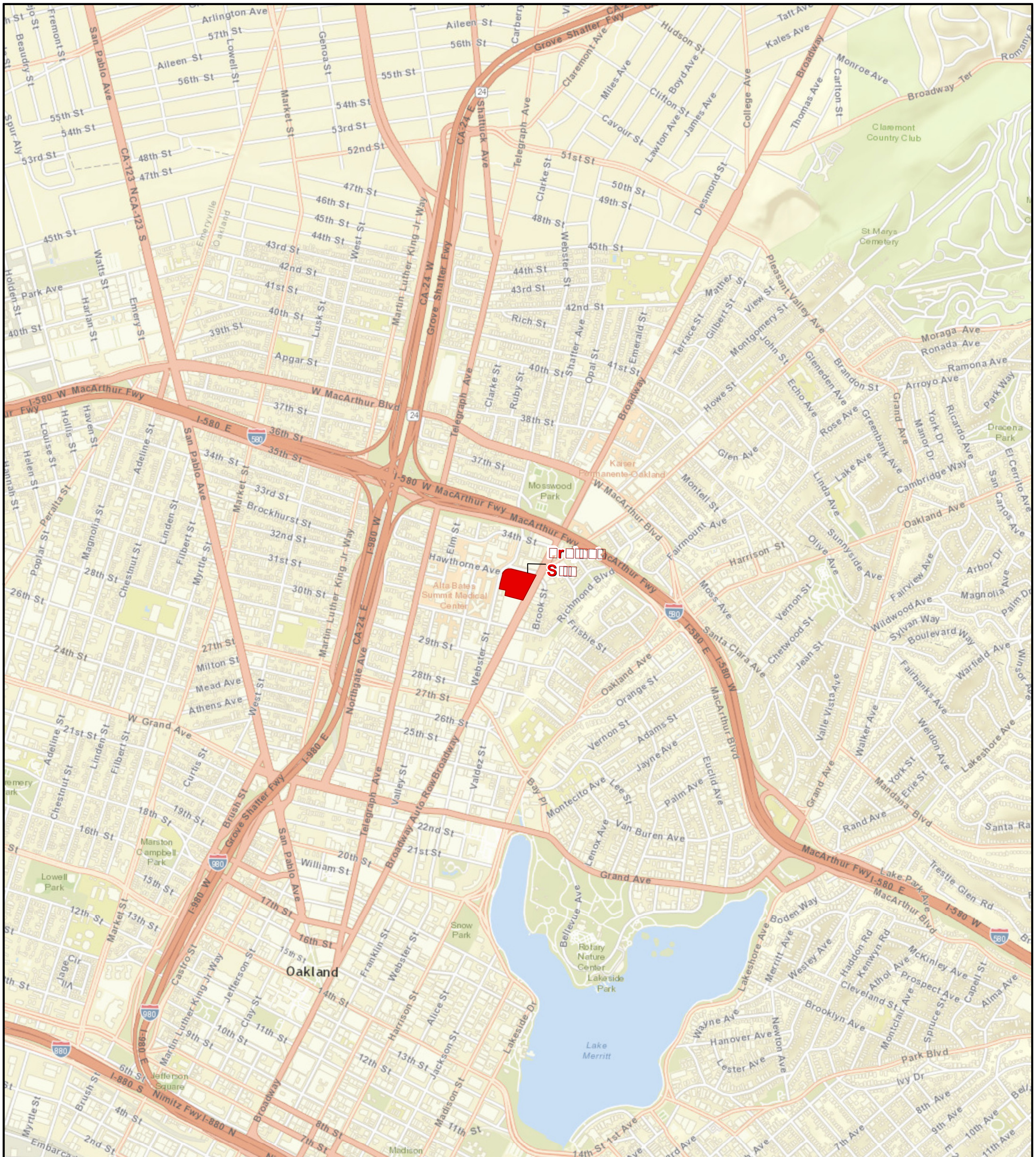
TABLE

Table 1
Proposed Groundwater Sampling and Analysis Schedule
3093 Broadway
Oakland, California

						Contaminants				Electron Acceptors/Reduced Electron Acceptors					Nutrients		Metals	Water Quality Parameters			Microbial
Sampling Location	Location	TOC Elevation	Casing Diameter	Screened Interval	Depth to Groundwater (May 2014)	BTEX/ MTBE	TPH-Gasoline and Diesel	1,2-DCA	Naphthalene	Nitrate/ Nitrite	Total Manganese	Total Iron/ Ferrous Iron	Sulfate/ Sulfite/ Sulfide	Dissolved Methane	Total Nitrogen	Total Phosphorus	CAM17 Metals	Total Organic Carbon (TOC)	Total Dissolved Solids (TDS)	Alkalinity	Sulfate Reducing Bacteria
Analytical Methods						8260B	8015B	8260B	8260B	E300.1	E200.8	E200.8 SM 3500Fe	E300.1	RSK175	SM4500-N	SM4500-P	E200.8	E415.3	SM2540C	SM2320B	CENSUS APS
		feet a-msl	inches	feet bgs	feet bgs	μg/L	μg/L	μg/L	μg/L	mg/L	μg/L	μg/L	mg/L	μg/L	mg/L	mg/L	μg/L	mg/L	mg/L	mg/L $CaCO_3$	cells/mL
Pre-Construction Sampling - once at pre-remediation event (2015)																					
MW-1	In plume	60.57	2	19 to 35	22.13	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW-3	Cross-gradient	56.87	2	20 to 35	19.51	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
MW-4	In plume	55.67	2	15 to 30	18.15	X	X	X	X				X								
MW-5	Downgradient	51.7	2	15 to 35	25.97	X	X	X	X				X								
MW-6	In plume	51.65	2	15 to 35	22.93	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW-7	Downgradient	52.25	2	13.5 to 33.5	16.99	X	X	X	X				X								
MW-8	Downgradient	52.30	6	19.5 to 40	26.14	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X
MW-14	In plume	61.5[b]	--	10 to 40	--	X	X	X	X				X								
MW-18	Assumed in plume	52[a]	2	20 to 30[a]	--	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MW-19	Downgradient	52[a]	2	20 to 30[a]	--	X	X	X	X				X								
RW-3A	In plume	54[b]	4	16 to 26	--	X	X	X	X				X								
RW-3B	In plume	54[b]	4	32 to 37	--	X	X	X	X				X								
MW-25	Downgradient	52[a]	2	20 to 30[a]	--	X	X	X	X				X								
MW-26	Downgradient	52[a]	2	13 to 23[a]	--	X	X	X	X				X								
MW-27	Downgradient	52[a]	2	15 to 25[a]	--	X	X	X	X				X								
Post-Development Sampling - quarterly for one year (estimated 2017)																					
MW-20	In plume	52[a]	2	10 to 20[a]	--	X	X	X	X				X								
MW-21	In plume	52[a]	2	10 to 20[a]	--	X	X	X	X				X								
MW-22	In plume	52[a]	2	20 to 30[a]	--	X	X	X	X				X								
MW-23	In plume	52[a]	2	10 to 20[a]	--	X	X	X	X				X								
MW-24	In plume	52[a]	2	15 to 25[a]	--	X	X	X	X				X								
MW-25	Downgradient	52[a]	2	20 to 30[a]	--	X	X	X	X				X								
MW-26	Downgradient	52[a]	2	13 to 23[a]	--	X	X	X	X				X								
MW-27	Downgradient	52[a]	2	15 to 25[a]	--	X	X	X	X				X								

Notes:
a. Estimated value for proposed well, screened interval selected be 10 feet long and intersecting the top of the water table.
b. Estimated value based on topographic contour
a-msl = above mean sea level
bgs = below ground surface
BTEX/MTBE = benzene, toluene, ethylbenzene, xylenes, methyl tertiary butyl ether
TPH = total petroleum hydrocarbons
μg/L = micrograms per liter
-- not applicable
Wells are to be sampled using low-flow sampling methodology and field parameters will be collected: including turbidity, pH, dissolved oxygen, oxidation-reduction potential, specific conductivity and temperature.
Additional parameters may be added to the post-development sampling as needed based on remediation progress.

FIGURES



Notes:

1. World street basemap is provided through Langan's Esri ArcGIS software licensing and ArcGIS online. Credits: Sources: Esri, DeLorme, NAVTEQ, USGS, Intermap, iPC, NRCAN.
2. Map displayed in California State Plane Coordinate System, Zone III, North American Datum of 1983 (NAD83), US Survey Feet.

0 1,000 2,000 4,000

Feet

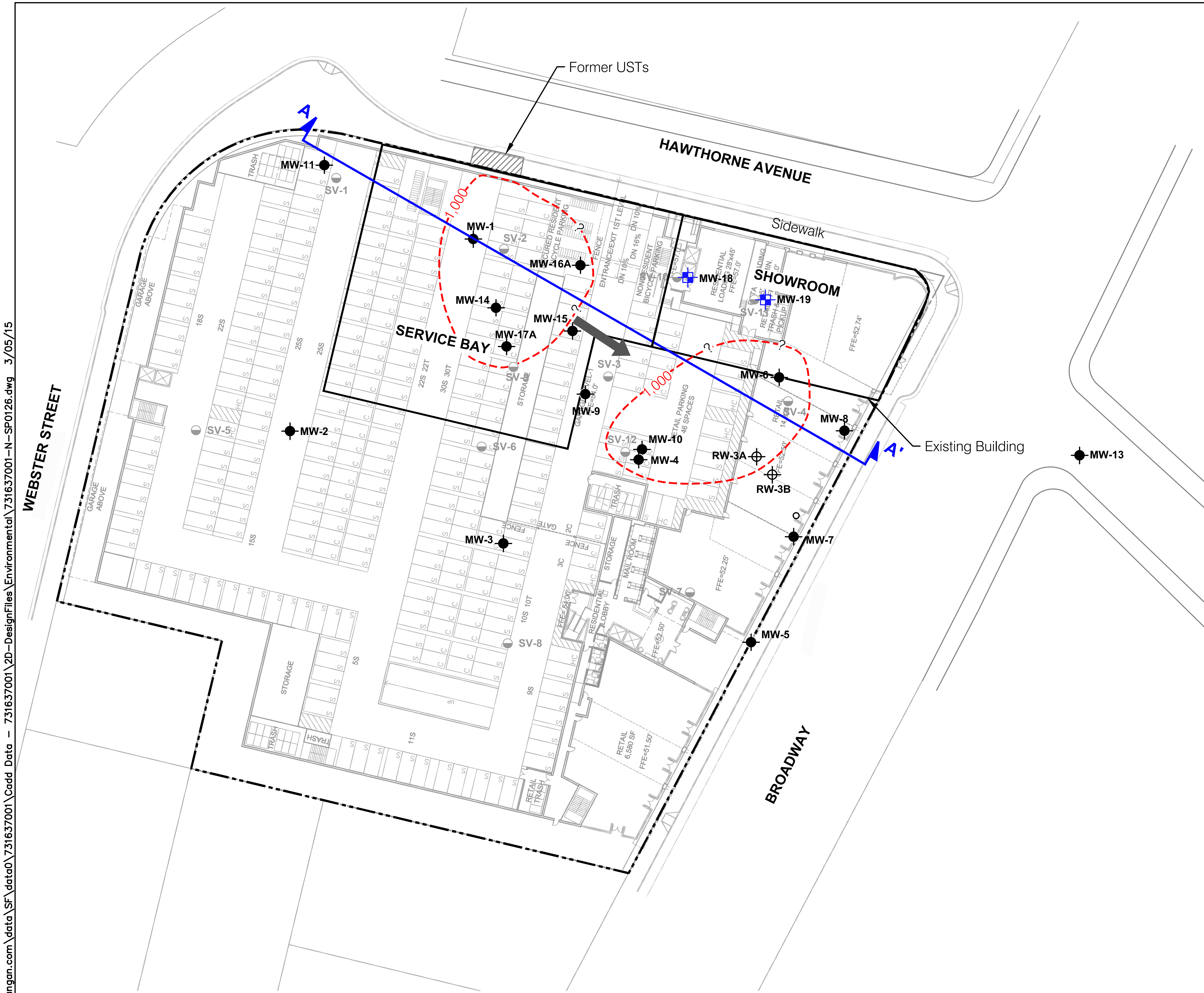
N

3093 BROADWAY
Oakland, California

LANGAN TREADWELL ROLLO

SITE LOCATION MAP

Date 3/4/2015	Project 7316317001	Figure 1



EXPLANATION

MW-18 — Proposed groundwater monitoring well location

SV-1 — Soil vapor well location

MW-1 — Monitoring well location

RW-4 — Remediation monitoring well location

1,000 — Benzene Isoconcentration in water, queried where uncertain (May 2014)

Site boundary

A — A' Cross Section Line

Direction of Groundwater flow

3093 BROADWAY
Oakland, California

SITE PLAN AND PROPOSED PRE-REMEDIATION GROUNDWATER MONITORING WELL LOCATIONS

Date 02/13/15	Project No. 731637001	Figure 2

LANGAN TREADWELL ROLLO

Reference: Base map from a drawing titled "C2.0 Conceptual Grading Plan," by BKF, dated 08/19/14 and "First Floor Plan," by Van Tilburg, Babvard & Soderbergh, AIA, dated 10/03/14.

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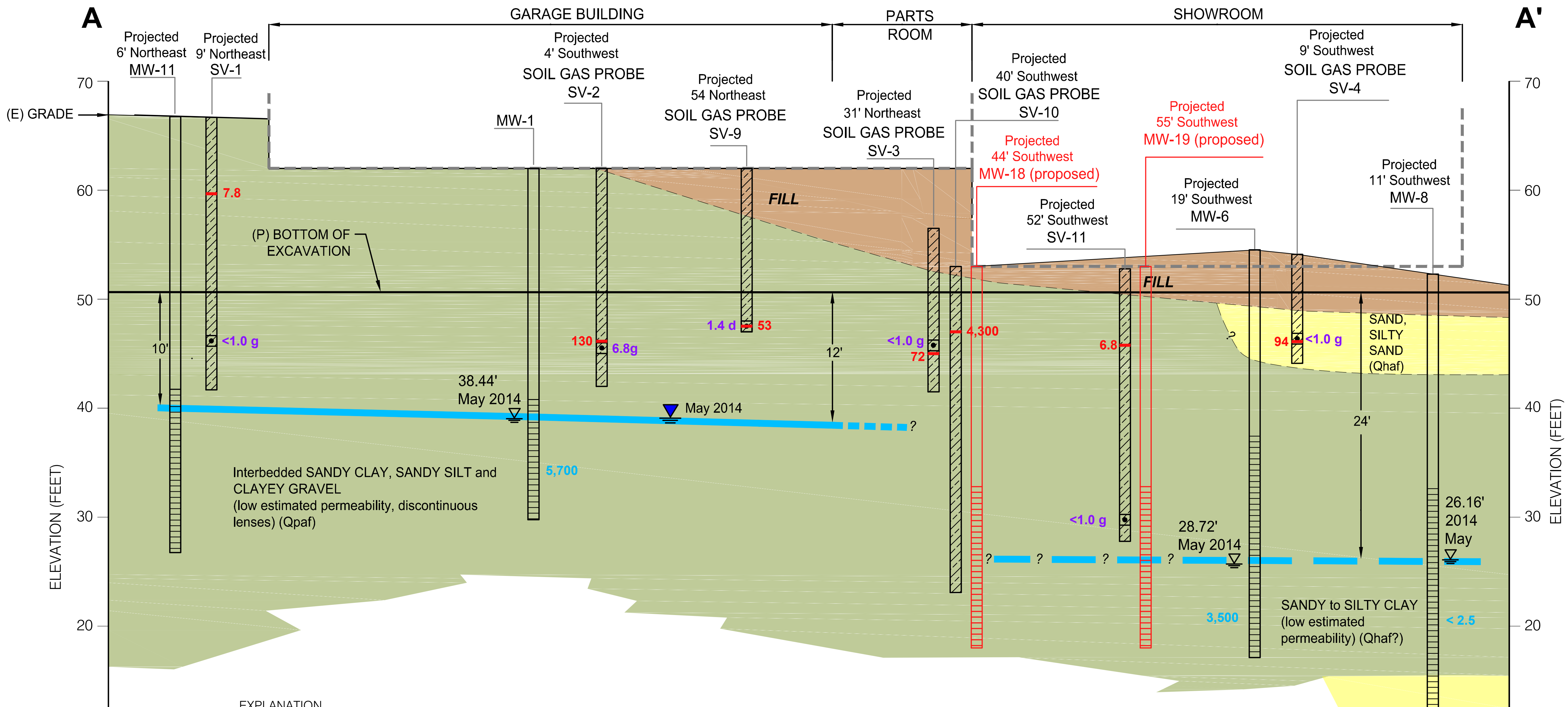
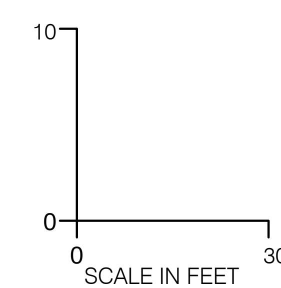


EXPLANATION

⊡	Soil sample location
(red line)	Soil gas sample location
(blue line)	Approximate groundwater elevation estimated from 2014 Groundwater Elevation Contour Map
7.8	Benzene concentration in soil gas in micrograms per cubic meter (µg/m³), November 2014
5,700	Benzene concentration in groundwater in micrograms per liter (µg/L), May and November 2014
<1.0	Total Petroleum Hydrocarbon concentration as diesel (d) or gasoline (g) (highest concentration value denoted) in soil in milligrams per kilogram (mg/kg), November 2014
(Qhaf)	Alluvial fan and fluvial deposits (Holocene)
(Qpaf)	Alluvial fan and fluvial deposits (Pleistocene)

Note:

1. The interpretation of geologic units in this figure is based on Figure 6 of the 24 October 2014 Conceptual Site Model, perpared by Lagan.



3093 BROADWAY
Oakland, California

GEOLOGIC CROSS SECTION A-A'

Date 02/19/15 | Project No. 731637001 | Figure 3

LANGAN TREADWELL ROLLO

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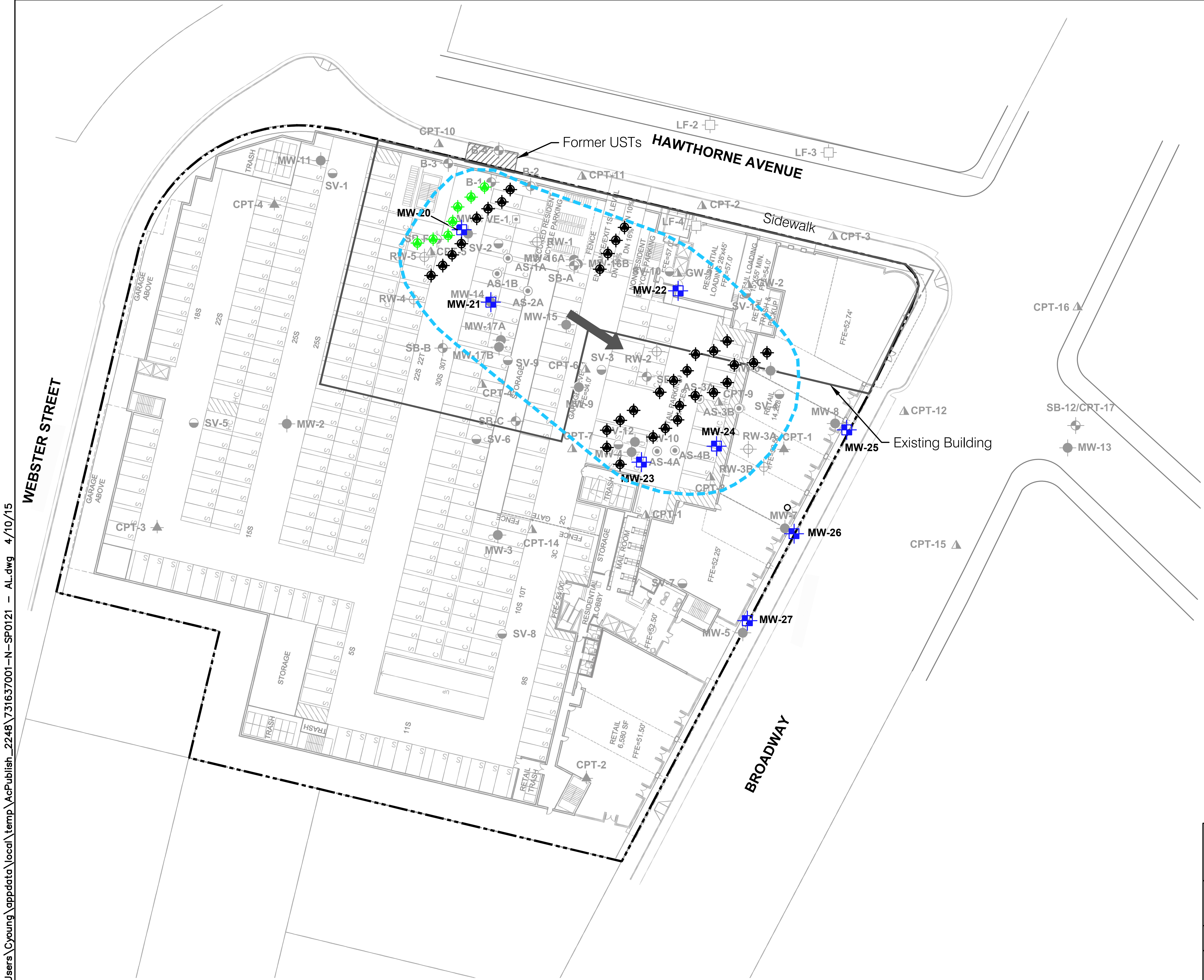

EXPLANATION

- MW-20 — Proposed post construction monitoring well
- Remediation boring location
- Pilot study remediation boring location
- SV-1 — Soil vapor well location
- MW-1 — Monitoring well location
- RW-4 — Remediation monitoring well location
- AS-1B — Air sparge well location
- VE-1 — Vapor extraction well location
- SB-A — Soil boring
- CPT-6 — Penetration test boring - 1992
- CPT-4 — Penetration test boring - 2014
- LF-2 — Abandoned monitoring well location
- Approximate targeted treatment area
- Site boundary
- Direction of groundwater flow

0 60 Feet

Approximate scale

3093 BROADWAY
Oakland, California

PROPOSED REMEDIATION SITE PLAN AND MONITORING WELL NETWORK

Date 02/13/15	Project No. 731637001	Figure 4

LANGAN TREADWELL ROLLO

Reference: Base map from a drawing titled "C2.0 Conceptual Grading Plan," by BKF, dated 08/19/14 and "First Floor Plan," by Van Tilburg, Babvard & Soderbergh, AIA, dated 10/03/14.

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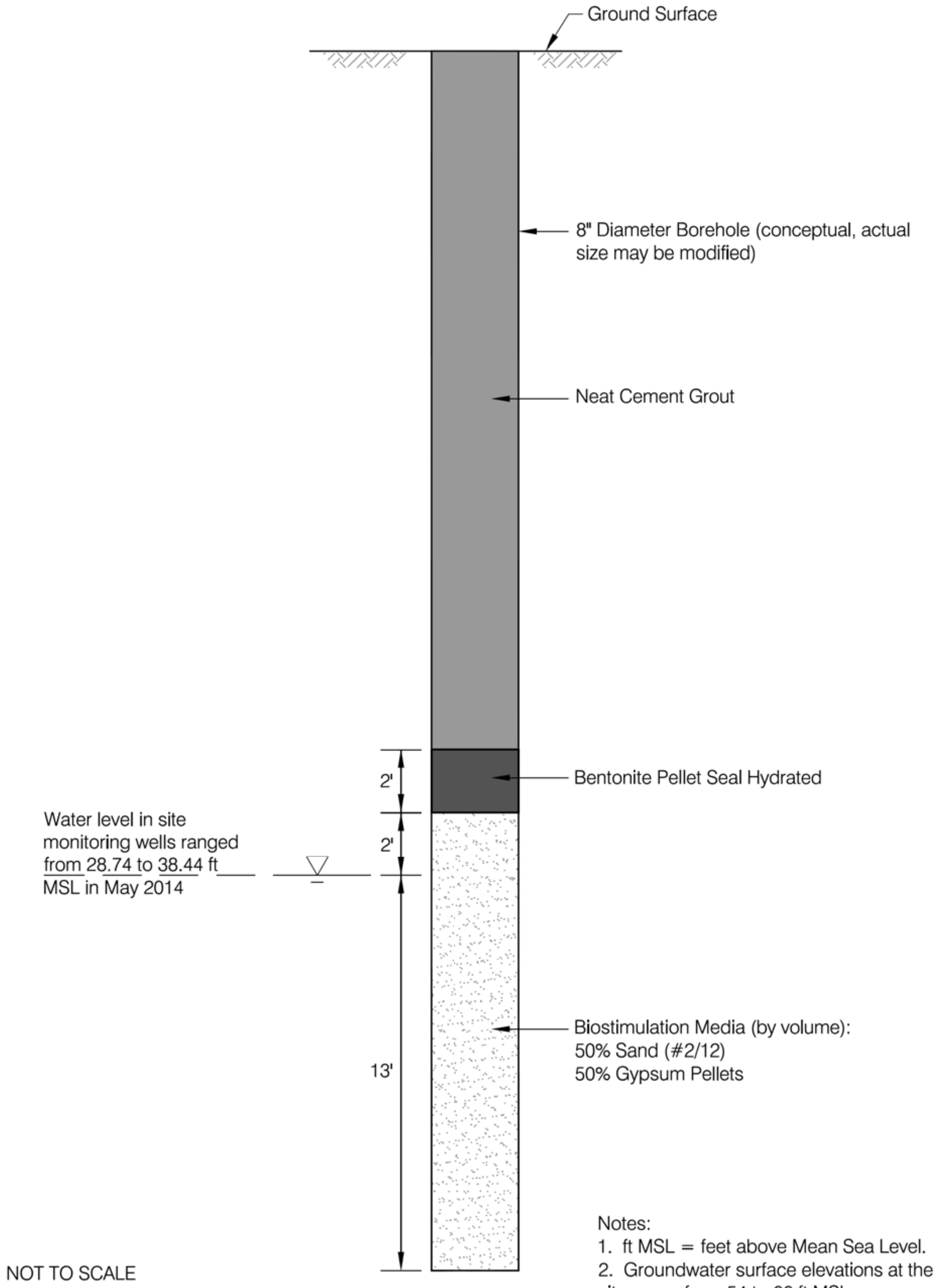

Notes:
1. ft MSL = feet above Mean Sea Level.
2. Groundwater surface elevations at the site range from 54 to 66 ft MSL.

3093 BROADWAY
Oakland, California

LANGAN TREADWELL ROLLO

REMEDIATION BORING CONSTRUCTION DETAIL

Date 02/13/15	Project No. 731637001	Figure 5

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APPENDIX A

WELL INSTALLATION AND DEVELOPMENT STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE FOR MONITORING WELL INSTALLATION

PURPOSE

The purpose of this standard operating procedure is to delineate the quality control measures required to ensure the accurate installation of monitoring wells.

FIELD SUPPLIES

Drilling Equipment

- Appropriately sized drill adequately equipped with augers, bits, drill stem, etc.
- Steam cleaner and water obtained from approved source for decontaminating drilling equipment
- PID, LEL-Oxygen monitor, and other air monitoring as required
- Water level indicator
- Weighted Steel tape measure
- Drums, bins or other storage containers of generated wastes (drill cuttings, contaminated PPE, decon solutions, etc.)
- Source of approved water
- Waste container labels
- Heavy plastic sheeting

Well Installation Materials

- Well screen :

  Screen will be constructed of appropriate materials (PVC, stainless steel, etc.) cleaned and prepackaged by manufacturer or decontaminated and wrapped in plastic before use.

- Riser pipe:

  Riser will be cleaned and prepackaged by manufacturer or decontaminated and wrapped in plastic before use.

- Plugs or sump: a cap or a 2-foot length of capped riser to be used as a sump.

- Filter pack: chemically and texturally clean sand of appropriate grain size distribution.

- Bentonite seal: bentonite pellets (3/8-inch diam.)
- Cement: Portland Cement
- Steel Monitoring well monument: lockable water-tight flush mount or aboveground stove pipe set in place with cement and protected with zinc-plated steel crash posts.
- Containers for purged water, as required.
- Submersible pump or bailer of appropriate capacity, and surge block sized to fit well.
- PH, specific conductivity, and temperature meters
- Electric well sounder and measuring tape
- PPE as required by HSP

Documentation

- Copy of appropriate work plan and field sampling plan
- Copy of approved Health And Safety Plan
- Copies of well and excavation permits
- Boring log forms
- Well completion diagram form
- Well development form

Lithologic Logging equipment

- Hand lens
- Unified Soil Classification System chart
- Munsell color chart

PROCEDURE

Drilling

- The objective of the selected drilling technique is to ensure that the drilling, method provides representative data while minimizing subsurface contamination, cross contamination of aquifers, and drilling costs. The common drilling methods are hollow-stem auger and direct-push techniques.

- A Field Geologist will be present during all well drilling and installation activities and will fully document all tasks performed in support of these activities into a field book. The Field Geologist will be responsible for the logging of samples, monitoring, of drilling operations, recording, of water losses/gains and groundwater data, preparing the boring logs and well diagrams, and recording the well installation procedures of the rig. The Field Geologist will have onsite sufficient equipment in operable condition to perform efficiently his/her duties as outlined in the field sampling plan.

- Surface runoff or other fluids will not be allowed to enter any boring or well during or after drilling/construction.

- An accurate measurement of the water level will be made upon encountering water in the borehole and later upon stabilization. Levels will be periodically checked throughout the course of drilling. Any unusual change in the water level in the hole such as a sudden rise of a few inches may indicate artesian pressure in a confined aquifer will be the basis for cessation of drilling. The geologist will immediately contact his or her supervisor. Particular attention for such water-level changes will be given after penetrating any clay or silt bed, regardless of thickness, which has the potential to act as a confining layer.

- If required, drilling will continue 2-foot into the confining clay layer to allow for the installation of a sump beneath the screened section.

Lithologic Logging

All borings for monitoring wells will be logged by a geologist. Logs will be recorded in a field logbook and/or a boring log. If the information is recorded in a logbook, it will be transferred to Boring Log Forms on a daily basis. Field notes are to include, as a minimum:

- Boring Number

- Material Description (as listed below)

- Weather conditions

- Evidence of Contamination
- Water Conditions (including measured water levels)
- Daily Drilling Footage and Quantities (for billing purposes)
- Drilling Method and Bore Hole Diameter
- Any Deviations from Established Field Plans
- Blow Counts for Standard Penetration Tests
- Core and Split-Spoon Recoveries
- Well construction details: quantities of materials used, material types and dimensions

Material description for soil samples include, as appropriate:

- Classification
- Unified Soil Classification Symbol
- Secondary Components and Estimated Percentages
- Color
- Plasticity
- Consistency
- Density
- Moisture Content
- Texture/Fabric/Bedding and Orientation
- Grain Angularity
- Depositional Environment and Formation
- Incidental odors
- PID readings
- Staining

Material description for rock samples include, as appropriate:

- Classification
- Lithologic Characteristics
- Bedding/Banding Characteristics
- Color
- Hardness
- Degree of Cementation
- Texture
- Structure and Orientation
- Degree of Weathering
- Solution or Void Conditions
- Primary and Secondary Permeability
- Sample Recovery
- Incidental odors
- PID readings
- Staining

Well Construction

After the hole is drilled and logged, backfill hole as required for proper screen/sump placement.

In unconfined aquifers where floating product and/or tidal fluctuation is anticipated, the screen will extend 2 feet above the water table. If feasible, the bottom of the screened section will rest at or just below the top of the aquitard. The 2-foot length of plugged riser section will be in place below the screen, if a sump is required.

- The installation of monitoring wells in uncased or partially cased holes will begin within 12 hours of completion of drilling, or if the hole is to be logged, within 12 hours of well logging, and within 48 hours for holes fully cased with temporary drill casings. Once installation has begun, work will continue until the well has been grouted and the drill casing has been removed.

- Well screens, casings, and fittings will conform to National Sanitation Foundation Standard 14 or American Society for Testing and Materials (ASTM) equivalent for potable water usage. Material used will be new and essentially chemically inert to the site environment.

- Filter pack will extend from the bottom of the screened section (top of aquitard) to a height of 2 ft above the top of the screen. If the water table is relatively close to the ground surface, the filter pack may extend less than 2 ft above the screen to avoid surface water infiltration into the well and to allow for placement of the bentonite seal, grout, and protective casing. If the hole is less than 20 ft deep, the filter pack may be poured into the annulus directly. If the hole is deeper than 20 ft, the filter pack must be tremied into place.

  – Granular filter packs will be chemically and texturally clean, inert, and siliceous.

  – Filter pack grain size will be based on formation grain-size analysis.

  – Calculations regarding filter pack volumes will be entered into the Field Logbook along with any discrepancies between calculated and actual volumes used. If a discrepancy of greater than 10 % exists between calculated and actual volumes, an explanation for the discrepancy will also be entered in the Logbook.

- Bentonite seals will be no less than one foot or more than three feet thick as measured immediately after placement.

- Grout

  Grout used in construction will be composed by weight of:

  – 20 parts cement (Portland cement, type II)

  – 0.6 to 1 part (max.)(3-5%) bentonite = 2.8 lbs to 4.7 lbs of bentonite to one 94 lb bag of cement

  – 6.5 gallons approved water per 94-lb bag of cement.

  Neither additives nor borehole cuttings will be mixed with the grout. Bentonite will be added after the required amount of cement is mixed with the water.

  - All grout material will be combined in an above-ground container and mechanically blended to produce a thick, lump-free mixture. Mixing of the grout will be performed by mixing the bentonite powder and water before adding cement. The mixed grout will be recirculated through the grout pump prior to placement.

- Grout placement will be performed using a commercially available grout pump and a rigid, side discharge tremie pipe.

- The following will be noted in the Field Investigation Daily Report: a) predicted grout volumes, b) amounts of cement, bentonite, and water used in mixing grout, c) actual volume of grout placed in the hole, d) discrepancies between calculated and actual volumes used. If a discrepancy of greater than 10% exists between calculated and actual volumes, an explanation for the discrepancy will also be entered in the Logbook.

Well protective casings will be installed around all monitoring wells on the same day as the initial grout placement around the well. Any annulus formed between the outside of the protective casing and the borehole will be filled to ground surface with cement.

The construction of each well will be depicted as built in a well construction diagram. The diagram will be attached to the boring log and will graphically denote:

- Screen location, length
- Joint location
- Granular filter pack
- Seal
- Grout
- Cave-in
- Centralizers
- Height of riser
- Protective casing detail

Monitoring Well Installation and Completion

- Assemble appropriate decontaminated lengths of pipe, screen, and end cap/sump. Make sure these are clean and free of grease, soil, and residue.

- Attach the end cap/sump to the bottom of the screened section. Lower the screen and each section of pipe into the borehole, one at a time, screwing each section securely into the section below it. No grease, lubricant, polytetrafluoroethleyene (PTFE) tape or glue, may be used in joining the pipe and screen sections.

- If a well extends below 50 ft, centralizers should be installed at 50 ft and every 50 ft thereafter except within screened interval and bentonite seal. Centralizer material will be PVC, PTFE, or stainless steel. Centralizer material should be of the same material as the well screen.

- Cut the riser with a pipe cutter approximately 2-2.5 ft above grade. All pipe cuts MUST be square to ensure that the elevation between the highest and lowest point of the well casing is less than or equal to 0.02 ft. Notch, file, or otherwise scribe a permanent reference point on the top of the casing.

- If a flush-mounted well is required at a given location, an internal pressure cap must be used to ensure that rainwater cannot pool around the wellhead and enter the well through the cap.

- When the well is set to the bottom of the hole, temporarily place a cap on top of the pipe to keep the well interior clean.

- Place the appropriate filter pack. Monitor the rise annulus with a weighted tape to assure that bridging is not occurring.

- After the pack is in place, wait three to five minutes for the material to settle, tamp and level a capped PVC pipe, and check its depth with a weighted steel tape.

- Install the bentonite seal (2 ft to 5 ft thick) by dropping bentonite pellets into the hole gradually. If the well is deeper than 30 feet, a tremie pipe should be used to place either bentonite pellets or slurry.

- Wait for the pellets to hydrate and swell. Hydration times will be determined by field test or by manufacturer's instructions. Normally this will be 30 to 45 minutes. Document the hydration time in the field notebook. If the pellets are above the water level in the hole, add several buckets of clean water to the boring. Document the amount of water added to the hole.

- Mix an appropriate cement-bentonite slurry. Be sure the mixture is thoroughly mixed and as thick as is practicable.

- Lower a side discharge tremie pipe into the annulus to the level of the pellet seal.

- Pump the grout slurry into the annulus while withdrawing the tremie pipe and temporary casing.

- Continue the grout fill to the ground surface. Seat the protective casing in the grout, allowing no more than 0.2 ft between the top of the well casing and the bottom of the protective casing cap. Lock the cap.

- Fill the outer annulus (between the casing and the borehole) with neat cement. Allow the cement to mound above ground level and finish to a 2-ft square 6-in thick cement pad. If needed, install crash posts to protect above-ground completion.

PRECAUTIONS

Refer to the site-specific Health and Safety Plan for discussion of hazards and preventive measures during well development activities.

REFERENCES

A ller, Linda, *et al.*, 1989. Handbook of Suggested Practices for the Design and Installation of Groundwater Monitoring Wells, National Water Well Association

Cohen, Robert M., and Mercer, James W. 1993. DNAPL Site Evaluation, CRC Press, Inc.

EPA Groundwater Handbook 1989

Nielsen, David M., 1993. Correct Well Design Improves Monitoring in "Environmental Protection", Vol.4, No.7, July 1993

USATHAMA, 1987. Geotechnical Requirements for Drilling. Monitoring Wells, Data Acquisition, and Reports, March 1987

ASTM D 5092-90 Standard Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers

STANDARD OPERATING PROCEDURE FOR
MONITORING WELL DEVELOPMENT

PURPOSE

The purpose of this standard operating procedure is to delineate protocols for monitoring well development.

FIELD SUPPLIES

- Well Development Form
- Boring Log and Well Completion Diagram for the well
- Containers for purified water, as required
- Decontaminated submersible pump or bailer of appropriate capacity, and surge block sized to fit well
- Conductivity, pH, temperature and turbidity meters
- Electric well sounder and measuring tape

PROCEDURE

- Well development is the process by which drilling fluids, solids, and other mobile particulates within the vicinity of the newly installed monitoring well have been removed to restore the aquifer hydraulic conductivity. Development corrects damage to or clogging of the aquifer caused by drilling, increases the porosity of the aquifer in the vicinity of the well, and stabilizes the formation and filter pack sands around the well screen.

- Well development will be initiated after 48 consecutive hours but no longer than 7 calendar days following grouting and or placement of surface protection.

- Multiple well development techniques, bailing, over pumping, and surging, will be employed in tandem. Over pumping is simply pumping the well at a rate higher than recharge. Surging a method of forcing water to flow into and out of the screen by operating of a plunger up and down within the well casing, similar to a piston in a cylinder.

- Pump or bail the well to ensure that water flows into it, and to remove some of the fine materials from the well. Removal of a minimum of one well volume is initially recommended. The rate of removal should be high enough to stress the well by lowering the water level to approximately one-half its original level, if well recharge allows.

- Slowly lower a close-fitting surge block into the well until it rests below the static water level, but above the screened interval, if possible.

- Begin a gentle surging motion that will allow any material blocking the screen to break up, go into suspension, and move into the well. Continue surging for 5-10 minutes, remove surge block, and pump or bail the well, rapidly removing at least one well volume.

- Repeat previous step at successively lower levels within the well screen until the bottom of the well is reached. Note that development should always begin above, or at the top of, the screen and move progressively downward to prevent the surge block from becoming sand locked in the well casing. As development progresses, successive surging can be more vigorous and of longer duration as long as the amount of sediment in the screen is kept to a minimum.

- At a minimum, 3 to 5 well volumes are removed during development.

WATER QUALITY MONITORING

- Monitor water quality parameters before beginning development procedures, and after removing each well volume.

- If water quality parameters have stabilized over the three readings, the well will be considered developed.

- If the parameters have not stabilized after these three readings, continue pumping the well to develop, but stop surging. Monitor the stabilization parameters every one-half well volume.

- When the parameters have stabilized over three consecutive readings at one-half well volume intervals, the well is considered developed.

DOCUMENTATION

Record all data as required on a Monitoring Well Developing Record. These data include:

- Depths and dimensions of the well, the casing, and the screen, obtained from the Monitoring Well Construction Form.

- Water losses and uses during drilling, obtained from the boring log for the well.

- Water levels.

- Using a properly calibrated water quality meter, measure the following indicator parameters: turbidity, pH, conductivity, oxidation-reduction potential (Eh), dissolved oxygen, and temperature.

- Target values for the indicator parameters listed above are as follows: pH - stabilize, conductivity - stabilize, temperature - stabilize, turbidity NTU 10 or stabilize. A value is considered to have stabilized when 3 consecutive readings taken at one-half well volume intervals are within 10% of each other (pH stabilization = 0.2 pH units).

- Notes on characteristics of the development water.

- Data on the equipment and technique used for development.

PRECAUTIONS

Refer to the site-specific Health and Safety Plan for discussion of hazards and preventive measures during well development activities.

REFERENCES

Fletcher G. Driscoll, 1986, "Groundwater and Wells", 2nd Addition.

APPENDIX B

BIOREMEDIATION DOSING CALCULATION

Appendix B
Dosing Calculations
TPHg Mass Estimates
3093 Broadway, Oakland, CA

Assumptions: Treatment interval ranges from 15 ft thick near former USTs to 3 feet in downgradient area
Approximately 28,500 square feet treatment area, as shown on Figure 8

Porosity: 0.35 (Estimated based on soil type)
LNAPL Saturation: Estimated to be 10% of pore volume over a 2 foot smear zone where residual NAPL is suspected to be present, roughly one tenth of the overall treatment area
LNAPL Density: 750 g/L for gasoline http://www.atsdr.cdc.gov/toxprofiles/tp72-c3.pdf

Treatment Area Characteristics		
Area (SF)	28,500	
Depth Int (ft)	8	(Areally-weighted average within treatment area)
TPHg Conc (ug/L)	30,692	(Average concentration within treatment area)
Benzene Conc (ug/L)	2,326	(Average concentration within treatment area)
Groundwater Volume (ft^3)	83,825	
Groundwater Volume (L)	2,373,656	

Estimated Mass of TPHg (grams)	
in groundwater (g)	59,625
sorbed to soil (g)	596,255
as NAPL (g)	4,236,901
Total	**4,892,781**

Estimated Mass of TPHg (lbs)	
in groundwater (lb)	131
sorbed to soil (lb)	1,315
as NAPL (lb)	9,341
Total	**10,787**

Notes:
Sorbed mass is estimated to be 10 times the dissolved phase mass
Benzene mass is included in the TPHg mass and is therefore not calculated separately
TPHg - gasoline-range Total Petroleum Hydrocarbons

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Appendix B
Dosing Calculations
Sulfate Demand Estimates
3093 Broadway, Oakland, CA

Representative Equation for Microbially Mediated Hydrocarbon Degradation

1 C8H18 + 6.25 SO4^-2 --> 8 CO2 + 9 H2O + 6.25 S^-2

Note: For the purposes of reaction stoichiometry, octane (C8H18) is used as a representative compound for the petroleum impacts at the site, including the gasoline-range Total Petroleum Hydrocarbons and benzene

Physical Properties

Molecular Mass of Sulfate (SO4)	96.1 g/mol
Molecular Mass of Octane (C8H18)	114.2 g/mol
Molecular Mass of Gypsum (CaSO4-2H20)	172.2 g/mol

Gypsum Properties

Solubility of Gypsum	2 to 2.5 g/L
Corresponding Sulfate Concentration	1.1 to 1.4 g/L
% Sulfate in Gypsum	50%
Assumed gypsum bulk density	68 lb/ft3

Mass Calculations

	TPHg	Sulfate Demand	Gypsum Demand	
mols	42,833	267,704		
g	4,892,781	25,715,961	51,431,921	
pounds		56,694	113,388	< total stoichiometric gypsum demand
ft3			1,667	< estimated volume of gypsum required to meet stoichiometric gypsum demand

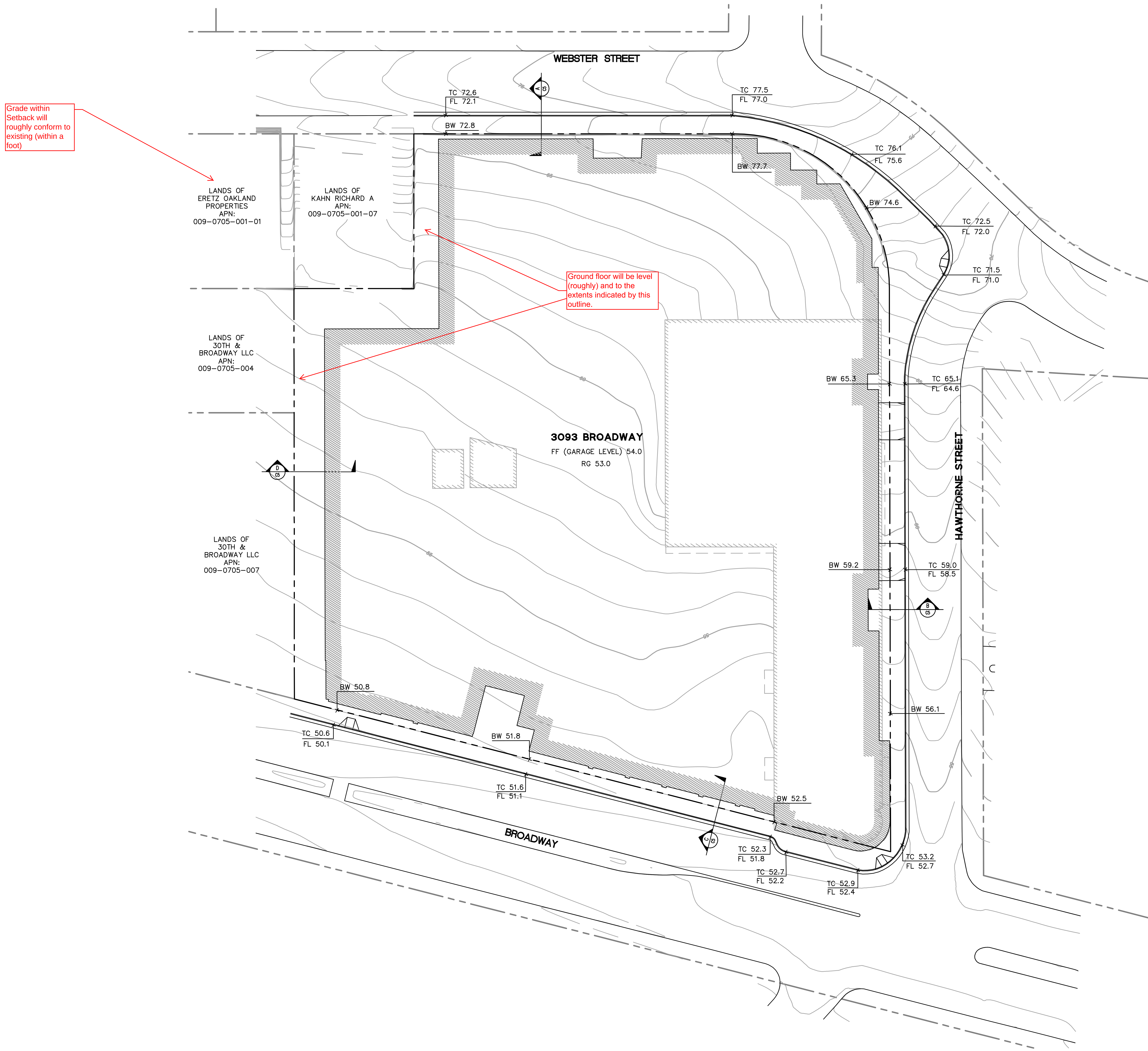
Proposed Gypsum Dosage

Proposed Borehole Size	8 inches
Volume of Borehole	20.9 ft3 over 15 feet depth
Proposed % Gypsum in Borehole (by volume)	50%
Proposed # Boreholes	40
Total gypsum volume proposed	419 ft3
Total gypsum mass proposed	28,484 lbs
	25% of total gypsum demand satisfied

APPENDIX C

CONCEPTUAL GRADING PLAN

NOTE
TOTAL EARTHWORK: 36,900 CUBIC YARDS EXPORT



CITYVIEW
Smart Capital for Smart Growth™

3093 BROADWAY
OAKLAND, CALIFORNIA

CONCEPTUAL GRADING PLAN 32

GRAPHIC SCALE
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VTBS 14063

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APPENDIX D

ESTIMATE FOR INDOOR AIR CONCENTRATION OF BENZENE AND 1,2-DICHLOROETHANE IN GARAGE

Appendix D
Estimate for Indoor Air Concentration of Benzene and 1,2-Dichloroethane in Garage
3093 Broadway, Oakland, CA

Input Parameters:	Benzene	1,2-Dichloroethane	Units	Reference
Max Concentration (C_{max})	4,300	290	µg/m^3	A
Depth Beneath Surface (X)	1.5	1.5	m	A
Average height of indoor space (h)	3.6576	3.6576	m	B
Air exchange rate b/t indoor and atm (λ)	90	90	1/day	C

Diffusion Coefficient in Air (D_{ia}) at 25C, Fuller et al (1966)	Benzene	1,2-Dichloroethane	Units	Reference
$D_{ia} = 0.001 * [T^{1.75}[[(1/M_{air}) + (1/M_i)]^{0.5}]/[P[V_{air}^{1/3} + V_i^{1/3}]^2]]$	0.085	0.087	cm^2/s	D
Absolute Temperature (T) 15C	288.15	288.15	K	
Chemical's Liquid Density (ρ_{iL}) at 25C	0.879	1.256	g/cm^3	
Average Molar Mass of Air (M_{air})	28.97	28.97	g/mol	
Chemical's Molar Mass (M_i)	78.11	98.96	g/mol	
Total Pressure (P)	1	1	atm	
Average Molar Volume of the gases in air (V_{air})	20.1	20.1	cm^3/mol	
Chemical's Molar Volume (V_i) = M_i/ρ_{iL} C	88.9	78.8	cm^3/mol	

Effective Diffusion Coefficient (D_e) in Vadose Zone at 15C	Benzene	1,2-Dichloroethane	Units	Reference
$D_e = D_{ia} * \tau_{ug}^{-1}$	0.024	0.024	cm^2/s	D
	0.207	0.211	m^2/d	
Tortuosity^{-1} (τ_{ug}^{-1}) = $\theta_g^4/\varphi^{5/2}$	0.282	0.282		D
Volumetric Gas Content of Soil (θ_g)	0.43	0.43		
Total Porosity (φ)	0.43	0.43		B

Flux at 15C	Benzene	1,2-Dichloroethane	Units	Reference
Flux = $\varphi * D_e * C_{max} / X$	251.25	17.29	µg/m^{2}d	D

VOC Concentrations in Indoor Air:	Benzene	1,2-Dichloroethane	Units	Reference
$C_{indoorair}$ = (Flux) / (h * λ)	7.63E-01	5.25E-02	µg/m^3	D

VOC Concentrations in Indoor Air, Adding Effect of Structural Concrete Slab:	Benzene	1,2-Dichloroethane	Units	Reference
Slab attenuation factor	0.1	0.1		
$C_{indoorair}$	**7.63E-02**	**5.25E-03**	**µg/m^3**	

Screening Levels	Benzene	1,2-Dichloroethane	Units	Reference
Residential ESL, Indoor Air	8.40E-02	1.20E-01	µg/m^3	E
Commercial ESL, Indoor Air	4.20E-01	5.80E-01	µg/m^3	E

Conclusion:
Estimated indoor air concentrations of benzene and 1,2-dicloroethane are one to two orders of magnitude less than commercial environmental screening levels for indoor air. Note that bioattenuation could further reduce projected indoor air concentrations by a factor of 1,000 according to assumptions inherent in the State's Low Threat Closure Policy.

Assumptions:
1. System is diffusion controlled.
2. Effect of sorbing can be neglected.
3. Calculation does not account for bioattenuation.

Appendix D
Estimate for Indoor Air Concentration of
Benzene and 1,2-Dichloroethane in Garage
3093 Broadway, Oakland, CA

Reference:

(A) Langan Treadwell Rollo, 2014. "Additional Investigation Results, 3093 Broadway, Oakland, California." 5 December.

(B) U.S. Environmental Protection Agency, 2004. User's Guide for Evaluating Subsurface Vapor Intrusion into Buildings. Revised February 22.

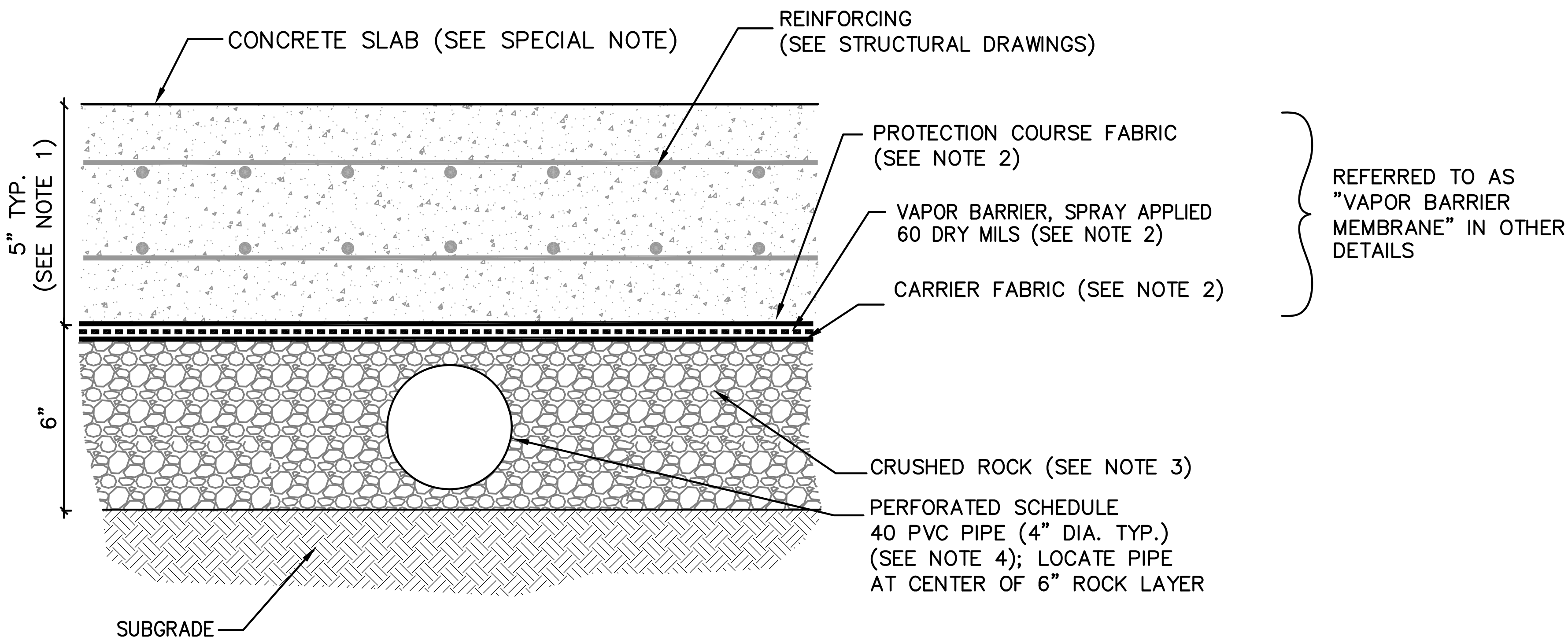
(C) Enclosed garages are required to meet minimum exhaust rate of 0.75 cfm/ft^2. California Mechanical Code Table 403.7.

(D) Schwarzenbach et al., 2003. Environmental Organic Chemistry. Second Edition. John Wiley & Sons, Inc., Hoboken New Jersey. Pages 777 to 848.

(E) Residential and Commercial ESLs for Indoor Air and Soil Gas provided by Summary Table E -Environmental Screening Levels (ESLs) Indoor Air and Soil Gas (Vapor Intrusion Concerns), as established by the RWQCB-SFBR, December 2013.

APPENDIX E

CONCEPTUAL VAPOR MITIGATION SYSTEM DESIGN DETAILS



NOT TO SCALE

3093 BROADWAY
Oakland, California

TYPICAL VMS CROSS SECTION

Date 02/12/15	Project No. 731637001	Figure 1

LANGAN TREADWELL ROLLO

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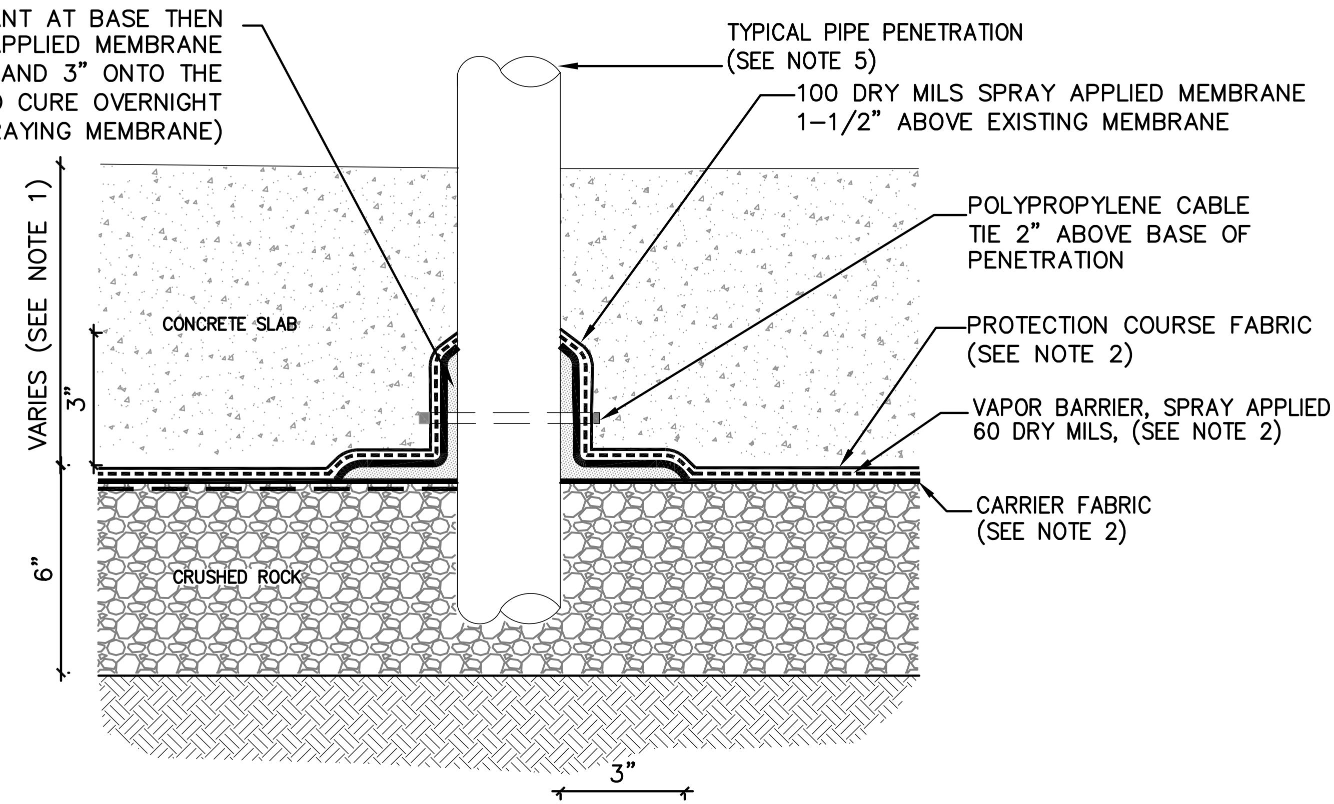

NOT TO SCALE

3093 BROADWAY
Oakland, California

TYPICAL SEALING OF ALL PENETRATIONS THROUGH CONCRETE SLAB

Date 02/12/15	Project No. 731637001	Figure 2

LANGAN TREADWELL ROLLO

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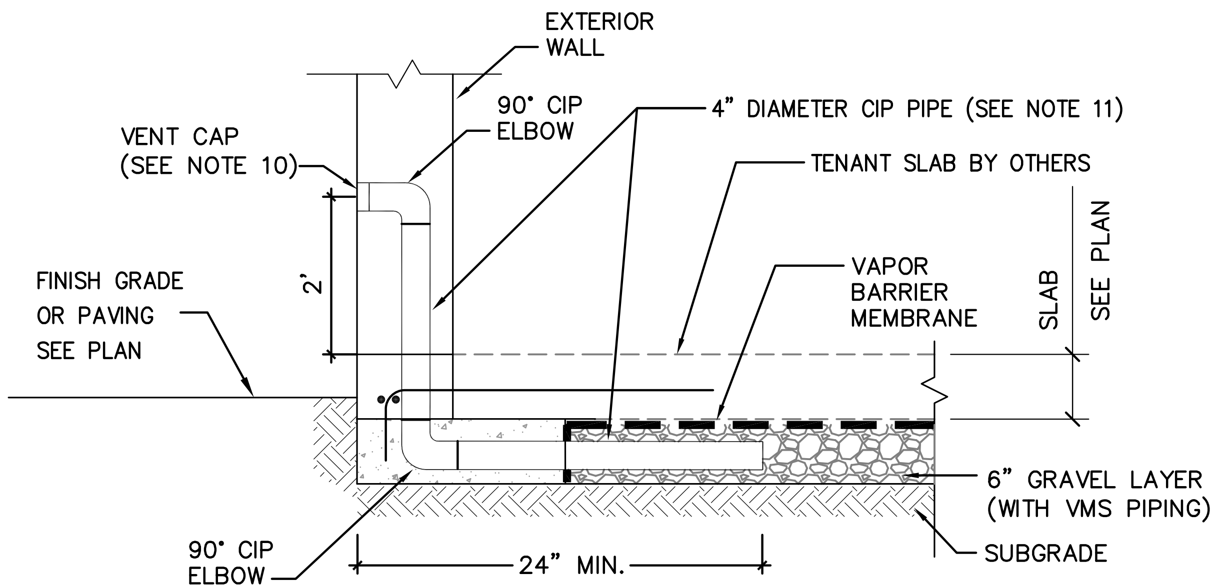


NOT TO SCALE

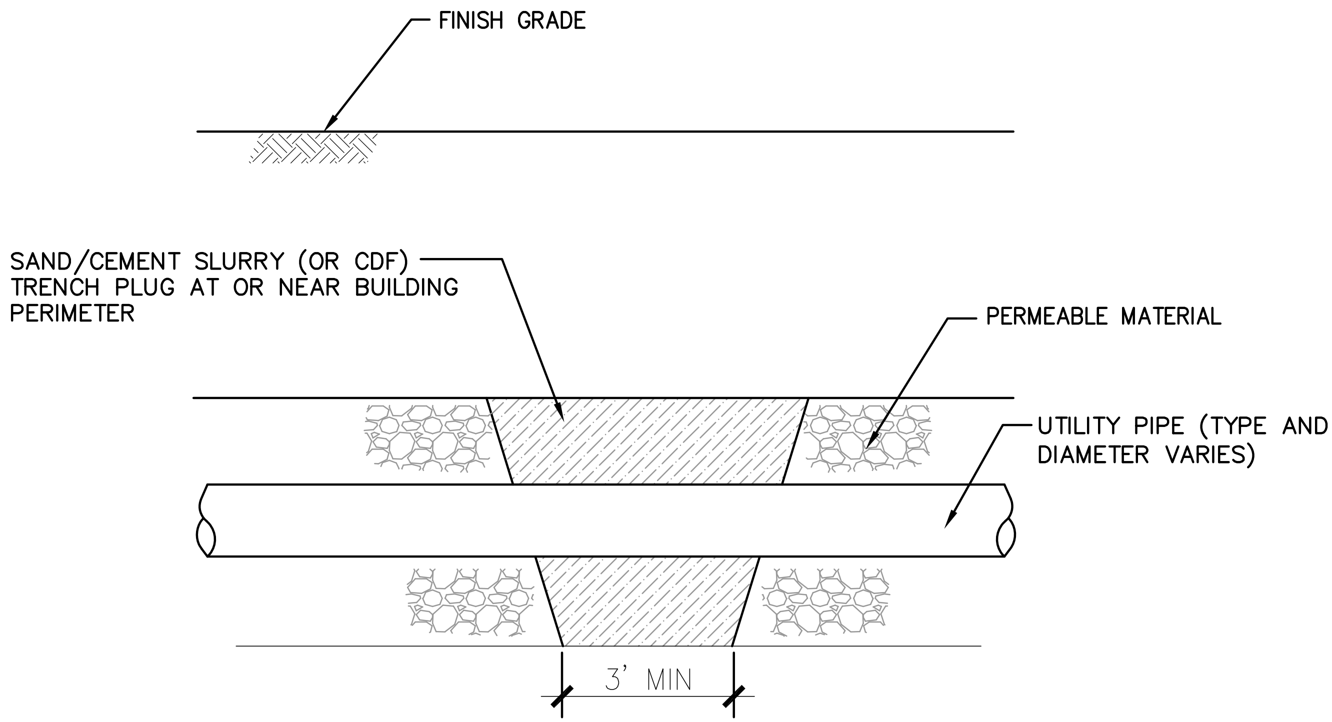
PERIMETER INLET VENT MAY BE INSTALLED OUTSIDE OF EXTERIOR WALL WITHIN LANDSCAPING. CERTAIN RESTRICTIONS TO LOCATION APPLY.

3093 BROADWAY
Oakland, California

TYPICAL PERIMETER INLET VENT AT EXTERIOR WALL

Date 02/12/15	Project No. 731637001	Figure 3

LANGAN TREADWELL ROLLO



NOT TO SCALE

3093 BROADWAY
Oakland, California

TYPICAL SOIL CUT-OFF BARRIER IN UTILITY TRENCH

Date 02/12/15	Project No. 731637001	Figure 4

LANGAN TREADWELL ROLLO

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NOTES:

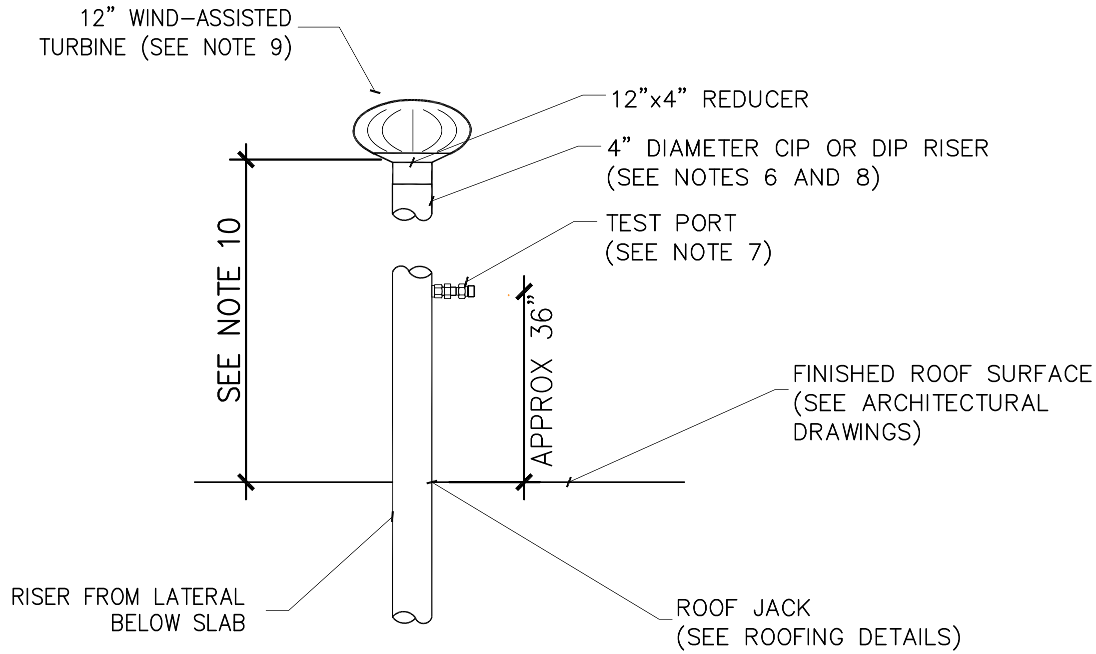
1. ALL LOCATIONS AND DIMENSIONS OF BUILDING SLABS, FOOTINGS, AND GRADE BEAMS TO BE CONFIRMED WITH STRUCTURAL DETAILS.
2. THE SPRAY APPLIED MEMBRANE SHALL BE INSTALLED ACCORDING TO MANUFACTURERS SPECIFICATIONS AND QA/QC REQUIREMENTS (INCLUDING COUPON AND SMOKE TESTING) BY A MANUFACTURER APPROVED APPLICATOR. CARRIER FABRIC AND PROTECTION COURSE FABRIC SHALL BE PER MEMBRANE MANUFACTURES'S SPECIFICATIONS. SLAB PENETRATIONS SHALL NOT BE IN CONTACT WITH AN ADJACENT PENETRATION THAT WOULD PREVENT PROPER SEALING OF THE PENETRATION CIRCUMFERENCE.
3. CRUSHED ROCK (GRAVEL) LAYER SHALL BE 1/4" X 3/4" (100% PASSING 1-INCH; 90% PASSING 3/4-INCH; 10% MAXIMUM PASSING #4). SURFACE OF CRUSHED ROCK LAYER SHALL BE SMOOTH-ROLLED PRIOR TO APPLICATION OF THE CARRIER FABRIC.
4. THE HORIZONTAL PIPE SHALL BE OF SCHEDULE 40 PVC OR HDPE PIPE. INDICATED SECTIONS OF HORIZONTAL PIPE SHALL BE PERFORATED WITH 5/8 INCH DIAMETER HOLES, THREE HOLES ACROSS THE UPPER ONE-THIRD OF THE PIPE, EVERY THREE INCHES ALONG THE PERFORATED SECTION; AN ADDITIONAL 5/8 INCH DIAMETER HOLE SHALL BE DRILLED ON THE UNDERSIDE OF THE PIPE AT LEAST EVERY 2 LINEAR FEET ALONG THE PERFORATED SECTION TO ALLOW WATER, IF ANY, TO DRAIN FROM THE PIPE.
5. SLAB PENETRATION SHALL NOT BE IN CONTACT WITH ADJACENT PENETRATIONS OR STEEL COLUMNS TO ALLOW TROWEL GRADE MEMBRANE APPLICATION AROUND ENTIRE PENETRATION CIRCUMFERENCE.
6. THE VERTICAL RISER PIPE TO THE WIND TURBINE SHALL BE SUPPORTED AT THE PIPE CHASE WALLS AND LABELED AS "CONTAINS VAPORS; DO NOT BREAK OR CUT".
7. A TEST PORT SHALL BE INSTALLED TO SAMPLE AIR FROM THE COLLECTION PIPE 36 INCHES ABOVE ROOF LEVEL.
8. THE VERTICAL RISER PIPE TO THE WIND-ASSISTED TURBINE VENT SHALL BE 4 INCH DIAMETER CIP (MAY TRANSITION AT ROOF LEVEL TO SCH. 80 PVC) AND EXTEND TO AN ELEVATION ABOVE THE ROOF LEVEL SUCH THAT IT EXTENDS A MINIMUM OF 12 INCHES ABOVE SURROUNDING PARAPET OR WINDSCREEN AND IS OUTSIDE OF ANY WIND SHADOW. THE RISER PIPE SHALL BE SECURED TO A SUITABLE VERTICAL SURFACE AND SHALL BE LOCATED A MINIMUM OF 15 FEET FROM ANY FRESH AIR INTAKES.
9. THE WIND-ASSISTED TURBINE VENT ON TOP OF THE 4 INCH PVC RISER SHALL BE 12 INCH DIA. STAINLESS STEEL (McMASTER-CARR CAT# 1992K48) AND SHALL BE SECURELY ATTACHED TO TOP OF RISER.
10. THE VENT PIPE CAP SHALL KEEP OUT DEBRIS BUT ALLOW AIR TO ENTER THE PIPE; CONTRACTOR MAY COORDINATE PLACEMENT OF PIPING INSIDE EXTERIOR WALL WITH ARCHITECT AND SUBMIT SAMPLE CAP TO ARCHITECT FOR APPROVAL. VENTS SHALL BE LOCATED A MINIMUM OF 36 INCHES AWAY FROM DOOR JAMS.
11. CONSTRUCTION SEQUENCE OF ELEVATOR PIT SHALL BE CLOSELY COORDINATED BETWEEN GENERAL CONTRACTOR AND MEMBRANE APPLICATOR. COLD JOINTS SHALL BE PROPERLY SEALED IN ACCORDANCE WITH MEMBRANE MANUFACTURER'S STANDARD PROCEDURES, SUCH AS LAPPING OF CONSECUTIVE MEMBRANE SEGMENTS OR OTHER APPROVED METHODS.

3093 BROADWAY
Oakland, California

NOTES

Date 02/12/15	Project No. 731637001	Figure 5

LANGAN TREADWELL ROLLO



NOT TO SCALE

3093 BROADWAY
Oakland, California

TYPICAL RISER AND TURBINE AT ROOF

Date 02/12/15	Project No. 731637001	Figure 6

LANGAN TREADWELL ROLLO

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SECTION 02 56 19.13 – FLUID-APPLIED GAS BARRIER

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes:
1. Substrate preparation.
2. Seam sealer and accessories.
3. Protection courses, carrier fabrics, vapor barriers, and waterproofing as part of the vapor barrier system.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Division 3 “Concrete” for concrete placement, curing, and finishing.
2. Division 22 “Plumbing” for piping hangers and supports.
3. Division 31 “Earthwork” for sub-grade preparation.

1.2 PERFORMANCE REQUIREMENTS

A. General: Provide a vapor barrier system that prevents the passage of vapor gas, including under hydrostatic conditions, and complies with physical requirements as demonstrated by testing performed by an independent testing agency of Manufacturer’s current formulations and system design.

1.3 SUBMITTALS

A. Product Data: Submit Product Data of the following for approval:
1. Product Data for each type of vapor barrier and waterproofing specified, including Manufacturer’s printed instructions for evaluating and preparing the substrate, technical data, and tested physical and performance properties.
2. Gas vapor vent piping and fittings.
3. Product Data for gravel aggregate base, including grading and location/source.

B. Project Data – Submit Shop Drawings showing locations and extent of vapor barrier, including details for overlaps, sheet flashing, penetrations, and other termination conditions.

C. Samples – Submit representative samples of the following for approval:
1. Carrier fabric material.
2. Vapor barrier membrane material.
3. Protection course material.
4. Waterproofing material.

D. Installer Certificates: Submit certificates signed by Manufacturer certifying that Installers comply with requirements under the “Quality Assurance” Article.

E. As-Builts: Furnish As-Built Drawings and other relevant close-out documents related to the vapor barrier system shown on the Design Drawings.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who is certified in writing and approved by the vapor gas barrier Manufacturer for the installation of the vapor barrier system.

B. Manufacturer Qualification: Obtain vapor barrier and waterproofing materials and system components from a single Manufacturer. The gas vapor barrier manufacturer must specifically manufacture, market, and warranty products for the intended use of preventing vapor intrusion into structures.

C. Test Area: Apply vapor barrier system field sample to 100 square feet (9.3 square meters) of field area to demonstrate application, detailing, thickness, texture, and standard of workmanship.
   1. Notify Engineer one week in advance of the dates and times when field sample will be prepared.
   2. If Engineer determines that field sample does not meet requirements, reapply field sample until field sample is approved.
   3. Retain and maintain approved field sample during construction in an undisturbed condition as a standard for judging the completed vapor barrier system. An undamaged field sample may become part of the completed work.

D. Pre-installation Conference: A pre-installation conference shall be held prior to application of the vapor barrier system to assure proper site and installation conditions, to include General Contractor, Installer, Architect, Engineer, and Special Inspector.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Project site as specified by Manufacturer labeled with Manufacturer’s name, product brand name and type, date of manufacture, shelf life, and directions for storing and mixing with other components.

B. Store materials as specified by the Manufacturer in a clean, dry, protected location and within the temperature range required by Manufacturer. Protect stored materials from direct sunlight.

C. Remove and replace material that cannot be applied within its stated shelf life.

1.6 PROJECT CONDITIONS

A. Protect all adjacent areas not to be installed on. Where necessary, apply masking to prevent staining of surfaces to remain exposed wherever membrane abuts to other finish surfaces.

B. Perform work only when existing and forecast weather conditions are within Manufacturer’s recommendations for the material and application method used.

C. Maintain adequate clearance as required for application.

D. Ambient temperature shall be within Manufacturer’s specifications. Consult Manufacturer for the proper requirements when desiring to apply vapor barrier at ambient temperatures outside of Manufacturer’s specifications.

E. Appropriately protect and positively secure in their proper positions all plumbing, electrical, mechanical, and structural items to be under or passing through the vapor barrier membrane system, prior to membrane application.

F. Install vapor barrier system before placement of reinforcing steel. When not possible, mask all exposed reinforcing steel prior to membrane application.

G. Maintain adequate ventilation during preparation and membrane application.

H. Stakes used to secure the concrete forms shall not penetrate the vapor barrier system after it has been installed. If stakes need to puncture the vapor barrier system after it has been installed, the certified Installer should make the necessary repairs. Contact the Manufacturer, to confirm the staking procedure is in agreement with the Manufacturer’s recommendations.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents, and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: Submit a written warranty signed by vapor barrier Manufacturer and Installer agreeing to repair or replace vapor barrier that does not meet requirements or that does not remain vapor free or watertight within the specified warranty period.
   1. Warranty Period: 5 years after date of Substantial Completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. CETCO, Santa Ana, CA (714) 384-0111
   1. Spray-applied vapor barrier system LIQUID BOOT® . LIQUID BOOT® 500 - LIQUID BOOT® 500 may be used in lieu of LIQUID BOOT® for horizontal surfaces.
   2. Carrier fabric LIQUID BOOT® BaseFabric T-40.
   3. Protection course LIQUID BOOT® UltraShield P-100 for vertical surfaces, LIQUID BOOT® UltraShield G-1000 for horizontal surfaces.
   4. Waterproofing Coreflex 60.
   5. Seam detailing sealant mastic LIQUID BOOT® UltraGrip.
   6. All other accessory components: Provide all Manufacturer recommended items required for complete installation, including but not limited to surface primers, seam tape, mastic, termination bars, protection boards, flashings, adhesives, etc.

B. Land Science Technologies, San Clemente, CA (949) 481-8118
   1. Spray-applied Geo-Seal CORE and Geo-Seal CORE Detail.
   2. Carrier fabric Geo-Seal BASE.
   3. Protection course Geo-Seal BOND.
   4. Waterproofing protection course Geo-Seal BOND-B.
   5. Seam detailing sealant mastic Geo-Seal CORE Detail.
   6. All other accessory components: Provide all Manufacturer recommended items required for complete installation, including but not limited to surface primers, seam tape, mastic, termination bars, protection boards, etc.

C. Or Engineer-approved equal.

2.2 FLUID APPLIED MATERIALS

A. Fluid applied vapor barrier system: A single course, high build, polymer modified, asphalt emulsion. Waterborne and spray applied at ambient temperatures. A nominal thickness of 60 dry mils, unless specified otherwise. Non-toxic and odorless.

B. Fluid applied vapor barrier physical properties:
   1. CETCO System:

LIQUID BOOT®

Properties	Test Method	Results
Acid Exposure (10% H_2SO_4 for 90	ASTM D543	Less than 1% weight change
Diesel (1000 mg/l), Ethylbenzene (1000 mg/l), Naphthalene (5000 mg/l) and Acetone (500 mg/l) Exposure for 7 days	ASTM D543	Less than 1% weight change, Less than 1% tensile strength change
Radon Permeability	Tested by US	Zero permeability to Radon
Bonded Seam Strength Tests	ASTM D6392	Passed*
Micro Organism Resistance (Soil	ASTM D4068-88	Passed*
Methane Permeability	ASTM 1434-82	Passed*
Oil Resistance Test- average weight change, average tensile strength change, average tensile stress change, average elongation change, bonded seams, methane permeability	ASTM D543-87	Passed*
Heat Aging- average tensile strength change, average tensile stress change, average elongation change, bonded	ASTM D4068-88	Passed*
Dead Load Seam Strength	City of Los	Passed*
Environmental Stress-Cracking	ASTM D1693-78	Passed*
PCE Diffusion Coefficient	Tested at 6,000	2.74 x 10-14 m^2/sec
TCE Diffusion Coefficient	Tested at 20,000	8.04 x 10-14 m^2/sec
Soil Burial	ASTM E154-88	Passed
Water Vapor Permeability	ASTM E96	0.24 perms
Water Vapor Transmission	ASTM E96	0.10 grains/h-ft^2
Toxicity Test	22 CCR 66696	Passed. CCR Bioassay—Flathead Minnow
Potable Water Containment	ANSI/NSF 61	NSF Certified for tanks >300,000 gal**
Hydrostatic Head Resistance	ASTM D751	Tested to 138 feet or 60 p.s.i
Freeze-Thaw Resistance (100 Cycles)	ASTM A742	Meets criteria. No spalling or disbondment
Accelerated Weathering & Ultraviolet Exposure	ASTM D822	No adverse effect after 500 hours
Elongation	ASTM D412	1,332% - Ø reinforcement, 90% recovery
Tensile Strength	ASTM D412	58 p.s.i. without reinforcement
Tensile Bond Strength to Concrete	ASTM D413	2,707 lbs/ft^2 uplift force

* per City of Los Angeles approval for 100-mil LIQUID BOOT® gas vapor barrier.

** per NSF approval for 80-mil LIQUID BOOT® potable water containment membrane

LIQUID BOOT® 500

Properties	Test Method	Results
Elongation	ASTM D412	542%
Bond Seam Strength Tests	ASTM D6392	Passed
Methane Permeability	ASTM D1434	None detected
Water Vapor Permeability	ASTM E96	0.22 perms

2. Land Science Technologies System:

Geo-Seal CORE

Properties	Test Method	Results
Tensile Strength - CORE only	ASTM 412	32 psi
Tensile Strength - Geo-Seal System	ASTM 412	662 psi
Elongation	ASTM 412	4140%
Resistance to Decay	ASTM E 154 Section 13	4% Perm Loss
Accelerated Aging	ASTM G 23	No Effect
Moisture Vapor Transmission	ASTM E 96	.026 g/ft^2/hr
Hydrostatic Water Pressure	ASTM D 751	26 psi
Perm rating	ASTM E 96 (US Perms)	0.21
Methane transmission rate	ASTM D 1434	Passed
Adhesion to Concrete & Masonry	ASTM C 836 & ASTM C 704	11 lbf./inch
Hardness	ASTM C 836	80
Crack Bridging	ASTM C 836	No Cracking
Heat Aging	ASTM D 4068	Passed
Environmental Stress Cracking	ASTM D 1693	Passed
Oil Resistance	ASTM D543	Passed
Soil Burial	ASTM D 4068	Passed
Low Temp. Flexibility	ASTM C 836-00	No Cracking at – 20°C
Resistance to Acids:		
Acetic		30%
Sulfuric and Hydrochloric		13%
Temperature Effect:		
Stable		248°F
Flexible		13°F

Geo-Seal CORE Detail

Properties	Test Method	Results
Tensile Strength	ASTM 412	32 psi
Elongation	ASTM 412	3860%
Resistance to Decay	ASTM E 154 Section 13	9% Perm Loss
Accelerated Aging	ASTM G 23	No Effect
Moisture Vapor Transmission	ASTM E 96	.026 g/ft^2/hr
Hydrostatic Water Pressure	ASTM D 751	28 psi
Perm rating (US Perms)	ASTM E 96	0.17
Methane transmission rate	ASTM D 1434	Passed
Adhesion to Concrete & Masonry	ASTM C 836	7 lbf./inch
Hardness	ASTM C 836	85
Crack Bridging	ASTM C 836	No Cracking
Low Temp. Flexibility	ASTM C 836-00	No Cracking at –20ºC
Resistance to Acids:		
Acetic	-	30%
Sulfuric and Hydrochloric		13%
Temperature Effect:		
Stable		248°F
Flexible		13°F

2.3 CARRIER FABRIC

A. Manufacturer approved geotextile as a cushion layer on gravel base aggregate. All base fabrics must be manufactured and approved for use with the spray-applied gas vapor barrier membrane by the Manufacturer.

2.4 PROTECTION COURSE

A. Use protection course as a top protective layer. All protection materials must be manufactured and approved for use with the spray-applied vapor barrier membrane by the Manufacturer.

2.5 WATERPROOFING, AS REQUIRED BY VAPOR BARRIER SYSTEM

A. CETCO System: Coreflex 60, 60 mil (1.5 mm) nominal thick PVC, Elvaloy KEE thermoplastic membrane reinforced with a 5.0 oz. weft inserted knit polyester fabric integrally bonded to an Active Polymer Core (APC), with the following physical properties:

Properties	Test Method	Results

Membrane Composite Thickness	ASTM D751	150 mil (3.8 mm)
Hydrostatic Pressure Resistance (min 1 hour @ 100 psi)	ASTM D5385	231 ft (70 m)
Puncture Resistance	ASTM D4833	224 lbs (996 N)
Tensile Strength	ASTM D751	549 lbs (2,442 N)
Bonded Seam Strength	ASTM D751	705 lbs (3,136 N)
Peel Adhesion to Concrete	ASTM D903 (mod)	10 lbs/in (1,751 N/m)
Methane Permeability	ASTM D1434	25 mL (STP)/m^2/day
Oil Resistance	ASTM D543	Passed
Micro organism Resistance	ASTM D4068-88	Passed
Environmental Stress Cracking	ASTM D1693	Passed
Water Vapor Retarder	ASTM E1745	Class A
Water Vapor Transmission	ASTM E96	0.1 perms (0.036 gr/m/hr)
Tensile Strength	ASTM E154	387 lbf/in (68 kN/m)
Puncture Resistance	ASTM D1709	12.0 lbs (5,500 grams)* *Maximum of Test Equipment

B. Land Science Technologies System: Land Science Technologies System utilizes the spray-applied vapor barrier membrane (Geo-Seal CORE and Geo-Seal CORE Detail) and carrier fabric (Geo-Seal BASE) of the overall vapor barrier system, with a specialized protection course (Geo-Seal BOND-B) comprised of a chemically resistant 5 mil high density polyethylene sheet with geotextile laminated to a bentonite geomembrane. Geo-Seal BOND-B has the following physical properties:

Properties	**Test Method**	**Results**
Hydrostatic Pressure Resistance	ASTM D 5385	231 ft. (70 m)
Permeability	ASTM E 96-80	0.03 Perms (grains/ft²-hr-in HG)
Tensile Strength	ASTM D 638	MD: 3670 psi (31.3 MPa) TD: 3500 psi (29.9 MPa)
Puncture Resistance	ASTM E 154-88	171 lbs. (77.5 kg.)
Low Temperature Flexibility	ASTM D 1970	Unaffected at -25°F (-32°C)
% Elongation at Break	ASTM D 638	>700%
Resistance to Micro Organisms	ASTM E 154-88-13	Unaffected

2.6 OTHER AUXILIARY AND INSTALLATION MATERIALS

A. All auxiliary and installation materials must be approved for use with the spray-applied vapor barrier membrane and waterproofing system by the Manufacturer.

B. Sheet Flashing: 60-mil reinforced modified asphalt sheet good with double-sided adhesive.

C. Reinforcing Strip: Manufacturer's recommended fabric.

D. Waterstops: Per Manufacturer's recommendations.

E. Seam Detailing Sealant Mastic: Per Manufacturer's recommendations.

F. Drain Board: Per Manufacturer's recommendations.

2.7 GAS VAPOR SUB-SLAB, INLET VENT, AND RISER PIPING

A. 4-inch diameter, Schedule 40 PVC pipe and ductile iron pipe (DIP) or cast iron pipe (CIP) piping, as shown in Design Drawings.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions under which vapor barrier system will be applied, with Installer present, for compliance with requirements. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

A. Provide minimum clearance specified by Manufacturer for surfaces to receive the spray-applied vapor barrier membrane.

B. Prepare and provide an application surface to the Installer that is smooth, uniform, free of debris and standing water, and in accordance with Manufacturer's specifications.

C. Verify substrate is prepared according to Design Drawings and Manufacturer's recommendations.

D. Install gas vapor vent piping as shown in Design Drawings.

E. Gravel subgrade:
1. Quality and grading requirements as noted in Design Drawings.
2. Moisture condition and compact as specified by the Geotechnical Engineer.

3. Prepare and compact to local building code requirements.

F. Mask off adjoining surfaces not receiving vapor barrier system to prevent spillage or over spray affecting other construction.

3.3 PREPARATION AND TREATMENT AT TERMINATIONS AND PENETRATIONS

A. Secure pipe penetrations in place prior to installation of the spray-applied vapor barrier system.

B. Prepare penetrations and terminations in accordance with Manufacturer's recommendations.

C. Prepare transitions between vertical and horizontal surfaces in accordance with Manufacturer's recommendations.

3.4 CARRIER FABRIC INSTALLATION

A. Roll out carrier fabric on subgrade as specified by the Manufacturer. Install carrier fabric in one direction. Overlap seams a minimum of 6 inches, or as specified by the Manufacturer, whichever is greater. Lay carrier fabric tight at all inside corners.

B. Minimize the use of nails to secure the base layer to the subgrade. Remove all nails before spraying membrane, if possible. Nails that cannot be removed from the subgrade are to be patched as specified by the Manufacturer.

C. Secure carrier fabric seams between the overlapped sheets with the spray-applied vapor barrier membrane as specified by the Manufacturer. Visually verify no gaps in seams. Repair any gaps in seams prior to application of spray-applied vapor barrier membrane, as specified by the Manufacturer.

D. Refer to Manufacturer's recommended details and literature for complete installation guidelines

3.5 SPRAY-APPLIED VAPOR BARRIER MEMBRANE APPLICATION

A. Set up spray equipment according to Manufacturer's instructions and place spray-markers in field of carrier fabric.

B. Mix and prepare materials according to Manufacturer's instructions.

C. Start installing fluid-applied vapor barrier in presence of Manufacturer's technical representative.

D. Apply spray-applied vapor barrier to obtain a seamless membrane free of entrapped gases, with a minimum dry film thickness of 60 mils. Apply spray-applied vapor barrier, according to Manufacturer's recommendations, by spray or roller. A minimum dry film thickness of 60 mils is typically achieved by applying one spray coat or four roller coats of the spray-applied vapor barrier.

E. Apply vapor barrier to prepared wall terminations and to the horizontal surface of the carrier fabric to a thickness indicated by the placed spray-markers and according to Manufacturer's recommendations and details.

F. Refer to Manufacturer's recommended details and literature for complete installation guidelines

G. Verify film thickness every 100 square feet (9.3 square meters).

3.6 PROTECTION COURSE INSTALLATION

A. Remove any standing water from the membrane before installing protection course.

B. Install protection course perpendicular to the direction of the bottom course as recommended by the Manufacturer. Install protection course over nominally cured membrane no sooner or later than recommended by Manufacturer and before starting subsequent construction operations.

C. Overlap protection course seams as recommended by the Manufacturer.

D. Secure protection course seams between the overlapped sheets with the spray-applied vapor barrier membrane as specified by the Manufacturer.

E. Refer to Manufacturer's recommended details and literature for complete installation guidelines.

3.7 WATERPROOFING

A. CETCO System:
1. Install Coreflex 60 at pits and subgrade walls as shown on Design Drawings, and other areas under hydrostatic conditions.
2. Install with fully welded seams.
3. At Coreflex 60 to LIQUID BOOT® tie in locations, lay Coreflex 60 over 100 mils minimum dry thickness LIQUID BOOT®, extending onto LIQUID BOOT® a minimum of 12 inches. Install 60 mils minimum dry thickness LIQUID BOOT® counterflashing directly over Coreflex 60 membrane.
4. Refer to Manufacturer's recommended details and literature for complete installation guidelines.

B. Land Science Technologies System:
1. Utilize waterproofing protection course Geo-Seal BOND-B as shown on Design Drawings, and other areas under hydrostatic conditions.

2. Install carrier fabric, spray-applied vapor barrier membrane, and protection course as detailed in Articles 3.4, 3.5, and 3.6 above.
3. Refer to Manufacturer's recommended details and literature for complete installation guidelines.

3.8 FIELD QUALITY CONTROL

A. General:

1. Installers are to check their own work for coverage, thickness, and all around good workmanship before calling for inspections by the Contractor's Professional Engineer.
2. The membrane must be cured at least overnight before inspecting for dry-thickness, holes, shadow shrinkage, and any other membrane damage.
3. When thickness or integrity is in question, the membrane should be tested in the proper manner as described below. However, over-sampling defeats the intent of inspections. Inspectors should always use visual and tactile measurement to guide them. Areas suspected of being too thin to the touch should be measured with gauges to determine the exact thickness.
4. A minimum of one (1) sample per 500 square feet of applied material shall be observed by the Engineer.

B. Gauging Thickness:

1. Membrane will be checked for coverage with a lightly oiled, needle nose depth gauge, taking four (4) readings over a 1 square inch area, every 500 square feet. Record the minimum reading. Mark the test area for repair.
2. Test areas are to be patched over with spray-applied vapor barrier to an 80 mil minimum dry thickness, extending a minimum of 1 inch beyond the test perimeter.

C. Coupon Samples:

1. Coupon samples shall be cut from the spray-applied gas vapor barrier system to a maximum area of 2 square inches. Measure the thickness with a mil-reading caliper, minimum once per every 500 square feet. Deduct the thickness of the base and protection course layers to determine the thickness of the spray-applied vapor barrier membrane. Mark the test area for repair.
2. Voids left by sampling are to be repaired and patched over as specified by the Manufacturer. Test areas are to be patched over with spray-applied vapor barrier to an 80 mil minimum dry thickness, extending a minimum of 1 inch beyond the test perimeter.

D. Smoke Test: All Spray-applied vapor barriers shall be Smoke Tested in accordance with the following protocol:

1. The vapor membrane shall be visually inspected. Any apparent deficiencies and/or installation problems shall be corrected prior to Smoke Testing.
2. Smoke Testing of the spray-applied vapor barrier system to be conducted by Installer and observed by the Contractor's Professional Engineer.

3. The date, time, testing reference area, temperature, wind speed/direction, and cloud cover shall be recorded on the Smoke Testing Record. The ambient air temperature at the time of testing should be in excess of 45° F and the wind speed at ground level should be 15 miles per hour (mph) or less since visual identification of leaks becomes more difficult with increasing wind speed.
4. Delineate a Smoke Testing area of 2,000 to 5,000 square feet (maximum). Assemble and situate Smoke Testing system to inject smoke beneath membrane. Only inert, non-toxic smoke is to be utilized for membrane Smoke Test.
5. Designate testing control areas by cutting openings in an "X" pattern (minimum 4 inch by 4 inch) in the membrane at selected locations. Mark testing control areas for identification prior to conducting the Smoke Test.
6. Activate smoke generator / blower system (nominal 150 – 950 cubic feet per minute [cfm]). Apply sufficient pressure as to ensure that smoke will permeate the designated testing area. For verification, ensure that smoke is leaking through testing control areas.
7. Pump smoke beneath the membrane for a minimum 1 to 2 minutes. Observe for leaks in the membrane. Reduce pressure / flow rate if excessive lifting of the membrane occurs.
8. Thoroughly inspect entire membrane surface within area delineated for testing. Use marking device as approved by the Manufacturer to mark any leak locations. Mark leak locations on floor plan and corresponding testing reference area.
9. Repair leak locations in accordance with the Manufacturer's recommendations and specifications.
10. Repeat Steps "7.", "8.", and "9.", as necessary to confirm integrity of the membrane.

E. Maintain record log of membrane thickness, coupon testing, and smoke test results indicating at a minimum: (1) date; (2) site location; (3) test result; (4) employee name and all criteria required by City Building Code. Record log shall be made available to Owner, City, Special Inspector, General Contractor, Architect, Engineer, and Manufacturer.

3.8 CURING, PROTECTING, AND CLEANING

A. Cure according to Manufacturer's recommendations. It should be noted, in some conditions such as a saturated substrate, extremely cold conditions and/or high humidity, the full adhesion of the membrane may be delayed. The length of delay may be subject to the membrane thickness and severity of conditions.

B. Take care to prevent contamination and damage during application stages and curing.

C. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by Manufacturer of affected construction.

D. Protect the spray-applied vapor barrier system in accordance with Manufacturer's recommendations to prevent disturbance, damage, or deterioration by work of other trades or environmental conditions. Protect spray-applied vapor barrier system from damage during installation of reinforcing steel and utilities and during placement of concrete slab or granular materials. Do not place sharp angular backfill materials immediately against the spray-applied gas vapor barrier membrane.

E. Engineer shall visually inspect the condition of the spray-applied vapor barrier membrane immediately prior to placing the overlying protective layer or below-grade wall backfill. All damage to the installed spray-applied vapor barrier membrane shall be repaired at the Contractor's expense prior to placement of concrete or backfill.

F. Ensure there is no moisture entrapment by vapor barrier due to rainfall or ground water intrusion. If moisture entrapment is present, implement procedures for removal of moisture and to prevent re-occurrence. Contractor’s Professional Engineer’s approval of drying procedures shall be required prior to implementation.

G. Protect spray-applied vapor barrier system from damage until covered by finish wall, floor, etc.

H. Immediately repair damaged spray-applied vapor barrier membrane and components of vapor barrier system in accordance with Manufacturer’s instructions. Contractor’s Professional Engineer’s approval of repair procedures shall be required prior to implementation.

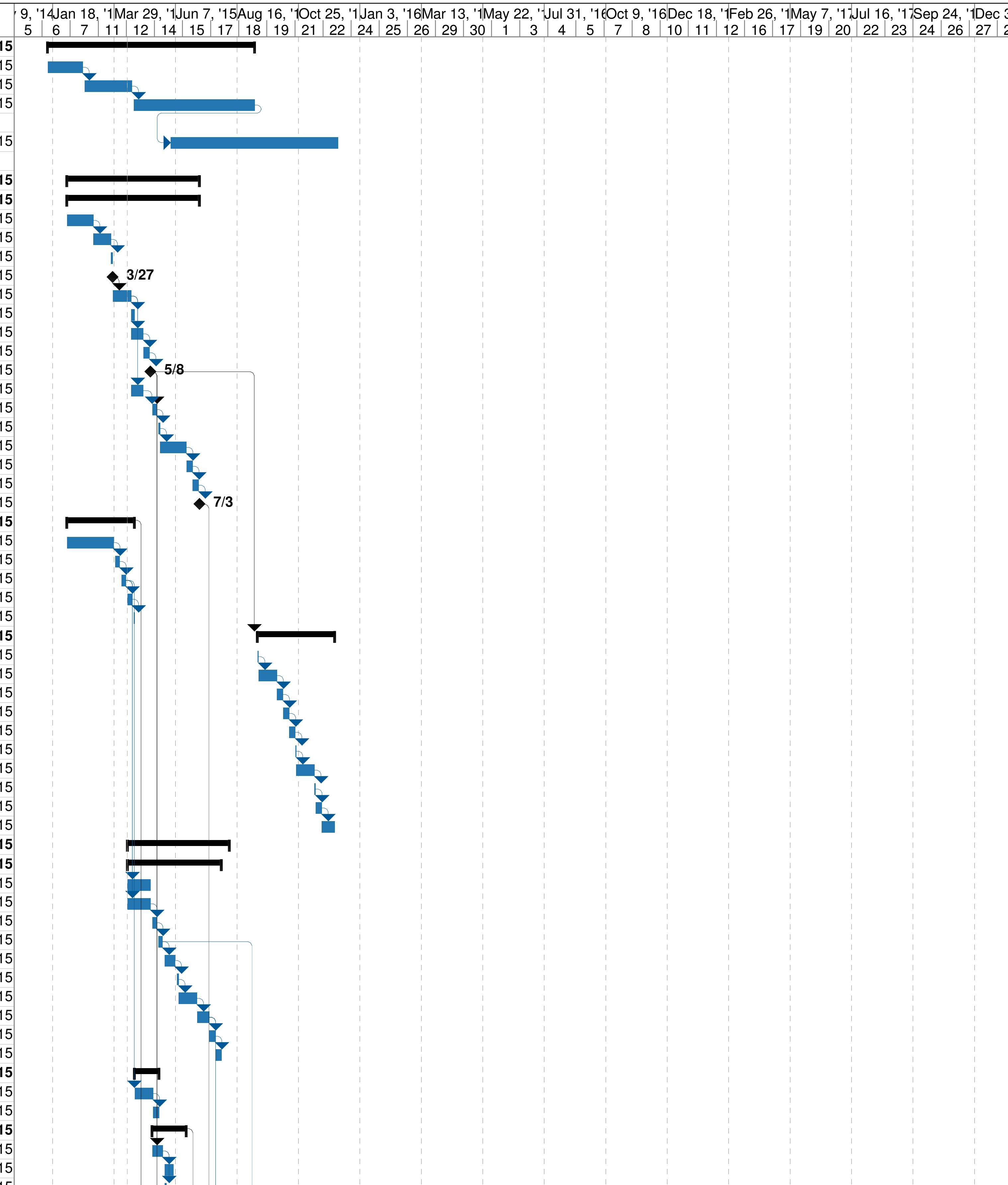
END OF SECTION

APPENDIX F

PROJECT SCHEDULE

3093 Broadway, Oakland, CA

ID	Task Name	Duration	Predecessors	Start	Finish
1	**Permit Drawings**	**170 days**		**Mon 1/12/15**	**Fri 9/4/15**
2	SD	30 days		Mon 1/12/15	Fri 2/20/15
3	DD	40 days	2	Mon 2/23/15	Fri 4/17/15
4	CD	100 days	3	Mon 4/20/15	Fri 9/4/15
5					
6	**Permitting/Bidding**	135 days	4FS-70 days	Mon 6/1/15	Tue 12/8/15
7					
8	**Remedial Planning and Design**	**109 days**		**Tue 2/3/15**	**Fri 7/3/15**
9	**FS-CAP**	**109 days**		**Tue 2/3/15**	**Fri 7/3/15**
10	Internal draft of FS-CAP	22 days		Tue 2/3/15	Wed 3/4/15
11	Client draft of FS-CAP	14 days	10	Thu 3/5/15	Tue 3/24/15
12	ACEH Draft of FS-CAP	2 days	11	Wed 3/25/15	Thu 3/26/15
13	Meeting with ACEH, Langan, and CityView	0 days		Fri 3/27/15	Fri 3/27/15
14	ACEH Review of FS-CAP	15 days	13	Fri 3/27/15	Thu 4/16/15
15	Mailing List for Public Review	2 days	14	Fri 4/17/15	Mon 4/20/15
16	Revisions to FS/CAP based on Comments from ACEH	10 days	14	Fri 4/17/15	Thu 4/30/15
17	ACEH Review of Redline FS-CAP	5 days	16	Fri 5/1/15	Thu 5/7/15
18	Finalize FS-CAP	1 day	17	Fri 5/8/15	Fri 5/8/15
19	Fact Sheet	10 days	14	Fri 4/17/15	Thu 4/30/15
20	ACEH Review of Fact Sheet	5 days	19,18	Mon 5/11/15	Fri 5/15/15
21	Mail Fact Sheet	2 days	20	Mon 5/18/15	Tue 5/19/15
22	Public Review Period (30 Days)	22 days	21	Wed 5/20/15	Thu 6/18/15
23	Prepare RTCs	5 days	22	Fri 6/19/15	Thu 6/25/15
24	ACEH Review of RTCs	5 days	23	Fri 6/26/15	Thu 7/2/15
25	Final FS-CAP	1 day	24	Fri 7/3/15	Fri 7/3/15
26	**Groundwater Sampling and Pilot Study Work Plan**	**55 days**		**Tue 2/3/15**	**Mon 4/20/15**
27	Draft Pilot Study Work Plan	39 days		Tue 2/3/15	Fri 3/27/15
28	ACEH Review of Pilot Study Work Plan	5 days	27	Mon 3/30/15	Fri 4/3/15
29	Revisions based on Comments from ACEH	5 days	28	Mon 4/6/15	Fri 4/10/15
30	ACEH Review of Redline Work Plan	5 days	29	Mon 4/13/15	Fri 4/17/15
31	Finalize Pilot Study Workplan	1 day	30	Mon 4/20/15	Mon 4/20/15
32	**VMS Design**	**63 days**	**18**	**Tue 9/8/15**	**Fri 12/4/15**
33	Structural Drawings to Langan	1 day		Tue 9/8/15	Tue 9/8/15
34	VMS Design 70%	15 days	33	Wed 9/9/15	Tue 9/29/15
35	Review by Architect/Structural/Contractor	5 days	34	Wed 9/30/15	Tue 10/6/15
36	Update design plans	5 days	35	Wed 10/7/15	Tue 10/13/15
37	ACEH Review and Comment	5 days	36	Wed 10/14/15	Tue 10/20/15
38	Meeting with City, Architect/Structural Engineer/Langan and ACEH	1 day	37	Wed 10/21/15	Wed 10/21/15
39	VMS Design 100%	15 days	38	Thu 10/22/15	Wed 11/11/15
40	ACEH Review	1 day	39	Thu 11/12/15	Thu 11/12/15
41	CQA Plan	5 days	40	Fri 11/13/15	Thu 11/19/15
42	OMP	10 days	41	Fri 11/20/15	Fri 12/4/15
43	**Design Investigations**	**84 days**		**Mon 4/13/15**	**Thu 8/6/15**
44	**Pilot Study and Groundwater Sampling**	**77 days**		**Mon 4/13/15**	**Tue 7/28/15**
45	Pilot Study Implementation Planning and Permitting	20 days	29	Mon 4/13/15	Fri 5/8/15
46	Onsite Well Installation Planning and Permitting	20 days	29	Mon 4/13/15	Fri 5/8/15
47	Onsite Groundwater Well Installation and Development	5 days	46	Mon 5/11/15	Fri 5/15/15
48	Pre-Remediation Groundwater Monitoring	5 days	47	Mon 5/18/15	Fri 5/22/15
49	Electron Acceptor Emplacement	10 days	48	Mon 5/25/15	Fri 6/5/15
50	Site Restoration and Demobilization	2 days	49	Mon 6/8/15	Tue 6/9/15
51	Technical Memorandum - GW Data and Design Confirmation	15 days	50	Wed 6/10/15	Tue 6/30/15
52	ACEH Review	10 days	51	Wed 7/1/15	Tue 7/14/15
53	Revisions based on Comments from ACEH	5 days	52	Wed 7/15/15	Tue 7/21/15
54	ACEH Review of Redline	5 days	53	Wed 7/22/15	Tue 7/28/15
55	**Offsite Well Installation**	**20 days**		**Tue 4/21/15**	**Mon 5/18/15**
56	Offsite Well Installation Planning and Permitting	15 days	29	Tue 4/21/15	Mon 5/11/15
57	Offsite Groundwater Well Installation and Development	5 days	56	Tue 5/12/15	Mon 5/18/15
58	**Soil Investigation**	**29 days**		**Mon 5/11/15**	**Thu 6/18/15**
59	Field Implementation Planning and Permitting	10 days	18	Mon 5/11/15	Fri 5/22/15
60	Soil Sampling Service Bay Area	8 days	59	Mon 5/25/15	Wed 6/3/15
61	Soil Sampling Site-Wide	2 days	59	Mon 5/25/15	Tue 5/26/15



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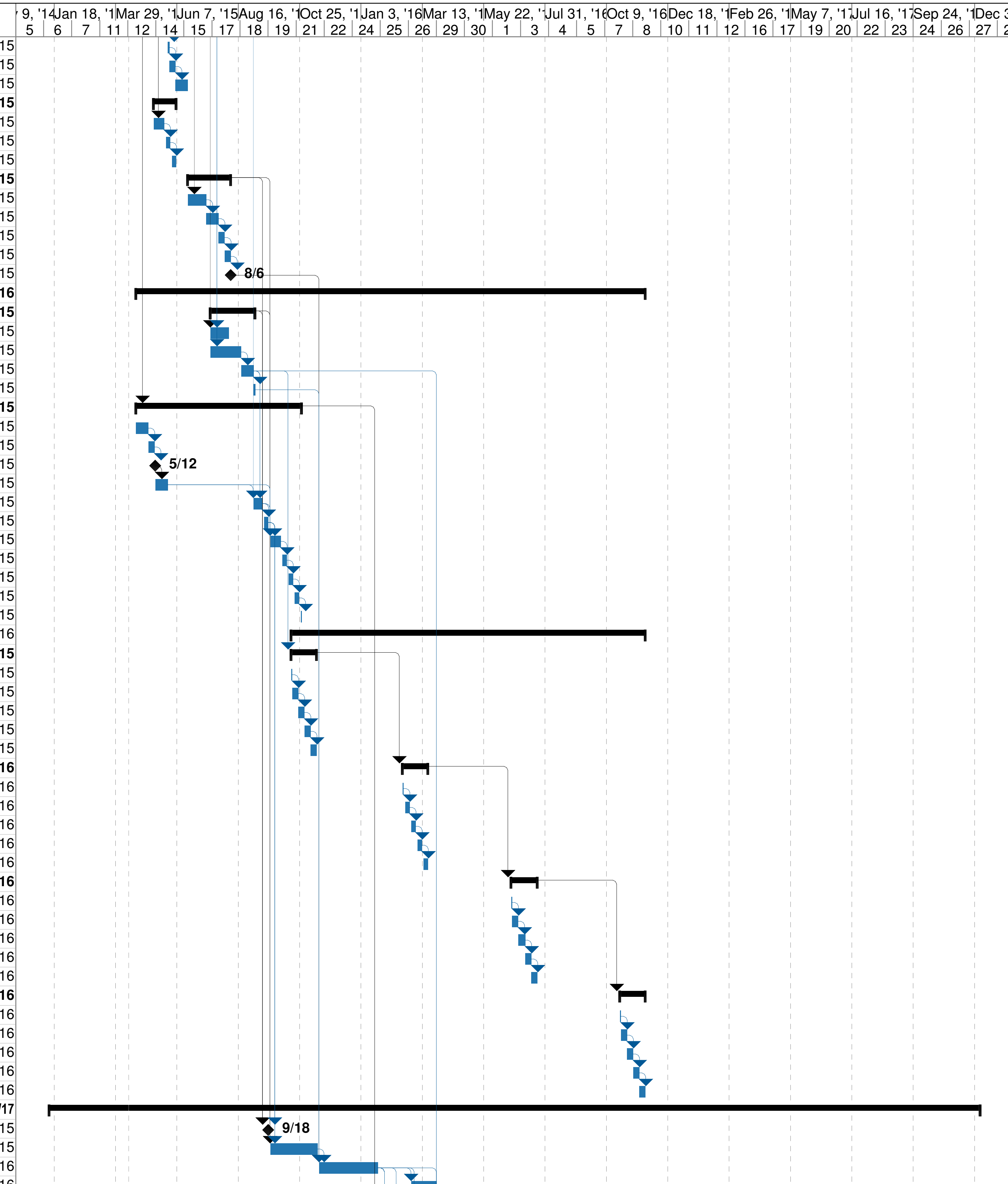
ID	Task Name	Duration	Predecessors	Start	Finish
62	Site Restoration and Demobilization	2 days	61	Wed 5/27/15	Thu 5/28/15
63	Sample Analysis	5 days	62	Fri 5/29/15	Thu 6/4/15
64	Soil Investigation Data Analysis	10 days	63	Fri 6/5/15	Thu 6/18/15
65	**Product pipeline investigation and line removal**	**20 days**		**Mon 5/11/15**	**Fri 6/5/15**
66	Field Implementation Planning and Permitting	10 days	18	Mon 5/11/15	Fri 5/22/15
67	Product Pipeline Investigation and Potholing	5 days	66	Mon 5/25/15	Fri 5/29/15
68	Trenching and Product Pipeline Removal	5 days	67	Mon 6/1/15	Fri 6/5/15
69	**Soil Management Plan For Construction**	**35 days**		**Fri 6/19/15**	**Thu 8/6/15**
70	Draft Soil Management Plan	15 days	58	Fri 6/19/15	Thu 7/9/15
71	ACEH Review of Soil Management Plan	10 days	70	Fri 7/10/15	Thu 7/23/15
72	Revisions based on Comments from ACEH	5 days	71	Fri 7/24/15	Thu 7/30/15
73	ACEH Review of Redline	5 days	72	Fri 7/31/15	Thu 8/6/15
74	Final SMP for Construction	0 days	73	Thu 8/6/15	Thu 8/6/15
75	**Corrective Action Implementation**	**405 days**		**Tue 4/21/15**	**Mon 11/21/16**
76	**Implementation of Enhanced Anaerobic Bioremediation**	**37 days**		**Wed 7/15/15**	**Thu 9/3/15**
77	Field Implementation Planning and Permitting	15 days	52,25	Wed 7/15/15	Tue 8/4/15
78	Acquire Materials (Gypsum, etc)	25 days	52	Wed 7/15/15	Tue 8/18/15
79	Electron Acceptor Emplacement	10 days	78	Wed 8/19/15	Tue 9/1/15
80	Site Restoration and Demobilization	2 days	79	Wed 9/2/15	Thu 9/3/15
81	**Onsite MW Destruction and AS/DPE System Removal**	**134 days**	**26**	**Tue 4/21/15**	**Mon 10/26/15**
82	Draft Work Plan for Removal/Destruction	10 days		Tue 4/21/15	Mon 5/4/15
83	ACEH Review of Work Plan for Removal/Destruction	5 days	82	Tue 5/5/15	Mon 5/11/15
84	ACEH Approval of Decommissioning	1 day	83	Tue 5/12/15	Tue 5/12/15
85	Field Implementation Planning and Permitting	10 days	84	Wed 5/13/15	Tue 5/26/15
86	Destroy Groundwater Monitoring Wells	7 days	85,48,79	Wed 9/2/15	Fri 9/11/15
87	Remove AS-DPE System	5 days	86	Mon 9/14/15	Fri 9/18/15
88	Letter Report	10 days	87,86,85	Mon 9/21/15	Fri 10/2/15
89	ACEH Review	5 days	88	Mon 10/5/15	Fri 10/9/15
90	Revisions based on Comments from ACEH	5 days	89	Mon 10/12/15	Fri 10/16/15
91	ACEH Review of Redline	5 days	90	Mon 10/19/15	Fri 10/23/15
92	Final Letter Report	1 day	91	Mon 10/26/15	Mon 10/26/15
93	**Remedial Progress Monitoring during Construction**	279 days		Thu 10/15/15	Mon 11/21/16
94	**GWM - 1st quarterly event**	**21 days**	**79FS+30 days**	**Thu 10/15/15**	**Thu 11/12/15**
95	GW Sample collection	1 day		Thu 10/15/15	Thu 10/15/15
96	Sample Analysis	5 days	95	Fri 10/16/15	Thu 10/22/15
97	Data Analysis	5 days	96	Fri 10/23/15	Thu 10/29/15
98	Report	5 days	97	Fri 10/30/15	Thu 11/5/15
99	ACEH Review	5 days	98	Fri 11/6/15	Thu 11/12/15
100	**GWM -2nd quarterly event**	**21 days**	**94FS+65 days**	**Fri 2/19/16**	**Fri 3/18/16**
101	GW Sample collection	1 day		Fri 2/19/16	Fri 2/19/16
102	Sample Analysis	5 days	101	Mon 2/22/16	Fri 2/26/16
103	Data Analysis	5 days	102	Mon 2/29/16	Fri 3/4/16
104	Report	5 days	103	Mon 3/7/16	Fri 3/11/16
105	ACEH Review	5 days	104	Mon 3/14/16	Fri 3/18/16
106	**GWM - 3rd quarterly event**	**21 days**	**100FS+65 days**	**Wed 6/22/16**	**Thu 7/21/16**
107	GW Sample collection	1 day		Wed 6/22/16	Wed 6/22/16
108	Sample Analysis	5 days	107	Thu 6/23/16	Wed 6/29/16
109	Data Analysis	5 days	108	Thu 6/30/16	Thu 7/7/16
110	Report	5 days	109	Fri 7/8/16	Thu 7/14/16
111	ACEH Review	5 days	110	Fri 7/15/16	Thu 7/21/16
112	**GWM - 4th quarterly event**	**21 days**	**106FS+65 days**	**Mon 10/24/16**	**Mon 11/21/16**
113	GW Sample collection	1 day		Mon 10/24/16	Mon 10/24/16
114	Sample Analysis	5 days	113	Tue 10/25/16	Mon 10/31/16
115	Data Analysis	5 days	114	Tue 11/1/16	Mon 11/7/16
116	Report	5 days	115	Tue 11/8/16	Mon 11/14/16
117	ACEH Review	5 days	116	Tue 11/15/16	Mon 11/21/16
118	**Construction**	**744 days**		**Mon 1/12/15**	**Fri 12/8/17**
119	Onsite Environmental Fieldwork Complete	0 days	87,76,69	Fri 9/18/15	Fri 9/18/15
120	Full Demolition	40 days	87,76,69	Mon 9/21/15	Fri 11/13/15
121	Grading / Sitework	45 days	120,74,80	Mon 11/16/15	Thu 1/21/16
122	VMS Construction Under Commercial	20 days	121,138	Mon 2/29/16	Mon 3/28/16



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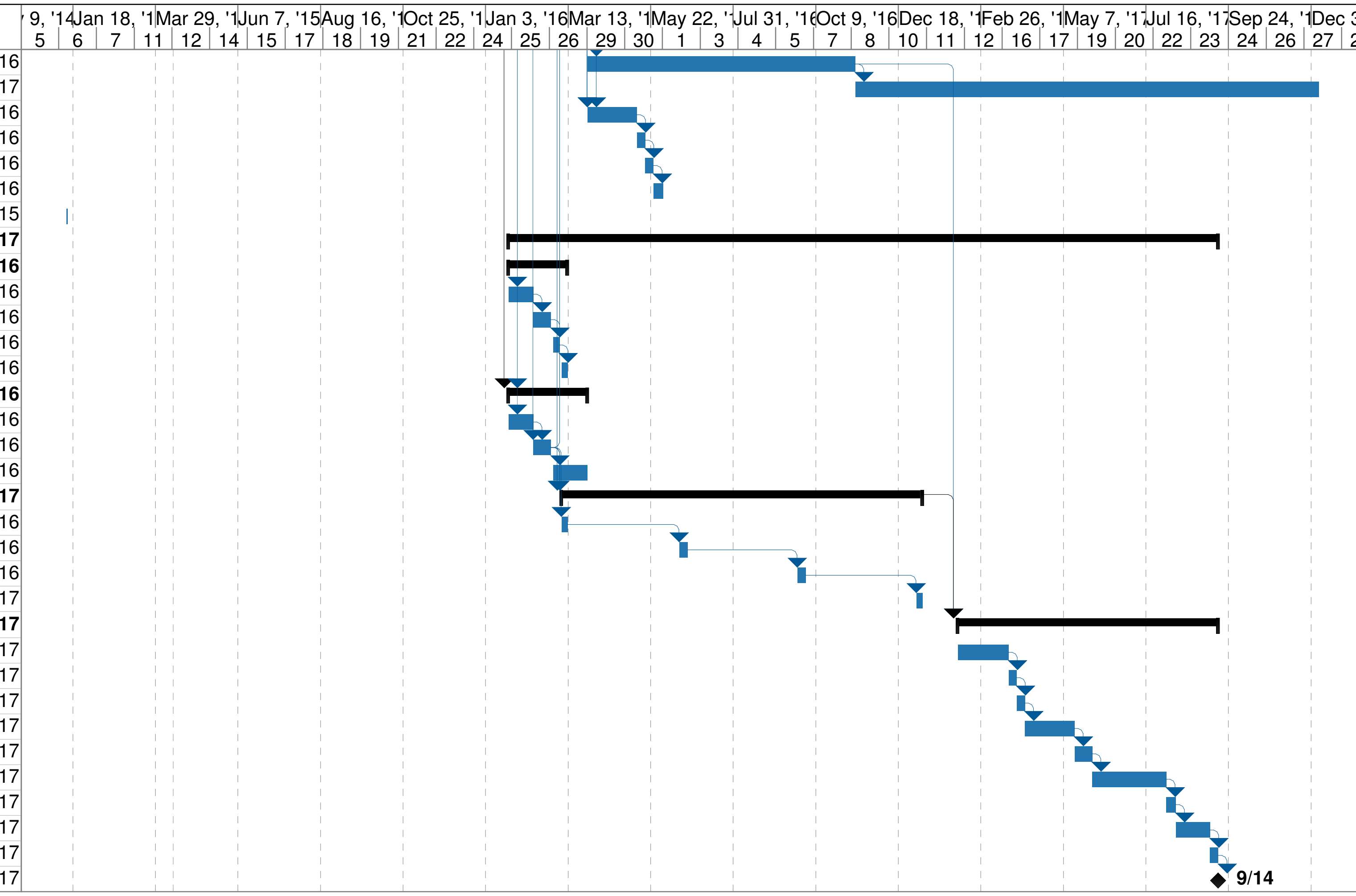
ID	Info	Task Name	Duration	Predecessors	Start	Finish
123		Foundation / Podium	160 days	122	Tue 3/29/16	Thu 11/10/16
124		Type III Construction	275 days	123	Fri 11/11/16	Fri 12/8/17
125		Corrective Action Implementation Completion Report	30 days	79,121,122	Tue 3/29/16	Mon 5/9/16
126		ACEH Review	5 days	125	Tue 5/10/16	Mon 5/16/16
127		Revisions based on Comments from ACEH	5 days	126	Tue 5/17/16	Mon 5/23/16
128		ACEH Review of Redline	5 days	127	Tue 5/24/16	Tue 5/31/16
129		Final Corrective Action Implementation Completion Report	1 day		Mon 1/12/15	Mon 1/12/15
130		**Case Closure**	**420 days**		**Fri 1/22/16**	**Thu 9/14/17**
131		**Soil Management Plan (Post Construction)**	**35 days**		**Fri 1/22/16**	**Fri 3/11/16**
132		Draft Soil Management Plan	15 days	121	Fri 1/22/16	Thu 2/11/16
133		ACEH Review of Soil Management Plan	10 days	132	Fri 2/12/16	Fri 2/26/16
134		Revisions based on Comments from ACEH	5 days	133	Mon 2/29/16	Fri 3/4/16
135		ACEH Review of Redline	5 days	134	Mon 3/7/16	Fri 3/11/16
136		**Post Construction Well Installation and Development**	**45 days**	**81,121**	**Fri 1/22/16**	**Mon 3/28/16**
137		Groundwater Monitoring Well Installation Planning and Permitting	15 days	121	Fri 1/22/16	Thu 2/11/16
138		Groundwater Well Installation and Development	10 days	121,137	Fri 2/12/16	Fri 2/26/16
139		Groundwater Well Installation Report	20 days	138	Mon 2/29/16	Mon 3/28/16
140		**Post Construction Groundwater Monitoring**	**215 days**	**121,138**	**Mon 3/7/16**	**Fri 1/6/17**
141		First Quarterly Groundwater Monitoring Event	5 days	138FS+5 days	Mon 3/7/16	Fri 3/11/16
142		Second Quarterly Groundwater Monitoring Event	5 days	141FS+65 days	Wed 6/15/16	Tue 6/21/16
143		Third Quarterly Groundwater Monitoring Event	5 days	142FS+65 days	Fri 9/23/16	Thu 9/29/16
144		Fourth Quarterly Groundwater Monitoring Event	5 days	143FS+65 days	Mon 1/2/17	Fri 1/6/17
145		**Data Evaluation and Case Closure Request**	**155 days**	**140FS+20 days,12**	**Mon 2/6/17**	**Thu 9/14/17**
146		Internal Draft Case Closure Report	30 days		Mon 2/6/17	Mon 3/20/17
147		Client Draft Case Closure Report	5 days	146	Tue 3/21/17	Mon 3/27/17
148		ACEH Draft Case Closure Report	5 days	147	Tue 3/28/17	Mon 4/3/17
149		ACEH Review of Case Closure Report	30 days	148	Tue 4/4/17	Mon 5/15/17
150		Revisions based on Comments from ACEH	10 days	149	Tue 5/16/17	Tue 5/30/17
151		Public Comment Period	44 days	150	Wed 5/31/17	Tue 8/1/17
152		Workplan for MW Abandonment	6 days	151	Wed 8/2/17	Wed 8/9/17
153		Monitoring Well Abandonment	20 days	152	Thu 8/10/17	Thu 9/7/17
154		Report of Well Abandonments	5 days	153	Fri 9/8/17	Thu 9/14/17
155		Closure	0 days	154	Thu 9/14/17	Thu 9/14/17



APPENDIX G

LOW-THREAT UNDERGROUND STORAGE TANK CASE CLOSURE POLICY

Low-Threat Underground Storage Tank Case Closure Policy

Preamble

The State Water Resources Control Board (State Water Board) administers the petroleum UST (Underground Storage Tank) Cleanup Program, which was enacted by the Legislature in 1984 to protect health, safety and the environment. The State Water Board also administers the petroleum UST Cleanup Fund (Fund), which was enacted by the Legislature in 1989 to assist UST owners and operators in meeting federal financial responsibility requirements and to provide reimbursement to those owners and operators for the high cost of cleaning up unauthorized releases caused by leaking USTs.

The State Water Board believes it is in the best interest of the people of the State that unauthorized releases be prevented and cleaned up to the extent practicable in a manner that protects human health, safety and the environment. The State Water Board also recognizes that the technical and economic resources available for environmental restoration are limited, and that the highest priority for these resources must be the protection of human health and environmental receptors. Program experience has demonstrated the ability of remedial technologies to mitigate a substantial fraction of a petroleum contaminant mass with the investment of a reasonable level of effort. Experience has also shown that residual contaminant mass usually remains after the investment of reasonable effort, and that this mass is difficult to completely remove regardless of the level of additional effort and resources invested.

It has been well-documented in the literature and through experience at individual UST release sites that petroleum fuels naturally attenuate in the environment through adsorption, dispersion, dilution, volatilization, and biological degradation. This natural attenuation slows and limits the migration of dissolved petroleum plumes in groundwater. The biodegradation of petroleum, in particular, distinguishes petroleum products from other hazardous substances commonly found at commercial and industrial sites.

The characteristics of UST releases and the California UST Program have been studied extensively, with individual works including:

a. Lawrence Livermore National Laboratory report (1995)
b. SB1764 Committee report (1996)
c. UST Cleanup Program Task Force report (2010)
d. Cleanup Fund Task Force report (2010)
e. Cleanup Fund audit (2010)
f. State Water Resources Control Board site closure orders
g. State Water Resources Control Board Resolution 2009-0081

In general, these efforts have recognized that many petroleum release cases pose a low threat to human health and the environment. Some of these studies also recommended establishing “low-threat” closure criteria in order to maximize the benefits to the people of the State of California through judicious application of available resources.

The purpose of this policy is to establish consistent statewide case closure criteria for low-threat petroleum UST sites. The policy is consistent with existing statutes, regulations, State Water Board precedential decisions, policies and resolutions, and is intended to provide clear direction to responsible parties, their service providers, and regulatory agencies. The policy seeks to increase UST cleanup process efficiency. A benefit of improved efficiency is the preservation of limited resources for mitigation of releases posing a greater threat to human and environmental health.

This policy is based in part upon the knowledge and experience gained from the last 25 years of investigating and remediating unauthorized releases of petroleum from USTs. While this policy does not specifically address other petroleum release scenarios such as pipelines or above ground storage tanks, if a particular site with a different petroleum release scenario exhibits attributes similar to those which this policy addresses, the criteria for closure evaluation of these non-UST sites should be similar to those in this policy.

This policy is a state policy for water quality control and applies to all petroleum UST sites subject to Chapter 6.7 of Division 20 of the Health and Safety Code and Chapter 16 of Division 3 of Title 23 of the California Code of Regulations. The term “regulatory agencies” in this policy means the State Water Board, Regional Water Quality Control Boards (Regional Water Boards) and local agencies authorized to implement Health and Safety Code section 25296.10. Unless expressly provided in this policy, the terms in this policy shall have the same definitions provided in Chapter 6.7 of Division 20 of the Health and Safety Code and Chapter 16 of Division 3 of Title 23 of the California Code of Regulations.

Criteria for Low-Threat Case Closure

In the absence of unique attributes of a case or site-specific conditions that demonstrably increase the risk associated with residual petroleum constituents, cases that meet the general and media-specific criteria described in this policy pose a low threat to human health, safety or the environment and are appropriate for closure pursuant to Health and Safety Code section 25296.10. Cases that meet the criteria in this policy do not require further corrective action and shall be issued a uniform closure letter consistent with Health and Safety Code section 25296.10. Annually, or at the request of the responsible party or party conducting the corrective action, the regulatory agency shall conduct a review to determine whether the site meets the criteria contained in this policy.

It is important to emphasize that the criteria described in this policy do not attempt to describe the conditions at all low-threat petroleum UST sites in the State. The regulatory agency shall issue a closure letter for a case that does not meet these criteria if the regulatory agency determines the site to be low-threat based upon a site specific analysis.

This policy recognizes that some petroleum-release sites may possess unique attributes and that some site specific conditions may make case closure under this policy inappropriate, despite the satisfaction of the stated criteria in this policy. It is impossible to completely capture those sets of attributes that may render a site ineligible for closure based on this low-threat policy. This policy relies on the regulatory agency’s use of the conceptual site model to identify the special attributes that would require specific attention prior to the application of low-threat criteria. In these cases, it is the regulatory agency’s responsibility to identify the conditions that make closure under the policy inappropriate.

General Criteria
General criteria that must be satisfied by all candidate sites are listed as follows:

a. The unauthorized release is located within the service area of a public water system;
b. The unauthorized release consists only of petroleum;
c. The unauthorized ("primary") release from the UST system has been stopped;
d. Free product has been removed to the maximum extent practicable;
e. A conceptual site model that assesses the nature, extent, and mobility of the release has been developed;
f. Secondary source has been removed to the extent practicable;
g. Soil or groundwater has been tested for methyl tert-butyl ether (MTBE) and results reported in accordance with Health and Safety Code section 25296.15; and
h. Nuisance as defined by Water Code section 13050 does not exist at the site.

a. The unauthorized release is located within the service area of a public water system
This policy is protective of existing water supply wells. New water supply wells are unlikely to be installed in the shallow groundwater near former UST release sites. However, it is difficult to predict, on a statewide basis, where new wells will be installed, particularly in rural areas that are undergoing new development. This policy is limited to areas with available public water systems to reduce the likelihood that new wells in developing areas will be inadvertently impacted by residual petroleum in groundwater. Case closure outside of areas with a public water system should be evaluated based upon the fundamental principles in this policy and a site specific evaluation of developing water supplies in the area. For purposes of this policy, a public water system is a system for the provision of water for human consumption through pipes or other constructed conveyances that has 15 or more service connections or regularly serves at least 25 individuals daily at least 60 days out of the year.

b. The unauthorized release consists only of petroleum
For the purposes of this policy, petroleum is defined as crude oil, or any fraction thereof, which is liquid at standard conditions of temperature and pressure, which means 60 degrees Fahrenheit and 14.7 pounds per square inch absolute, including the following substances: motor fuels, jet fuels, distillate fuel oils, residual fuel oils, lubricants, petroleum solvents and used oils, including any additives and blending agents such as oxygenates contained in the formulation of the substances.

c. The unauthorized release has been stopped
The tank, pipe, or other appurtenant structure that released petroleum into the environment (i.e. the primary source) has been removed, repaired or replaced. It is not the intent of this policy to allow sites with ongoing leaks from the UST system to qualify for low-threat closure.

d. Free product has been removed to the maximum extent practicable
At petroleum unauthorized release sites where investigations indicate the presence of free product, free product shall be removed to the maximum extent practicable. In meeting the requirements of this section:

(a) Free product shall be removed in a manner that minimizes the spread of the unauthorized release into previously uncontaminated zones by using recovery and disposal techniques appropriate to the hydrogeologic conditions at the site, and that properly treats, discharges or disposes of recovery byproducts in compliance with applicable laws;

(b) Abatement of free product migration shall be used as a minimum objective for the design of any free product removal system; and
(c) Flammable products shall be stored for disposal in a safe and competent manner to prevent fires or explosions.

e. A conceptual site model that assesses the nature, extent, and mobility of the release has been developed

The Conceptual Site Model (CSM) is a fundamental element of a comprehensive site investigation. The CSM establishes the source and attributes of the unauthorized release, describes all affected media (including soil, groundwater, and soil vapor as appropriate), describes local geology, hydrogeology and other physical site characteristics that affect contaminant environmental transport and fate, and identifies all confirmed and potential contaminant receptors (including water supply wells, surface water bodies, structures and their inhabitants). The CSM is relied upon by practitioners as a guide for investigative design and data collection. Petroleum release sites in California occur in a wide variety of hydrogeologic settings. As a result, contaminant fate and transport and mechanisms by which receptors may be impacted by contaminants vary greatly from location to location. Therefore, the CSM is unique to each individual release site. All relevant site characteristics identified by the CSM shall be assessed and supported by data so that the nature, extent and mobility of the release have been established to determine conformance with applicable criteria in this policy. The supporting data and analysis used to develop the CSM are not required to be contained in a single report and may be contained in multiple reports submitted to the regulatory agency over a period of time.

f. Secondary source has been removed to the extent practicable

"Secondary source" is defined as petroleum-impacted soil or groundwater located at or immediately beneath the point of release from the primary source. Unless site attributes prevent secondary source removal (e.g. physical or infrastructural constraints exist whose removal or relocation would be technically or economically infeasible), petroleum-release sites are required to undergo secondary source removal to the extent practicable as described herein. "To the extent practicable" means implementing a cost-effective corrective action which removes or destroys-in-place the most readily recoverable fraction of source-area mass. It is expected that most secondary mass removal efforts will be completed in one year or less. Following removal or destruction of the secondary source, additional removal or active remedial actions shall not be required by regulatory agencies unless (1) necessary to abate a demonstrated threat to human health or (2) the groundwater plume does not meet the definition of low threat as described in this policy.

g. Soil and groundwater have been tested for MTBE and results reported in accordance with Health and Safety Code section 25296.15

Health and Safety Code section 25296.15 prohibits closing a UST case unless the soil, groundwater, or both, as applicable have been tested for MTBE and the results of that testing are known to the Regional Water Board. The exception to this requirement is where a regulatory agency determines that the UST that leaked has only contained diesel or jet fuel. Before closing a UST case pursuant to this policy, the requirements of section 25296.15, if applicable, shall be satisfied.

h. Nuisance as defined by Water Code section 13050 does not exist at the site
Water Code section 13050 defines "nuisance" as anything which meets all of the following requirements:

(1) Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property.

(2) Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.

(3) Occurs during, or as a result of, the treatment or disposal of wastes.

For the purpose of this policy, waste means a petroleum release.

Media-Specific Criteria
Releases from USTs can impact human health and the environment through contact with any or all of the following contaminated media: groundwater, surface water, soil, and soil vapor. Although this contact can occur through ingestion, dermal contact, or inhalation of the various media, the most common drivers of health risk are ingestion of groundwater from drinking water wells, inhalation of vapors accumulated in buildings, contact with near surface contaminated soil, and inhalation of vapors in the outdoor environment. To simplify implementation, these media and pathways have been evaluated and the most common exposure scenarios have been combined into three media-specific criteria:

1. Groundwater
2. Vapor Intrusion to Indoor Air
3. Direct Contact and Outdoor Air Exposure

Candidate sites must satisfy all three of these media-specific criteria as described below.

1. Groundwater
This policy describes criteria on which to base a determination that threats to existing and anticipated beneficial uses of groundwater have been mitigated or are de minimis, including cases that have not affected groundwater.

State Water Board Resolution 92-49, *Policies and Procedures for Investigation and Cleanup and Abatement of Discharges Under Water Code Section 13304* is a state policy for water quality control and applies to petroleum UST cases. Resolution 92-49 directs that water affected by an unauthorized release attain either background water quality or the best water quality that is reasonable if background water quality cannot be restored. Any alternative level of water quality less stringent than background must be consistent with the maximum benefit to the people of the state, not unreasonably affect current and anticipated beneficial use of affected water, and not result in water quality less than that prescribed in the water quality control plan for the basin within which the site is located. Resolution No. 92-49 does not require that the requisite level of water quality be met at the time of case closure; it specifies compliance with cleanup goals and objectives within a reasonable time frame.

Water quality control plans (Basin Plans) generally establish “background” water quality as a restorative endpoint. This policy recognizes the regulatory authority of the Basin Plans but underscores the flexibility contained in Resolution 92-49.

It is a fundamental tenet of this low-threat closure policy that if the closure criteria described in this policy are satisfied at a petroleum unauthorized release site, attaining background water quality is not feasible, establishing an alternate level of water quality not to exceed that prescribed in the applicable Basin Plan is appropriate, and that water quality objectives will be attained through natural attenuation within a reasonable time, prior to the expected need for use of any affected groundwater.

If groundwater with a designated beneficial use is affected by an unauthorized release, to satisfy the media-specific criteria for groundwater, the contaminant plume that exceeds water quality objectives must be stable or decreasing in areal extent, and meet all of the additional characteristics of one of the five classes of sites listed below. A plume that is “stable or decreasing” is a contaminant mass that has expanded to its maximum extent: the distance from the release where attenuation exceeds migration.

Groundwater-Specific Criteria

(1) a. The contaminant plume that exceeds water quality objectives is less than 100 feet in length.
b. There is no free product.
c. The nearest existing water supply well or surface water body is greater than 250 feet from the defined plume boundary.

(2) a. The contaminant plume that exceeds water quality objectives is less than 250 feet in length.
b. There is no free product.
c. The nearest existing water supply well or surface water body is greater than 1,000 feet from the defined plume boundary.
d. The dissolved concentration of benzene is less than 3,000 micrograms per liter (µg/l), and the dissolved concentration of MTBE is less than 1,000 µg/l.

(3) a. The contaminant plume that exceeds water quality objectives is less than 250 feet in length.
b. Free product has been removed to the maximum extent practicable, may still be present below the site where the release originated, but does not extend off-site.
c. The plume has been stable or decreasing for a minimum of five years.
d. The nearest existing water supply well or surface water body is greater than 1,000 feet from the defined plume boundary.
e. The property owner is willing to accept a land use restriction if the regulatory agency requires a land use restriction as a condition of closure.

(4) a. The contaminant plume that exceeds water quality objectives is less than 1,000 feet in length.
b. There is no free product.
c. The nearest existing water supply well or surface water body is greater than 1,000 feet from the defined plume boundary.
d. The dissolved concentration of benzene is less than 1,000 µg/l, and the dissolved concentration of MTBE is less than 1,000 µg/l.

(5) a. The regulatory agency determines, based on an analysis of site specific conditions that under current and reasonably anticipated near-term future scenarios, the contaminant plume poses a low threat to human health and safety and to the environment and water quality objectives will be achieved within a reasonable time frame.

Sites with Releases That Have Not Affected Groundwater

Sites with soil that does not contain sufficient mobile constituents [leachate, vapors, or light non-aqueous-phase liquids (LNAPL)] to cause groundwater to exceed the groundwater criteria in this policy shall be considered low-threat sites for the groundwater medium. Provided the general criteria and criteria for other media are also met, those sites are eligible for case closure.

For older releases, the absence of current groundwater impact is often a good indication that residual concentrations present in the soil are not a source for groundwater pollution.

2. Petroleum Vapor Intrusion to Indoor Air

Exposure to petroleum vapors migrating from soil or groundwater to indoor air may pose unacceptable human health risks. This policy describes conditions, including bioattenuation zones, which if met will assure that exposure to petroleum vapors in indoor air will not pose unacceptable health risks. In many petroleum release cases, potential human exposures to vapors are mitigated by bioattenuation processes as vapors migrate toward the ground surface. For the purposes of this section, the term "bioattenuation zone" means an area of soil with conditions that support biodegradation of petroleum hydrocarbon vapors.

The low-threat vapor-intrusion criteria described below apply to sites where the release originated and impacted or potentially impacted adjacent parcels when: (1) existing buildings are occupied or may be reasonably expected to be occupied in the future, or (2) buildings for human occupancy are reasonably expected to be constructed in the future. Appendices 1 through 4 (attached) illustrate four potential exposure scenarios and describe characteristics and criteria associated with each scenario. Petroleum release sites shall satisfy the media-specific criteria for petroleum vapor intrusion to indoor air and be considered low-threat for the vapor-intrusion-to-indoor-air pathway if:

a. Site-specific conditions at the release site satisfy all of the characteristics and criteria of scenarios 1 through 3 as applicable, or all of the characteristics and criteria of scenario 4 as applicable; or

b. A site-specific risk assessment for the vapor intrusion pathway is conducted and demonstrates that human health is protected to the satisfaction of the regulatory agency; or

c. As a result of controlling exposure through the use of mitigation measures or through the use of institutional or engineering controls, the regulatory agency determines that petroleum vapors migrating from soil or groundwater will have no significant risk of adversely affecting human health.

Exception: 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 fueling facilities, except in cases where release characteristics can be reasonably believed to pose an unacceptable health risk.

3. Direct Contact and Outdoor Air Exposure

This policy describes conditions where direct contact with contaminated soil or inhalation of contaminants volatized to outdoor air poses a low threat to human health. Release sites where human exposure may occur satisfy the media-specific criteria for direct contact and outdoor air exposure and shall be considered low-threat if they meet any of the following:

a. Maximum concentrations of petroleum constituents in soil are less than or equal to those listed in Table 1 for the specified depth below ground surface (bgs). The concentration limits for 0 to 5 feet bgs protect from ingestion of soil, dermal contact with soil, and inhalation of volatile soil emissions and inhalation of particulate emissions. The 5 to 10 feet bgs concentration limits protect from inhalation of volatile soil emissions. Both the 0 to 5 feet bgs concentration limits and the 5 to 10 feet bgs concentration limits for the appropriate site classification (Residential or Commercial/Industrial) shall be satisfied. In addition, if exposure to construction workers or utility trench workers are reasonably anticipated, the concentration limits for Utility Worker shall also be satisfied; or

b. Maximum concentrations of petroleum constituents in soil are less than levels that a site specific risk assessment demonstrates will have no significant risk of adversely affecting human health; or

c. As a result of controlling exposure through the use of mitigation measures or through the use of institutional or engineering controls, the regulatory agency determines that the concentrations of petroleum constituents in soil will have no significant risk of adversely affecting human health.

Table 1

Concentrations of Petroleum Constituents in Soil That Will Have No Significant Risk of Adversely Affecting Human Health

Chemical	Residential		Commercial/ Industrial		Utility Worker
	0 to 5 feet bgs mg/kg	Volatilization to outdoor air (5 to 10 feet bgs) mg/kg	0 to 5 feet bgs mg/kg	Volatilization to outdoor air (5 to 10 feet bgs) mg/kg	0 to 10 feet bgs mg/kg
Benzene	1.9	2.8	8.2	12	14
Ethylbenzene	21	32	89	134	314
Naphthalene	9.7	9.7	45	45	219
PAH[1]	0.063	NA	0.68	NA	4.5

Notes:
1. Based on the seven carcinogenic poly-aromatic hydrocarbons (PAHs) as benzo(a)pyrene toxicity equivalent [BaPe]. Sampling and analysis for PAH is only necessary where soil as affected by either waste oil or Bunker C fuel.
2. The area of impacted soil where a particular exposure occurs is 25 by 25 meters (approximately 82 by 82 feet) or less.
3. NA = not applicable
4. mg/kg = milligrams per kilogram

Low-Threat Case Closure

Cases that meet the general and media-specific criteria established in this policy pose a low threat to human health, safety and the environment and satisfy the case-closure requirements of Health and Safety Code section 25296.10, and case closure is consistent with State Water Board Resolution 92-49 that requires that cleanup goals and objectives be met within a reasonable time frame. If the case has been determined by the regulatory agency to meet the criteria in this policy, the regulatory agency shall notify responsible parties that they are eligible for case closure and that the following items, if applicable, shall be completed prior to the issuance of a uniform closure letter specified in Health and Safety Code section 25296.10. After completion of these items, and unless the regulatory agency revises its determination based on comments received on the proposed case closure, the regulatory agency shall issue a uniform closure letter within 30 days from the end of the comment period.

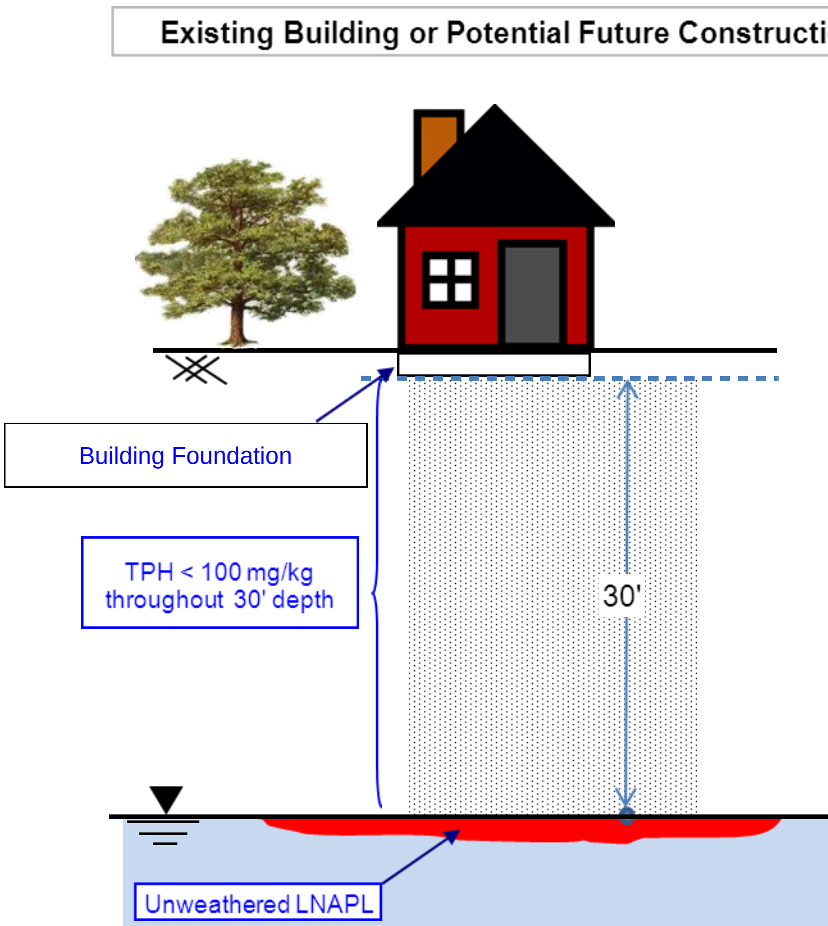
a. Notification Requirements – Municipal and county water districts, water replenishment districts, special act districts with groundwater management authority, agencies with authority to issue building permits for land affected by the petroleum release, owners and occupants of the property impacted by the petroleum release, and the owners and occupants of all parcels adjacent to the impacted property shall be notified of the proposed case closure and provided a 60 day period to comment. The regulatory agency shall consider any comments received when determining if the case should be closed or if site specific conditions warrant otherwise.

b. Monitoring Well Destruction – All wells and borings installed for the purpose of investigating, remediating, or monitoring the unauthorized release shall be properly destroyed prior to case closure unless a property owner certifies that they will keep and maintain the wells or borings in accordance with applicable local or state requirements.

c. Waste Removal – All waste piles, drums, debris and other investigation or remediation derived materials shall be removed from the site and properly managed in accordance with regulatory agency requirements.

Appendix 1
Scenario 1: Unweathered* LNAPL in Groundwater

Required Characteristics of the Bioattenuation Zone



Required Characteristics of the Bioattenuation Zone:

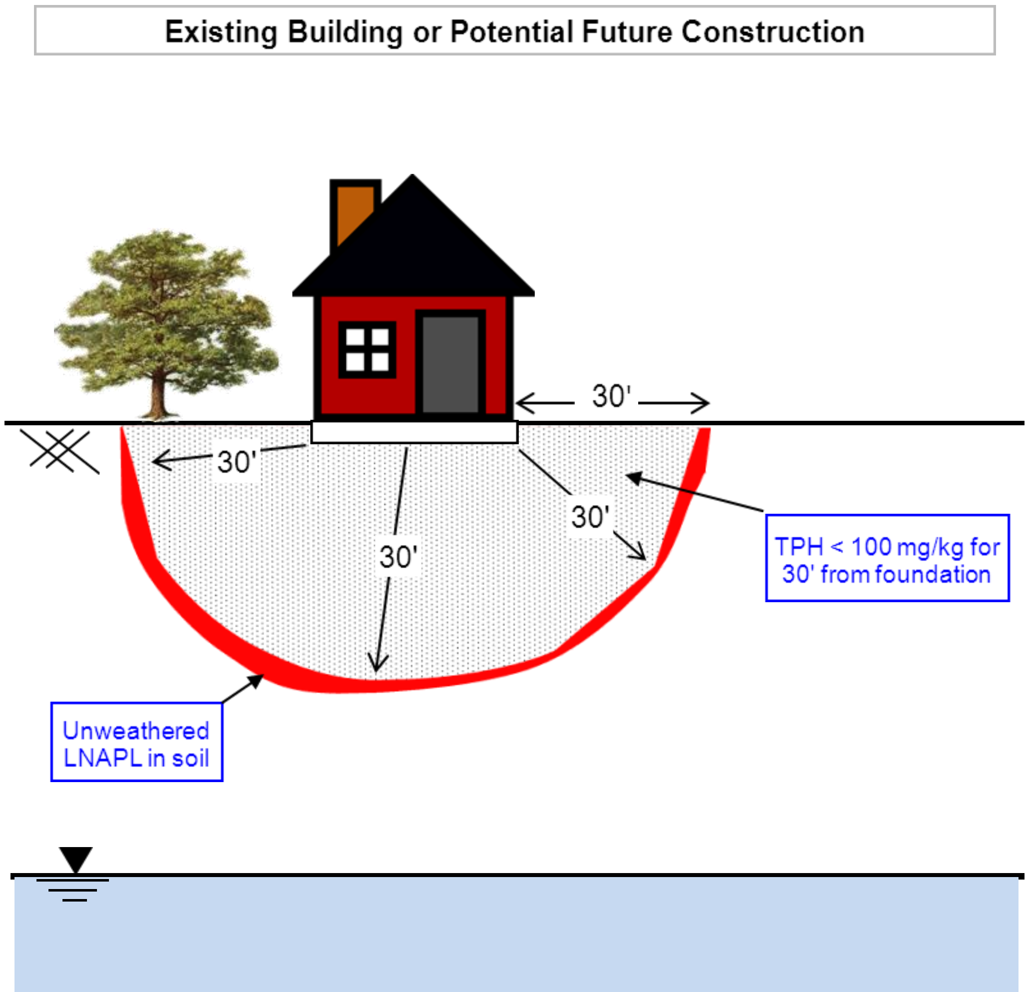
1. The bioattenuation zone shall be a continuous zone that provides a separation of at least 30 feet vertically between the LNAPL in groundwater and the foundation of existing or potential buildings; and
2. Total TPH (TPH-g and TPH-d combined) are less than 100 mg/kg throughout the entire depth of the bioattenuation zone.

TPH = total petroleum hydrocarbons
TPH-g = total petroleum hydrocarbons as gasoline
TPH-d = total petroleum hydrocarbons as diesel

*As used in this context, unweathered LNAPL is generally understood to mean petroleum product that has not been subjected to significant volatilization or solubilization, and therefore has not lost a significant portion of its volatile or soluble constituents (e.g., comparable to recently dispensed fuel).

Appendix 2
Scenario 2: Unweathered* LNAPL in Soil

Required Characteristics of the Bioattenuation Zone



Required Characteristics of the Bioattenuation Zone:

1. The bioattenuation zone shall be a continuous zone that provides a separation of at least 30 feet both laterally and vertically between the LNAPL in soil and the foundation of existing or potential buildings, and
2. Total TPH (TPH-g and TPH-d combined) are less than 100 mg/kg throughout the entire lateral and vertical extent of the bioattenuation zone.

*As used in this context, unweathered LNAPL is generally understood to mean petroleum product that has not been subjected to significant volatilization or solubilization, and therefore has not lost a significant portion of its volatile or soluble constituents (e.g., comparable to recently dispensed fuel).

Appendix 3
Scenario 3 - Dissolved Phase Benzene Concentrations in Groundwater
(Low concentration groundwater scenarios with or without oxygen data)
(1 of 2)

Defining the Bioattenuation Zone Without Oxygen Data or Oxygen < 4%

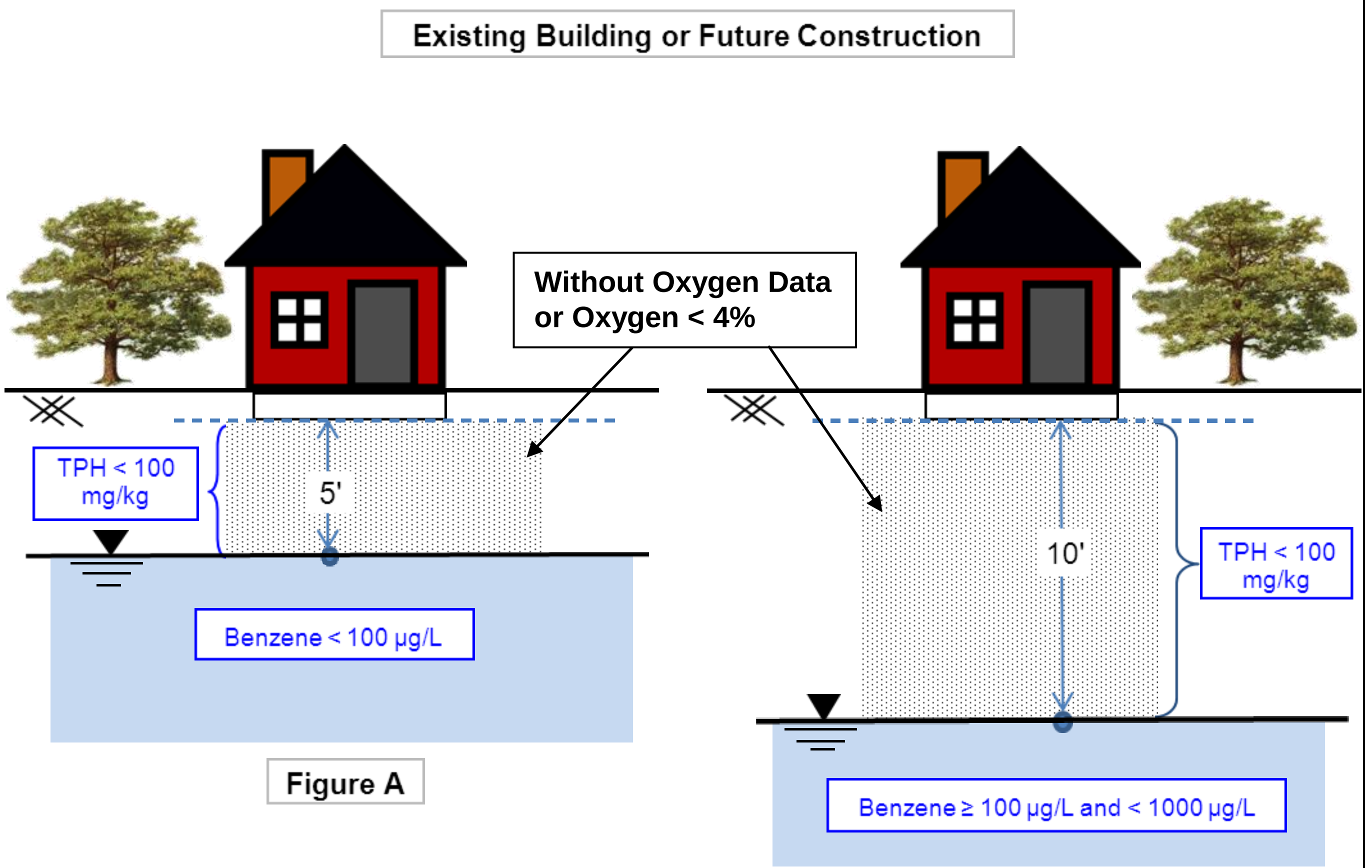


Figure A

Figure B

Required Characteristics of Bioattenuation Zone for Sites Without Oxygen Data or Where Oxygen is < 4%

Figure A: 1) Where benzene concentrations are less than 100 µg/L, the bioattenuation zone:

a) Shall be a continuous zone that provides a separation of at least 5 feet vertically between the dissolved phase Benzene and the foundation of existing or potential buildings; and
b) Contain Total TPH (TPH-g and TPH-d combined) less than 100 mg/kg throughout the entire depth of the bioattenuation zone.

Figure B: 1) Where benzene concentrations are equal to or greater than 100 µg/L but less than 1000 µg/L, the bioattenuation zone:

a) Shall be a continuous zone that provides a separation of at least 10 feet vertically between the dissolved phase Benzene and the foundation of existing or potential buildings; and b) Contain Total TPH (TPH-g and TPH-d combined) less than 100 mg/kg throughout the entire depth of the bioattenuation zone.

Appendix 3
Scenario 3 - Dissolved Phase Benzene Concentrations in Groundwater
(Low concentration groundwater scenarios with or without oxygen data)
(2 of 2)

Defining the Bioattenuation Zone With Oxygen ≥ 4%

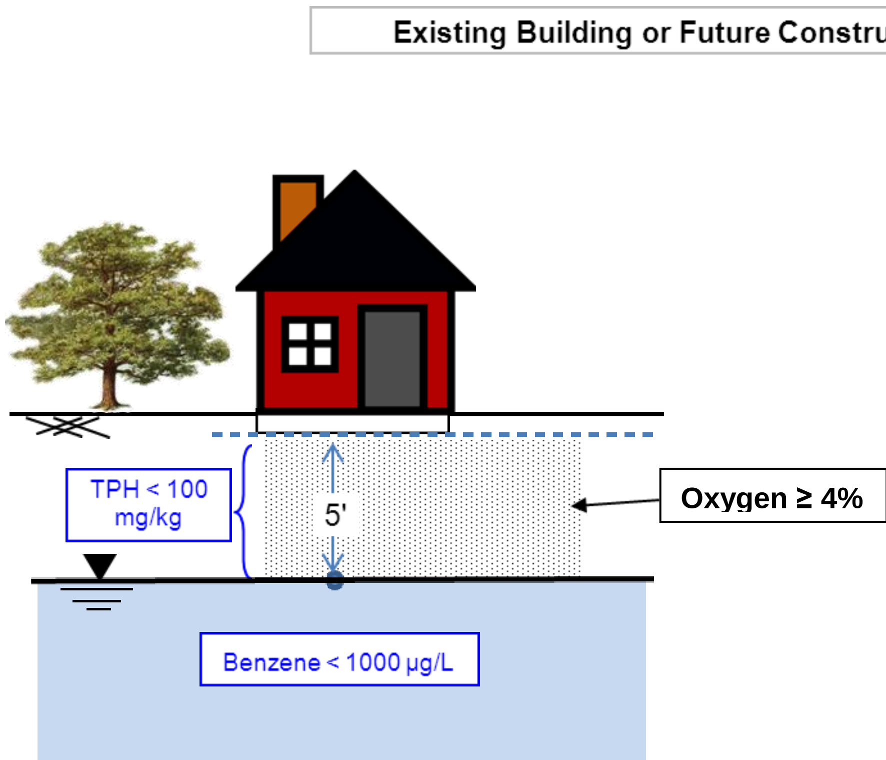


Figure C

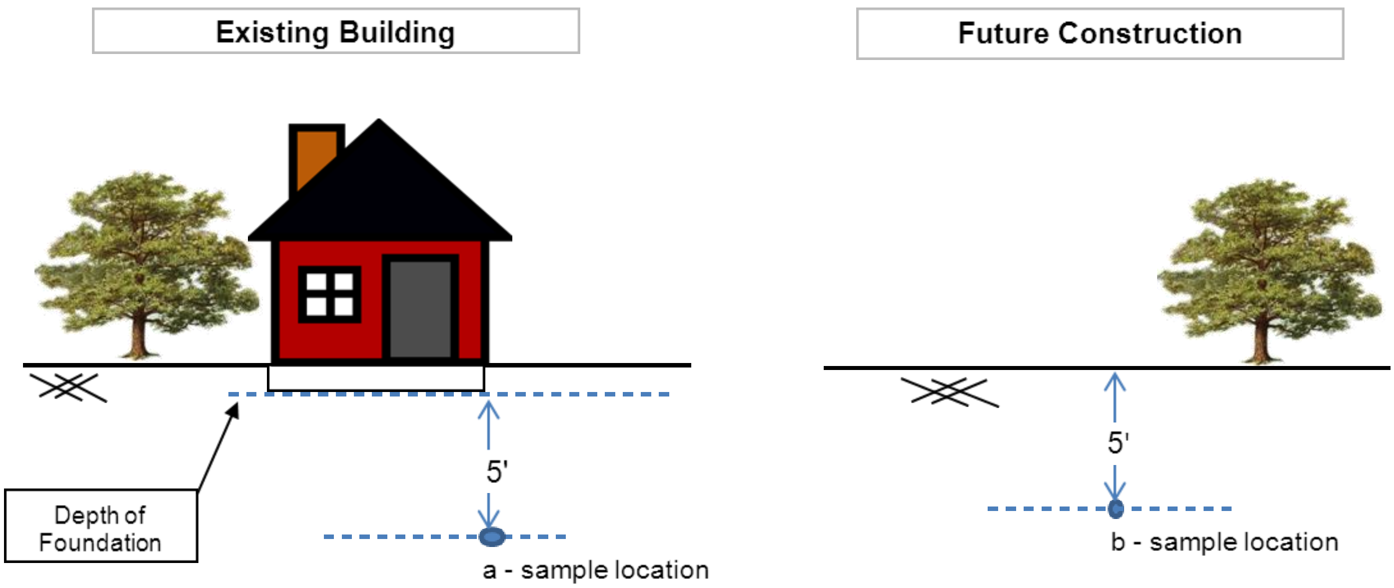
Required Characteristics of Bioattenuation Zone for Sites With Oxygen ≥ 4%

Where benzene concentrations are less than 1000 µg/L, the bioattenuation zone:

1. Shall be a continuous zone that provides a separation of least 5 feet vertically between the dissolved phase Benzene and the foundation of existing or potential buildings; and
2. Contain Total TPH (TPH-g and TPH-d combined) less than 100 mg/kg throughout the entire depth of the bioattenuation zone.

Appendix 4
Scenario 4 - Direct Measurement of Soil Gas Concentrations
(1 of 2)

Soil Gas Sampling – No Bioattenuation Zone



The criteria in the table below apply unless the requirements for a bioattenuation zone, established below, are satisfied.

When applying the criteria below, the soil gas sample must be obtained from the following locations:

a. Beneath or adjacent to an existing building: The soil gas sample shall be collected at least five feet below the bottom of the building foundation.
b. Future construction: The soil gas sample shall be collected from at least five feet below ground surface.

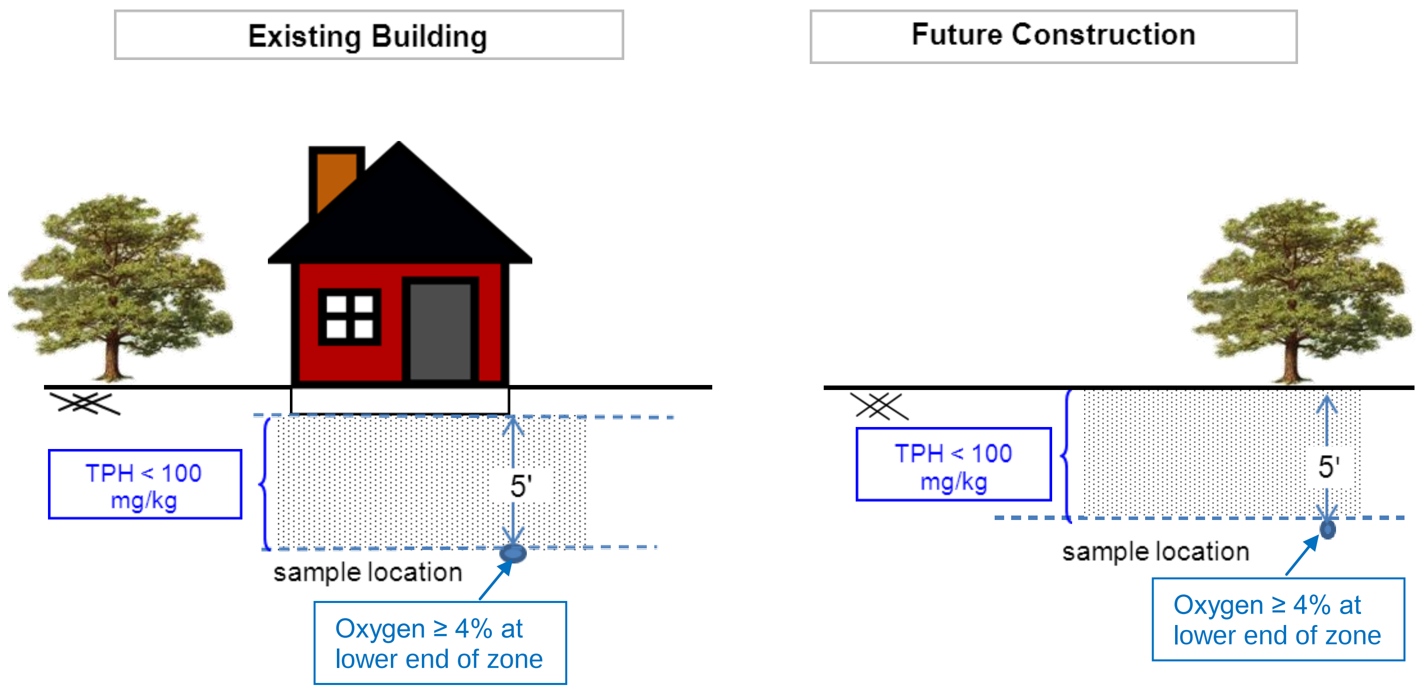
Soil Gas Criteria (µg/m^3)

	No Bioattenuation Zone*	
	Residential	**Commercial**
Constituent	Soil Gas Concentration (µg/m^3)	
Benzene	< 85	< 280
Ethylbenzene	<1,100	<3,600
Naphthalene	< 93	< 310

*For the no bioattenuation zone, the screening criteria are same as the California Human Health Screening Levels (CHHSLs) with engineered fill below sub-slab.

Appendix 4
Scenario 4 - Direct Measurement of Soil Gas Concentrations
(2 of 2)

Soil Gas Sampling – With Bioattenuation Zone



The criteria in the table below apply if the following requirements for a biattenuation zone are satisfied:

1. There is a minimum of five vertical feet of soil between the soil vapor measurement and the foundation of an existing building or ground surface of future construction.
2. TPH (TPHg + TPHd) is less than 100 mg/kg (measured in at least two depths within the five-foot zone.)
3. Oxygen is greater than or equal to four percent measured at the bottom of the five-foot zone.

Soil Gas Criteria (µg/m^3)		
	With Bioattenuation Zone**	
	Residential	**Commercial**
Constituent	Soil Gas Concentration (µg/m^3)	
Benzene	< 85,000	< 280,000
Ethylbenzene	<1,100,000	<3,600,000
Naphthalene	< 93,000	< 310,000

**A 1000-fold bioattenuation of petroleum vapors is assumed for the bioattenuation zone.