May 7, 2021

Joel Waxdeck
Assistant City Engineer
Engineering Division
City of Livermore
1052 South Livermore Ave
Livermore, CA 94550
jhwaxdeck@cityoflivermore.net

Re: **Data Gap Assessment Workplan**
Old Train Depot
APN: 098-0289-02100
20, 22 & 24 S. L Street & 2009 – 2073 Railroad Avenue
Livermore, California
SFBRWQCB Case No. 01S0831, Global ID T10000016758

Dear Mr. Waxdeck:

PANGEA Environmental Services, Inc. prepared this *Data Gap Assessment Workplan* for the subject site. This Workplan was requested by the San Francisco Bay Regional Water Quality Control Board letter dated February 9, 2021. The objective of the proposed assessment is to further characterize site conditions and help facilitate interim remedial action in advance of site development planned to commence in 2022. An interim remedial action plan will be provided in a separate report.

Pangea is pleased to provide this report to the City of Livermore. If you have any questions, feel free to contact me at (510) 435-8664 or briddell@pangeaenv.com.

Sincerely,
PANGEA Environmental Services, Inc.

Bob Clark-Riddell, P.E.
Principal Engineer

Attachment: *Data Gap Assessment Workplan*

cc: Bob Vinn, City of Livermore (electronic copy)

DATA GAP ASSESSMENT WORKPLAN

Old Train Depot
20, 22 & 24 S. L Street & 2009 – 2073 Railroad Avenue
Livermore, California 94550

May 7, 2021

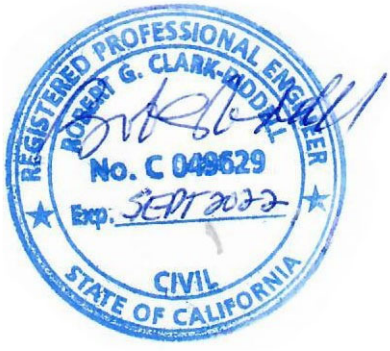
Prepared for:

City of Livermore
Engineering Division
1052 South Livermore Avenue
Livermore, California 94550

Prepared by:

PANGEA Environmental Services, Inc.
1250 Addison Street, Suite 213
Berkeley, California 94702

Written by:



Morgan Gillies
Project Manager

Bob Clark-Riddell, P.E.
Principal Engineer

DATA GAP ASSESSMENT WORKPLAN

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20, 22 & 24 S. L Street & 2009 – 2073 Railroad Avenue
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ATTACHMENTS

1.0 INTRODUCTION

PANGEA Environmental Services, Inc. (PANGEA) prepared this *Data Gap Assessment Workplan* (Workplan) for the subject site at 20, 22 and 24 S. L Street and 2009 to 2073 Railroad Avenue (Site). This Workplan was requested by the San Francisco Bay Regional Water Quality Control Board letter dated February 9, 2021 (Appendix A). The Site is in the northwest corner of Livermore Village and was historically used as a train depot and lumber yard (Figure 3B). Planned redevelopment of the Site includes construction of multifamily residences and Veteran's Park, scheduled to commence in early to mid 2022. The objective of the proposed assessment is to further characterize site conditions and help facilitate interim remedial action in advance of the planned site development. An interim remedial action plan will be provided in a separate report. The site background, site conceptual model and data gaps, and proposed data gap investigation activities are described below.

2.0 SITE BACKGROUND

This section describes the planned development, site history, prior environmental investigation, and constituents of concern from historical assessment data.

2.1 Prospective Development

Prospective development of the Site consists of construction of two multi-family residential building with approximately 130 units over underground or podium parking and a communal park (Veteran's Park).

The multifamily residences and Veteran's Park are a subset of the larger Downtown Core Development project (Figure 2). The Livermore Downtown Core Development project will involve several work phases by numerous contractors. The project area was initially developed with multiple single-story commercial retail buildings and paved and unpaved parking lots. The first development project consisted of a six-phase temporary parking plan. The future development project consists of construction of the following: (1) multi-family residential buildings with 130 units over a multi-level and underground parking structure; (2) a multi-level parking structure with underground parking; (3) several one-story commercial retail and two-story arts and science buildings; (4) a four-story hotel; (5) communal landscaped areas surrounding the proposed buildings, and (6) surface parking areas.

The footprint of the old train depot is located within Veteran's Park and overlaps with some planned multifamily residences. The City's grading plan for the project will include the import of top soil for the upper 2 ft of all lawn/landscaping areas. The location of former Site buildings and proposed buildings are shown on Figure 3.

2.2 Site History

According to project documents (Fugro, 2007a; Fugro, 2007b; SCI, 1998), historical site use for the Site included:

- Multiple railroad lines that ran parallel and approximately 100 to 350 ft south of Railroad Avenue;
- Former railroad depot building (Southern Pacific Railroad) at 22 South L Street; and
- Former lumber storage yard located at the corner of Railroad Avenue and L Street.

According to project documents (Fugro, 2007a; Fugro 2007b; SCI, 1998), historical site use for nearby properties within the Livermore Downtown Core Development project area has included, but was not limited to, the following:

- Former dry cleaner operations (J Cleaners) at 2093 Railroad Avenue and former dry cleaner operations (Quality Cleaners) at 2048 First Street;
- Auto body operations at 2121 and 2139 Railroad Avenue; and
- Various other commercial and industrial site uses, as well as paved parking lots.

2.3 Summary of Prior Environmental Investigation

- **May 2005, Fugro:** Data from the 2005 assessment by Fugro indicated the presence of petroleum hydrocarbons in soil and groundwater, and VOCs in groundwater at the Site. The detected petroleum hydrocarbons at the Site were primarily TPHg, TPHd, and TPHmo. The VOC primarily detected in groundwater beneath the Site was PCE (a common degreasing chemical), with a much smaller fraction of breakdown product TCE. Select concentrations detected in Site soil and groundwater exceed current 2019 Tier 1 environmental screening levels (ESLs) established by the San Francisco Regional Water Quality Control Board. Assessment procedures, results and conclusions of the 2005 investigation are documented in Fugro's *Phase 2 Summary Report* dated May 13, 2005.

- **April-May 2018, BSK:** In April and May 2018, BSK Associates performed shallow soil sampling for analysis of petroleum hydrocarbons and metals. Arsenic, lead, and nickel were detected at concentrations above 2019 Tier I ESLs. Most metal concentrations above Tier 1 ESL screening levels may represent background soil conditions (Lawrence Berkeley National Laboratory [LBNL], 2009). Arsenic concentrations in select samples above background conditions within the upper 2 ft of soil were located on the Site, possibly associated with the former lumber and/or railroad depot operations. Arsenic was reportedly used historically as a rodenticide in this area. Historical

property redevelopment reportedly involved the import of shallow material, an explanation for higher arsenic concentrations detected at 10 to 16 inches bgs than at 0 to 6 inches bgs.

- **June-November 2018, Pangea:** The 2018 investigation by Pangea included soil gas sampling from shallow and deep soil gas wells, soil sampling during select soil gas well installation, sampling of shallow zone groundwater via monitoring well MW-4, and discrete-depth grab groundwater sampling of perched and shallow zone groundwater. PCE was detected in shallow and deep soil gas, and in perched and shallow zone groundwater at concentrations above 2019 Tier 1 ESLs. Arsenic and nickel were detected in shallow soil at concentrations above 2019 Tier 1 ESLs. In the *Site Assessment Summary Report* dated April 18, 2018, Pangea concluded that additional investigation is merited to further characterize PCE in the subsurface, and to evaluate the need for Site remediation. Pangea also concluded that shallow metal-bearing soil (arsenic, lead and nickel) with concentrations above Tier 1 ESLs merits management during future soil grading and Site use, and profiling for any soil export during construction.

2.4 Constituents of Concern from Historical Data

Constituents of concern from historical assessment include the following:

- Metals arsenic, lead, and nickel in shallow soil,
- Petroleum hydrocarbons in soil and groundwater, including naphthalene, total petroleum hydrocarbons as gasoline (TPHg), diesel (TPHd), and motor oil-range (TPHmo), and
- Volatile organic compounds (VOCs) in groundwater including tetrachloroethene (PCE) and breakdown product trichloroethene (TCE).

However, note that vinyl chloride has been detected immediately upgradient of the Site in shallow-zone groundwater wells MW-2 and MW-3 located near the adjacent former Quality Cleaners. Vinyl chloride is a breakdown product of PCE, the dry-cleaning chemical used at the former Quality Cleaners. PCE may have been used at the subject Site as a degreaser.

2.5 Site Geology and Hydrogeology

Based on soil logging data from Site documents and available information from nearby sites, soil at and near the Site generally consists of interbedded coarse- and fine-grained materials including silt, clay, silty sand, silty/sandy/clayey gravel. The Site is located in the Mocho Subbasin in the south-central portion of the Livermore Valley. Available documents for the Site and nearby Sites and the well MW-4 soil logging, the subsurface at the Site and nearby is currently generally characterized as shown below on Table A.

Table A – Summary of Site Hydrogeology

Hydrologic Zone	Depth Interval (ft bgs)	Lithology	Notes
Vadose Zone	*0 to 35*	*Sandy/silty gravels*	---
Perched Groundwater	30 to 38	Sandy/silty gravels to 33 ft; fine-grained soil 33-41 ft.	If/when present
	41 to 46		---
Shallow Groundwater	52 to 56.5	Sandy gravel	Confined
	62 to 66	Gravelly sand	Confined
Aquitard	*66 to 100*	*Fine-grained soil*	---
Deep Groundwater	100 to 390	Unknown/ not explored	Drinking water source

Within the Downtown Core Project area, the historical perched groundwater zone was approximately 31 to 46 ft bgs with the confined shallow groundwater zone approximately 52 to 70 ft bgs within the Downtown Core Project area. For the subject Site, the perched and shallow groundwater zones include thin lenses of fine-grained material within these zones. The site geology and hydrogeology is summarized on cross section Figure 10. The cross section location is shown on Figure 8. Groundwater beneath the Site and vicinity reportedly flows in the approximate northwest direction.

2.6 Water Supply Wells and Nearby VOC Plumes

The Deep Zone is present approximately 100 to 390 ft bgs and is used by the City of Livermore for drinking water purposes. The closest water supply well (CalWater 8P1) is located approximately ½ mile hydraulically downgradient of the Site and apparently screened from 122 to 192 ft bgs. According to a Lawrence Livermore National Laboratory report, "PCE is nearly ubiquitous in Livermore wells…the Mocho Subbasin has a relative high degree of vulnerability to contamination from surface sources." Select nearby water supply wells have wellhead treatment for contamination.

From review of the State Board Geotracker database, there are several sites in the Site vicinity with subsurface PCE impact to groundwater. Groundwater beneath the Site and vicinity reportedly flows in the approximate northwest direction. Sites with known PCE groundwater plumes are located upgradient and cross-gradient of the Site and include Desert Petroleum/Valley Gas at 2008 First Street, Groth Brothers Chevrolet at 57-59 South L Street, and Mike's and Paul's Cleaners at the Livermore Arcade Shopping Center site.

From historical and 2018 assessment by the City, VOC and TPH groundwater impact has also been identified at adjacent properties 2048 First Street (former Quality Cleaners) and 2093 Railroad Avenue (former J Cleaners).

3.0 CONCEPTUAL SITE MODEL AND DATA GAPS

This section describes the Site geology/hydrogeology and chemical conditions in Site soil, soil gas, and groundwater based on field observations, information from nearby sites, and current/historical site assessment data. The distribution of chemicals of concern is summarized on Figures 4 through 9. The cross section on Figure 10 illustrates subsurface conditions with respect to Site soil type and hydrogeologic conditions.

3.1 Soil Conditions

Soil conditions are summarized as follows:

- The following compounds have been detected in shallow soil above 2019 Tier 1 ESLS: select metals (arsenic, lead, and nickel) and TPHd, and TPHmo. *(No PCE or chlorinated VOCs have been detected in analyzed soil samples for the Site).* Table 2 presents soil analytical data with respect to various environmental screening levels.

- Figure 4 shows the estimated extent of key metal impact in soil.

- The arsenic- and lead-bearing soil merits management during future soil grading and Site use, and profiling for any soil export during construction.

Arsenic, lead, and nickel were detected at concentrations above conservative Tier 1 ESLs. The maximum concentrations of these metals were 55 milligrams/kilogram (mg/kg) arsenic, 200 mg/kg lead, and 370 mg/kg nickel. Most metal concentrations above 2019 Tier 1 ESL screening levels may represent background soil conditions (LBNL, 2009). Arsenic concentrations in select samples above background conditions within the upper 2 ft of soil were located on the Site, possibly associated with the former lumber and/or railroad depot operations. Arsenic was reportedly used historically as a rodenticide in this area. Figure 4 shows the extent of arsenic in shallow soil above 11 milligrams/kilogram. Historical property redevelopment reportedly involved the import of shallow material, an explanation for higher arsenic concentrations detected at 10 to 16 inches bgs than at 0 to 6 inches bgs. Sampling locations where nickel concentrations exceeded background conditions and the construction worker ESL of 86 mg/kg are noted on Figure 4.

Select samples with metal impact were also analyzed using Toxic Characteristic Leaching Procedure (TCLP) and Waste Extraction Test (WET) test methods to help determine whether any future excavated soil would be classified as a California hazardous waste. As shown on Figure 4 and Table 2, soil samples at B-2 and B-4 from 10 to 16 inches bgs contained STLC *lead* concentrations (WET testing) above the Non-RCRA Class I (California) hazardous waste criteria of 5 mg/L. Lead TCLP data did *not* exceed 5 mg/L, the RCRA Class I (Federal) hazardous waste criteria.

Because Pangea performed sampling at the Site in conjunction with sampling at other locations within the Downtown Core Development Project area, laboratory analytical reports include data from other sites not related to the Multifamily Residence Redevelopment.

3.2 Soil Gas Conditions

Soil gas conditions are summarized as follows:

- The following compounds have been detected in soil gas above 2019 residential vapor intrusion ESLs: PCE and benzene. *TCE, trans-1,2-DCE, and ethylbenzene concentrations were below Tier 1 ESLs.* Table 4 presents soil gas analytical data with respect to various environmental screening levels.

- A PCE source could be near the historic railroads based on the highest PCE in shallow soil gas, while PCE concentrations are highest in deeper soil gas near historic perched groundwater. PCE in deeper soil gas could be affected by historical migration of PCE from the upgradient former Quality Cleaners (Figure 6).

- Figure 5 shows the estimated PCE extent in *shallow* soil gas (0-10 ft bgs).

- Figure 6 shows the estimated PCE extent in *deeper* soil gas (15-30 ft bgs).

- Figure 10 shows the estimated PCE extent in cross section.

For shallow soil gas (5 ft bgs), PCE was detected in all shallow *soil gas* monitoring wells at concentrations above the 2019 Tier 1 ESL of 15 µg/m^3. The PCE concentrations in shallow soil gas ranged from 34.6 to 387 µg/m^3, with the highest PCE at SGMF-4-5 near a historic railroad line.

For deeper soil gas (15-25 ft bgs), PCE was detected in all deeper *soil gas* monitoring wells at concentrations above the 2019 Tier 1 ESL of 15 µg/m^3. The PCE concentrations in deeper soil gas ranged from 111 to 5,340 µg/m^3, with the highest PCE at SGMF-3-25 near the former passenger depot and downgradient of the nearby Quality Cleaners at 2048 First Street. The PCE in deeper soil is present in the approximate zone of former perched groundwater that had PCE impact.

Near the former Site operations, benzene was detected primarily in the deeper soil gas wells. Benzene exceeded its Tier 1 ESL of 3.2 µg/m^3 at the following concentrations in *deeper* soil gas sampling locations at 25 ft bgs: 58 µg/m^3 (SGMF-2-25), 14.1 µg/m^3 (SGMF-4-25), and 5 µg/m^3 (SGMF-3-25), while at 15 ft bgs only 3.55 µg/m^3 at SGMF-4-15 slightly exceeded the Tier 1 ESL. However, for the clustered shallow and deeper soil gas wells at SGQC-6 (located closer to the Valley Gas and Quality Cleaner sites), maximum

benzene concentrations were higher at 27.1 µg/m^3 (SGQC-6-5), 115 µg/m^3 (SGQC-6-15), and 86.5 µg/m^3 (SGQC-6-30). This data suggests that benzene concentrations are highest in deeper soil gas.

PCE-breakdown products cis-1,2-dichloroethene and vinyl chloride were not detected in Site soil gas. Other VOCs were detected in soil gas at concentrations below 2019 Tier 1 ESLs, if ESLs established.

3.3 Groundwater Conditions

Groundwater conditions are summarized as follows:

- The following compounds have been detected in groundwater above Tier 1 ESLs: PCE, chloroform, TPHg and TPHd. The primary chemical of concern is PCE. Table 3 presents groundwater analytical data with respect to environmental screening levels.

- Perched and shallow groundwater data suggest PCE impact is highest near well MW-4 and HP-1-MF near the center of the Site, with additional PCE and VOC impact present at the upgradient edge of the Site near wells MW-2 and MW-3 monitoring the apparent PCE release from former Quality Cleaners.

- Figure 7 shows the estimated PCE extent in *perched* groundwater (31-44 ft bgs).

- Figure 8 shows the estimated PCE extent in *shallow zone* groundwater (60-72 ft bgs).

- Figure 10 shows the estimated PCE extent in perched and shallow groundwater in cross section.

PCE above Tier 1 ESL: PCE and its breakdown products have been detected in grab groundwater samples collected from borings and in samples collected from Site monitoring well MW-4. PCE was detected in monitoring well MW-4 at a concentration of 10.2 µg/L during the July 26, 2018 sampling. From 2018 grab sampling in shallow zone groundwater (66 to 70 ft bgs), PCE concentrations ranged from 4.6 µg/L to 16 µg/L. For perched zone groundwater in 2018, PCE was detected at a concentration of 4.9 µg/L at 41 to 45 ft bgs. From prior grab sampling of shallow perched groundwater at boring location B-1 in 2005, PCE was detected at 19 µg/L at 31 to 35 ft bgs, and 18 µg/L at 40 to 44 ft bgs. These concentrations exceed the 2019 Tier 1 ESL of 0.64 µg/L

TPHg, TPHd and Chloroform above Tier 1 ESLs: TPHg and TPHd was detected at maximum concentrations of 170 µg/L and 330 µg/L, respectively, above the Tier 1 ESL of 100 µg/L during perched groundwater sampling in 2005. Chloroform detected in the July 11, 2018 grab sample from the boring for well MW-4 contained a concentration of 1.3 µg/L, above the Tier I ESL of 0.81 µg/L.

Chemicals Below Tier 1 ESLs: Other VOCs detected in shallow zone groundwater from monitoring well MW-4 below Tier 1 ESLs included TCE (0.138 µg/L), chloroform (0.708 µg/L), and naphthalene (0.117

µg/L). Bromodichloromethane detected in the July 11, 2018 grab sample from the boring for well MW-4 contained a concentration of 0.57 µg/L, below the Tier I ESL of 0.87 µg/L.

However, note that vinyl chloride has been detected immediately upgradient of the Site in shallow-zone groundwater wells MW-2 and MW-3 located 40 ft south of the Site near the adjacent former Quality Cleaners. Vinyl chloride is a breakdown product of PCE, the dry cleaning chemical used at the former Quality Cleaners. The presence of petroleum hydrocarbons presumably associated with the Valley Gas case could be contributing to PCE degradation, as commonly occurs when PCE and petroleum plumes comingle.

For 2018 shallow zone grab groundwater sampling, no TCE or naphthalene was detected but chloroform was detected at 0.60 to 0.77 µg/L (below Tier I ESL of 0.81 µg/L). From prior grab sampling of shallow perched groundwater at boring location B-1 in 2005, TCE was detected at a maximum of 1.0 µg/L and chloroform was detected at 0.54 µg/L.

3.4 CSM and Data Gap Conclusions

Based on the above information, Pangea offers the following conclusions for the site CSM and data gaps:

- **The primary chemicals of concern at the Site are PCE and select metals**. PCE has been detected in soil gas and groundwater at concentrations above 2019 Tier 1 screening levels. This PCE impact merits further characterization and possible mitigation and/or remediation with respect to prospective development at the Site. Shallow metal-bearing soil (arsenic, lead and nickel) with concentrations above Tier 1 ESLs merits management during future soil grading and Site use, and profiling for any soil export during construction.

- **Soil Data Gaps Merit Investigation:** Shallow soil impact from historic uses has not been fully characterized. Arsenic and lead impact detected in shallow soil from prior investigations merits further characterization. Due to former site use as a lumberyard, soil assessment is merited for chemicals historically used to treat lumber (e.g., arsenic, chromium, copper, pentachlorophenol, creosote and dioxins).

- **PCE in Soil Gas Merits Investigation:** A PCE source could be present near the historic railroad lines based on the highest PCE impact in shallow soil gas. Higher PCE concentrations in deeper (15 to 30 ft bgs) soil gas are present near the depth of historical perched groundwater; this PCE in deeper soil gas could be affected by historical PCE migration from the upgradient former Quality Cleaners site (Figure 6).

- **PCE in Soil Gas Represents a Potential Vapor Intrusion Concern for Future Development:** Action is merited to assess, remediate, and/or mitigate PCE at the Site. Site assessment could help determine if any discrete PCE soil impact exists that merits excavation or vapor extraction to

remove the source of PCE volatilization into shallow soil gas. Deeper soil gas impact could also be remediated or mitigated by soil vapor extraction, if merited. For any residual PCE in soil gas above applicable screening levels or human health risk criteria at the time of future occupied Site structures, engineering controls can safeguard future occupants and receptors from potential vapor intrusion. The planned subgrade ventilated parking structure beneath the future buildings is an engineering control that would safeguard against vapor intrusion.

- **Data Gaps in Groundwater Merit Assessment.** The PCE impact in Site groundwater monitoring well MW-4 and prior grab groundwater sampling locations slightly exceeded Tier 1 ESLs. Additional grab groundwater sampling, well monitoring, and/or additional groundwater monitoring well installation is merited to further characterize and monitor the plume stability of PCE and its degradation products near existing well MW-4, and to evaluate the potential for VOC migration onto the Site from offsite sources. The limited PCE impact in shallow zone groundwater apparently does not represent a significant threat to the nearest water supply well (CalWater 8P1), located approximately ½ mile downgradient of the Site and screened from 122 to 192 ft bgs.

4.0 PROPOSED DATA GAP INVESTIGATION ACTIVITIES

The following proposed site assessment activities are designed to address the data gaps presented above. The proposed site assessment sampling locations are presented on Figures 4 through 10. The general *objectives* of the proposed site assessment are to:

- **Soil:** Assess shallow soil near the former lumberyard to evaluate possible impact from compounds (e.g., pentachlorophenol, creosote, and dioxins) not analyzed during prior assessment. And assessment of soil to 15 ft depth within the planned site grading/soil export area for planned underground parking to assist with soil profiling for disposal.

- **Soil Gas:** Further characterize the extent of VOCs in soil gas to evaluate potential vapor intrusion for future site use, and to assist with evaluating soil vapor extraction (SVE) described in a separate report; and

- **Groundwater:** Further characterize the extent of VOCs in perched and shallow groundwater (and assist with evaluating vapor extraction in historic perched zone).

The sampling and analysis plan for soil, groundwater and soil gas is summarized below on Table B and detailed on Table 1. The site assessment will be conducted in accordance with agency guidance described below and PANGEA's standard operating procedures included in Appendix B.

Table B – Sampling and Analysis Plan Summary

Media (Depth, ft bgs)	Boring/ Well ID	Boring Depth (Sample Depth, bgs)	Analyses (Compositing)	Rationale
Shallow Soil (0-3 ft bgs)	P1 to P6 P1b to P6b P7a to P9a P7b to P9b	3 ft (1, 2, 3 ft)	TPH, VOCs, Metals, PAH/SVOCs, pesticides, PCBs, and asbestos). Pentachlorophenol, creosote and dioxin for lumberyard (P1 and P2 grid) (4 pt compositing by depth: P1+P2; P4+P5; P6+P7; P8+P9)(2 pt for P3)	Characterize shallow soil for assessment and disposal profiling. Can run discretes as merited. Minimum 1 analysis every 1,000 CY. Estimate 6,000 CY soil offhaul for entire site up to 2 ft for landscaping, park, and parking. Yields 12 analysis, profiling to 3 ft..
Deeper Soil (2-15 ft bgs)	P1-P5	12 ft (4,8,12 ft)	TPH, VOCs, Metals (Discrete analyses) (Run PAHs/SVOCs, pesticides, PCBs and asbestos for Class III or soil reuse by others).	Minimum 1 analysis every 1,000 CY. Estimate up to 15,000 CY soil offhaul for garage below 2 ft. Yields 15 analysis.
Shallow Soil Gas (0-10 ft bgs)	SGMF-5 thru SGMF-11 VEMF-1 *SGMF-1-5* *SGMF-4-5* *SG-5-5* *SG-6-5*	5 ft (SG wells) 5-10 ft (SVE well)	VOCs and TPHg	Lateral characterization of prior impact at SGMF-4. Install SVE well for evaluating interim SVE.
Deeper Soil Gas (15-20 ft bgs)	SGMF-8 SGMF-10 SGMF-12 VEMF-1A thru VEMF-4A *SGMF-2-15/25* *SGMF-3-15/25* *SG-4-20*	15 ft (SG wells) 15-20 ft (SVE wells)	VOCs and TPHg	Lateral characterization of prior impact at SGMF-3 and SGMF-4. Install wells for evaluating interim SVE.
Perched Groundwater (31-44 ft bgs)	VEMF-1B thru VEMF-6B HP-5-MF thru HP-9-MF & Contingents	28-36 ft (SVE wells) 42-46 ft (HP sampling)	VOCs and TPH	Lateral characterization of prior impact at B-1. Contingent locations if more lateral assessment needed. Install wells for planned interim SVE (and/or groundwater monitoring). Contingent deeper wells (40-46 ft bgs) if elevated VOCs found in water.
Shallow Groundwater (60-72 ft bgs)	*MW-4* MWMF-5 MWMF-6 HP-8-MF HP-10-MF HP-11-MF & Contingents	62-72 ft (wells) 62-67? ft (HP sampling)	VOCs and TPH	Lateral characterization of impact at MW-4, HP-1-MF, and HP-3-MF. Grab sampling and groundwater monitoring well installation.

Italics = Existing Wells

TPH = TPH gas, TPH diesel, and TPH motor oil by EPA Method 8015
TPHg (soil gas) = TPH gas by EPA Methods TO-3 or TO-15.
VOCs = VOCs by EPA Methods 8260 or TO-15.
PAH/SVOCs = By EPA Method 8270C (special request for creosote).
SVE = Soil vapor extraction.

4.1 Pre-Field Activities

Prior to initiating field activities, the following tasks will be conducted:

- Obtain drilling permit from the Zone 7 Water Agency;
- Pre-mark the excavation area with white paint and notify Underground Service Alert (USA) of the excavation activities at least 48 hours before work begins;
- Prepare a Site-specific health and safety plan (HASP) to educate personnel and minimize their exposure to potential hazards related to Site activities; and
- Coordinate with drilling and laboratory contractors, and with involved parties.

4.2 Soil Assessment

PANGEA proposes to advance soil borings at locations shown on Figure 4. The proposed soil assessment program includes the following:

- Shallow sampling (up to 3 ft depth) within a grid in the former lumberyard area, including analysis for the following compounds associated with treated wood waste: arsenic, chromium, copper, pentachlorophenol, creosote and dioxins (DTSC, 2020).
- Shallow sampling (up to 3 ft depth) within a grid in the planned Veteran's Park and landscaping areas to assess metal impact in shallow soil.
- Deeper soil sampling (up to 15 ft depth) to profile soil for disposal within the planned site grading/soil export area for underground parking.

For efficiency and to facilitate composite sampling for waste profiling, the site has been divided into a grid of nine cells (1 through 9), as shown on Figure 4. Each cell contains two soil borings, which follow the nomenclature of the cell (e.g., Cell 1 contains borings P1 and P1b, Cell 2 contains borings P2 and P2b, etc.). The cells and borings are arranged with respect to historical land uses and proposed development:

- **Cells 1, 2 and 3 (P1 through P3b):** Within the former lumberyard area (Cells 1 and 2) and the planned northern Multifamily Residences building footprint with 15-ft depth subgrade garage (Cells 1, 2 and 3).
- **Cells 4 and 5 (P4 through P5b):** Within the southern Multifamily Residences building footprint with 15-ft depth subgrade garage.
- **Cells 6 through 9 (P6a through P9b):** Within planned Veteran's Park and grading to 2-ft depth.

Deeper borings (P1 through P5) will be cleared to 5 feet below ground surface (ft bgs) using a hand-auger and advanced to 12 ft depth using direct-push drilling techniques. These deeper borings will be used for deeper waste profiling in the proposed subgrade garage area. Other borings will be completed to 3 ft bgs to assist soil characterization and soil disposal profiling.

Soil assessment will be conducted in accordance with PANGEA's standard operating procedures included in Appendix B. Soil will be screened for VOCs using a photo ionization detector (PID) and logged by Pangea under the supervision of a professional geologist or engineer. Soil will be logged continuously per United Soil Classification System guidelines. Soil samples will be collected in laboratory-supplied contains and stored at or below 4° Celsius before transport to a State-certified laboratory. Samples will be collected and analyzed according to the sampling and analysis plan summarized above on Table B.

Following groundwater sampling, the borings will be filled to grade with cement grout with the oversight of a Zone 7 Water Agency inspector.

4.2.1 Soil Sampling and Analysis Plan

The soil sampling and analysis plan is summarized above on Table B.

- **Shallow Soil Assessment and Profiling for Disposal (all borings and cells):** Shallow discrete soil samples will be collected at 1, 2, and 3 ft bgs from all borings for soil assessment shown on Figure 4. Sufficient soil volume will be collected to facilitate subsequent discrete analysis and leachate testing, if merited. Four-point composite sample analysis will be performed by depth for each of the following cell pairs: cell 1 and 2 (P1, P1a, P2, P2a), cells 4 and 5 (P4, P4a, P5, P5a), and cells 6 and 7 (P6a, P6b, P7a, P7b), and cells 8 and 9 (P8a, P8b, P9a, P9b). Cell 3 will be a 2-point composite. This yields a total of 15 composite analyses. The 15 composite samples for each depth will be analyzed for the following:
    - TPH full scan by EPA Method 8015,
    - VOCs by EPA Method 8260B,
    - Title 22 Metals by EPA Method 6010/6020,
    - SVOCs/PAHs by EPA Method 8270C,
    - PCBs by EPA Method 8082,
    - Pesticides by EPA Method 8081A, and
    - Asbestos by PLM or OSHA 191.
- **Lumberyard Assessment and Profiling for Disposal:** The following compounds are associated with treated wood (DTSC, 2020): arsenic, chromium, copper, pentachlorophenol, creosote and dioxins. Arsenic, chromium, and copper will be evaluated by Title 22 analyses listed above. Pentachlorophenol and creosote will be evaluated by EPA Method 8270C listed above, but with

specific request for creosote analysis). Dioxin will be evaluated by EPA Method 8280A/8290A on all 4-point composites for cells 1 and 2 within the footprint of the former lumber yard. If concentrations of concern are detected in the composite analyses, discrete analyses will be performed.

- **Deeper Soil Assessment and Profiling for Disposal (P1 through P6):** For the five deeper borings (P1 through P5) will be advanced to 12 ft bgs to facilitate waste disposal profiling of soil excavated during construction of the proposed subgrade garage. Discrete samples will be collected and analyzed from each boring at 4, 8 and 12 ft bgs. The 15 discrete samples will be analyzed for the following:
    - TPH full scan by EPA Method 8015,
    - VOCs by EPA Method 8260B,
    - Title 22 Metals by EPA Method 6010/6020,
    - SVOCs/PAHs by EPA Method 8270C,
    - PCBs by EPA Method 8082,
    - Pesticides by EPA Method 8081A, and
    - Asbestos by PLM or OSHA 191.

Discrete soil analyses will be performed on the composite analysis if concentrations of concern are reported that merit further characterization. If necessary, additional shallow soil sampling will be performed for supplemental soil characterization for delineation and/or soil disposal profiling. Leachate wet testing for soluble threshold limit concentration (STLC) and toxicity characteristic leaching procedure (TCLP) analysis for metals will also be performed as merited for soil profiling. An STLC analysis is performed to determine if soil is characteristically hazardous by California Title 22 standards. A TCLP analysis is performed to determine if soil is characteristically hazardous by Federal RCRA standards.

4.3 Groundwater Assessment

To further assess the lateral and vertical extent of PCE in site groundwater. PANGEA proposes assessment at locations shown on Figures 5, 6 and 7. The proposed assessment includes:

- **Perched Groundwater:** Discrete-depth grab groundwater sampling of *perched* groundwater at five initial locations (HP-5-MF through HP-9-MF) at approximate depths of 42 – 46 ft bgs (Figure 7). Up to four contingent step-out grab sampling locations may be advanced after evaluation of conditions encountered at HP-5-MF through HP-9-MF. If elevated VOC or petroleum hydrocarbon impact is detected in perched groundwater, contingent groundwater monitoring wells may be installed at these locations. The perched zone groundwater appears to be only sporadically present and was not encountered during prior drilling of HP-1-JC through HP-6-JC at J Cleaner in November 2018.

- **Shallow Groundwater:** Discrete-depth grab groundwater sampling of *shallow* groundwater at three locations (HP-8-MF, HP-10-MF, HP-11-MF) at an approximate depth of 62-72 ft bgs (Figure 8). Two groundwater monitoring wells (MWMF-5 and MWMF-6) are proposed at an approximate depth of 62-72 ft bgs to facilitate groundwater flow calculation using existing well MW-4 (Figure 8). Well MWMF-5 is proposed near the downgradient edge of property southwest of existing well MW-4. Well MWMF-6 is proposed upgradient (southeast) of existing well MW-4, and near elevated VOCs in deeper soil gas at the site. Contingent step-out grab sampling of shallow water may be performed after evaluation of conditions encountered from the proposed assessment.

4.3.1 Groundwater Assessment Sequencing

The groundwater assessment sequence will be based on field conditions, available drilling/sampling equipment, and driller/geologist recommendations at the time. The tentative sequence includes the following:

- First using dual-tube tooling to assess soil lithology to approximately 45 ft bgs;
- Grab sampling of perched groundwater, if present, from approximately 40 to 45 ft bgs;
- Extending the tooling to 75 ft bgs for soil logging of shallow groundwater-bearing zone:
- Installation of perched SVE and/or groundwater monitoring wells from 28 to 36 ft bgs based on the logging information;
- Installation of shallow groundwater monitoring wells from 60 to 72 ft bgs based on the logging information;
- Subsequent installation of contingent deeper perched groundwater monitoring wells from 40-46 ft bgs, if merited from assessment data.

Alternatively, to minimize potential cross-contamination between upper and lower sampling intervals, the first logging and sampling will be conducted down to approximately 72 ft bgs using dual-tube tooling. Sampling of overlying perched groundwater would be sampled using a separate individual borehole.

4.3.2 Grab Groundwater Sampling

Discrete-depth grab groundwater samples will be collected from perched and/or shallow groundwater at boring locations HP-5-MF through HP-11-MF shown on Figures 7 and 8. The borings will be drilled in accordance with PANGEA's standard field procedures included in Appendix B1.

All boring locations will be cleared to 5 ft bgs using a hand-auger and advanced to depth using direct-push drilling techniques. Dual-tube equipment will be used to facilitate continuous soil logging and confirm the depths of the water-bearing zones described above in Section 2.5. During boring advancement, characteristics such as soil type, color, texture, and moisture will be continuously logged in the field using the Unified Soil Classification System (USCS) and soil will be screened using a photoionization detector (PID).

For perched zone sampling, the dual-tube tooling will be advanced to 46 ft bgs (or the observed bottom of the perched groundwater zone from soil logging) and the outer drill rods retracted to approximately 40 ft bgs, and new temporary PVC casing will be placed into the outer rods for sample collection. The perched zone borings may be left open overnight if water does not readily accumulate within the casing or Hydropunch™ screen. If water has not accumulated by the following day, and if time allows, a new boring may be advanced using dual-tube equipment to the first encountered groundwater depth, as determined by soil logging. Alternatively, Hydropunch™ sampling equipment will be used to facilitate sample depth from approximately 42-46 ft bgs.

For shallow groundwater zone sampling, upon reaching the total boring depth of 72 ft bgs, the outer drill rods will be retracted to 62 ft bgs, and new temporary PVC casing with 10 feet of screen will be placed into the outer rods for sample collection. Alternatively, Hydropunch™ sampling equipment will be used to facilitate sampling of the target depth.

Grab groundwater samples will be collected from each boring using a new disposable Teflon™ bailer inserted into the temporary PVC casing or Hydropunch™ sampler and decanted into laboratory-provided containers. The groundwater samples will be placed in a cooler with ice and transported under chain-of-custody protocol a California-certified laboratory for testing. Samples will be analyzed for VOCs by EPA Method 8260B and TPH full scan by EPA Method 8015. PANGEA's Standard Field Procedures for Soil Borings are included in Appendix B.

Following groundwater sampling, the borings will be filled to grade with cement grout poured through a tremie pipe with the oversight of a Zone 7 Water Agency inspector.

4.3.3 Monitoring Well Installation

Two groundwater monitoring wells (MWMF-5 and MWMF-6) will be installed at the locations shown on Figure 8. The groundwater monitoring wells will be installed and sampled in accordance with PANGEA's standard field procedures included in Appendix B. Depending on field conditions, the monitoring wells may be installed before or after completion of grab sampling.

Each groundwater well will be drilled to a total depth of approximately 72 ft bgs. Hand augering will be performed for the first 5 feet to clear each location of potential subsurface utilities. Direct-push equipment

may be used at each location to continuous log soil to confirm site lithology and the depth of the shallow groundwater zone. Any direct-push logs will be widened to 8-inch diameter using hollow stem auger drilling equipment. Each groundwater well will be constructed with 2-inch diameter, schedule 40 PVC well casing with 0.010-inch slotted screen. The well screen will be placed from approximately 62 to 72 ft bgs within the confirmed shallow groundwater zone. A filter pack annulus consisting of #2/12 sand will be placed from the bottom of the well up to one foot above the top of the well screen. A two-foot well seal of bentonite will be set above the filter pack. The remaining annular space will be backfilled with Portland cement and finished with a flush-mounted well box with the oversight of a Zone 7 Water Agency inspector.

Each well will be developed approximately 72 hours after well seal installation in accordance with PANGEA's standard field procedures. The monitoring well will be developed by surge block agitation followed by purging of 10 or more well casing volumes of groundwater. Well development will continue until a hard-well bottom has been achieved and turbidity of the groundwater has been reduced.

4.3.4 Monitoring Well Sampling

The groundwater in the well will be gauged and sampled following low flow sampling protocol. Groundwater will be collected into 40-mL sealed bottles and put on ice. Samples will be transported to a California-certified laboratory for analysis of VOCs by EPA Method 8260B.

4.3.5 Well Elevation Survey

The soil borings and groundwater monitoring well will be surveyed horizontally and vertically by a professional surveyor and elevations tied to a local City surveyor benchmark.

4.3.6 Contingent Perched Zone Grab Groundwater Borings and Monitoring Wells

Contingent step-out sampling is proposed at the locations shown on Figures 7 and 8, if merited by results from initial borings. If elevated VOC or petroleum hydrocarbon impact is detected in initial grab groundwater samples, contingent grab groundwater borings and/or monitoring wells may be installed in the *perched* zone and *shallow* zone as described above.

Any contingent groundwater assessment will be conducted in accordance with the procedures described above in Sections 4.1 through 4.3, and with Pangea's Standard Operating Procedures provided in Appendix B.

4.4 Soil Gas Assessment

To further assess the lateral and vertical extent of PCE in soil gas, PANGEA proposes assessment at locations shown on Figures 7, 8 and 10. The proposed assessment includes:

- Shallow soil gas assessment (within 5 to 10 ft bgs) at locations shown on Figure 5, which includes 6 soil gas wells and one SVE well.

- Deeper soil gas assessment (within 15 to 20 ft bgs) at locations shown on Figure 6, which includes 3 soil gas wells and four SVE wells.

- Even deeper soil gas assessment (within 28 to 36 ft bgs) within the historical perched groundwater zone via five SVE wells shown on Figure 7 (these wells will facilitate groundwater monitoring if significant perched groundwater is encountered).

The SVE wells will facilitate soil gas assessment and may serve as extraction wells for soil vapor extraction (SVE) as described in a separate interim remedial action plan.

4.4.1 Soil Gas Well Installation and Sampling

A total of ten soil gas wells are proposed at the eight locations shown on Figures 5 and 6. Shallow soil gas wells SGMF-5-5 through SGMF-12-5 (5 ft depth) will characterization shallow PCE impact. Deeper wells SGMF-8-15, SGMF-10-15, and SGMF-12-15 (15 ft depth) will be twinned in separate boreholes adjacent the 5 ft wells.

The soil gas wells will be installed and sampled following Department of Toxic Substances Control's (DTSC) July 2015 Advisory – Active Soil Gas Investigation guidance, and in accordance with Pangea's standard operating procedures in Appendix B. Twinned wells will be installed within individual boreholes, separated by at least 3 feet. Where underground utilities may be located, borings for soil gas wells will be hand-augured to minimum of 5 ft bgs. To reach the total soil gas well depth, borings will be advanced using direct-push drilling methods. Drilling equipment will be decontaminated after each use with distilled water to prevent cross-contamination between drilling locations.

The permanent soil gas wells will be constructed with a one-inch long stainless-steel implant connected to new ¼-inch diameter Teflon tubing and capped with a Swagelok® type fitting. The implant will be placed in a 1-foot thick sand pack with 6-inches of dry granular bentonite above, followed by cement with 5% bentonite. The wells will be protected by traffic-rated well vaults. All site investigation activities will be performed under the supervision of a California Registered Civil Professional Engineer (P.E.).

Shallow soil gas wells will be screened approximately 4.5 to 5.5 ft bgs. Deeper soil gas wells will be screened approximately 14.5 to 15.5 ft bgs. At least 48 hours will be allowed to pass after installation before

the wells are sampled to allow subsurface gases to equilibrate. Three casing volumes will be purged from each soil gas well prior to sampling at rate of 100-200 milliliters per minute (ml/min). Each well will be connected to a certified 1-Liter summa canister with a flow control manifold and placed in a sampling shroud. A quantitate leak check compound such as isopropanol will be introduced into the shroud at the time sampling begins. Isopropanol concentrations will be monitored by a photo ionization detector (PID) and maintained at a concentration of 10-20 parts per million (ppm). For additional quality-control, a replicate sample will be collected at one well sampling location. A schematic of the soil gas sampling and shroud apparatus is presented in Appendix B.

Soil gas samples will be transported to a California-certified laboratory under chain-of-custody protocol. Samples will be analyzed for VOCs, including isopropanol, by EPA Method TO-15.

4.4.2 SVE Well Installation and Sampling

A total of ten SVE wells are proposed in the six locations shown on Figures 5 through 7. Each location will consist of one shallow and one deeper well location. The wells by depth include:

- Well VEMF-1 screened in shallow soil from 5-10 ft bgs.
- Wells VEMF-1A, VEMF-2A, VEMF-3A and VEMF-4A screened in deeper soil from 15 to 20 ft bgs. The wells will be screened from approximately 15 to 20 ft bgs within permeable material just above the clay layer where PCE impact has previously been detected in deeper soil gas wells SGMF-3-25 and SGMF-4-25.
- Deeper wells VEMF-2B, VEMF-3B, VEMF-4B, VEMF-5B, and VEMF-6B will be screened from 28 to 36 ft bgs within the upper part of the historical perched groundwater zone. These deeper well locations will function as SVE wells if elevated VOCs and limited groundwater is encountered (or as groundwater monitoring wells if significant groundwater is present).

All boring locations will be cleared to 5 ft bgs using a hand-auger and advanced to depth using hollow-stem auger drilling equipment. All wells will be constructed with 2-inch diameter, Schedule 40 PVC casing with a 0.010-inch slotted screen. A filter pack annulus consisting of #2/12 sand will be placed from the bottom of the well up to one foot above the top of the well screen. A two-foot well seal of bentonite will be set above the filter pack. The remaining annular space will be backfilled with Portland cement and finished with a flush-mounted well box with the oversight of a Zone 7 Water Agency inspector.

At least 48 hours will be allowed to pass after installation before the wells are sampled to allow subsurface gases to equilibrate. Three casing volumes will be purged from each SVE well prior to sampling using a portable blower/sampling pump. A vapor sample will be collected for the SVE extraction piping using a

certified 1-Liter summa canister. SVE well samples will be transported to a California-certified laboratory under chain-of-custody protocol. Samples will be analyzed for VOCs by EPA Method TO-15.

4.5 Investigation Derived Waste

Investigation derived waste (IDW) generated during field activities will consist of soil from drilling activities and water from decontamination and well development activities. IDW will be temporarily stored on site in 55-gallon drums pending profiling and transportation to an appropriate disposal facility.

5.0 SCHEDULE AND REPORTING

In accordance with the Site project schedule and to support Site development, Pangea intends to implement the proposed assessment activities in June 2021. Pangea will prepare a *Data Gap Investigation Report* upon completion of the proposed assessment activities. The report will document assessment activities, tabulate analytical data, compare results to applicable ESLs, and provide conclusions and recommendations. Report figures will include key analytical results. Field sampling forms, laboratory analytical reports, chain-of-custody documentation, and waste disposal manifests will be provided as appendices. The report will be reviewed for accuracy and completeness and stamped by a California state-registered engineer or geologist.

6.0 REFERENCES

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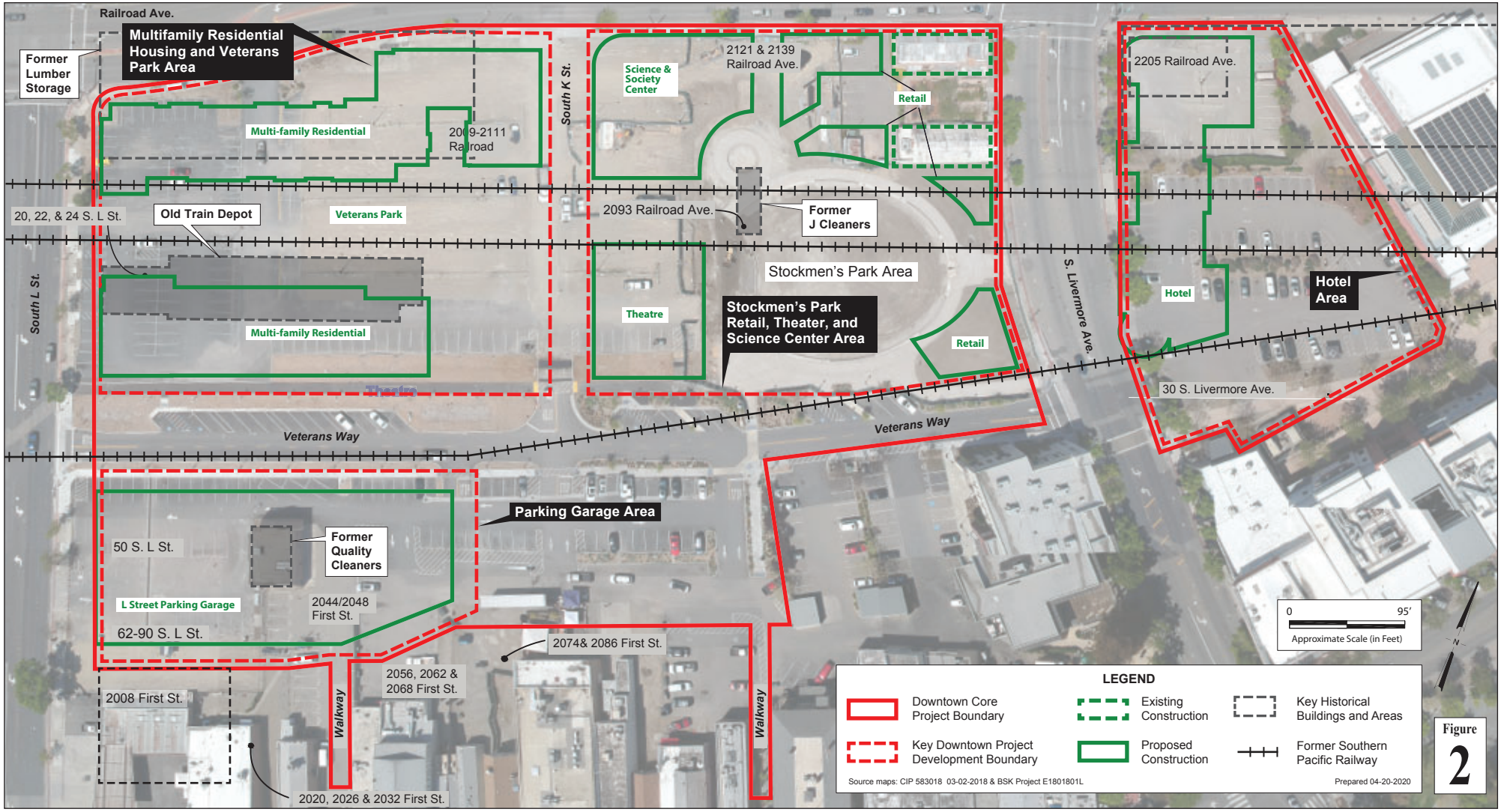
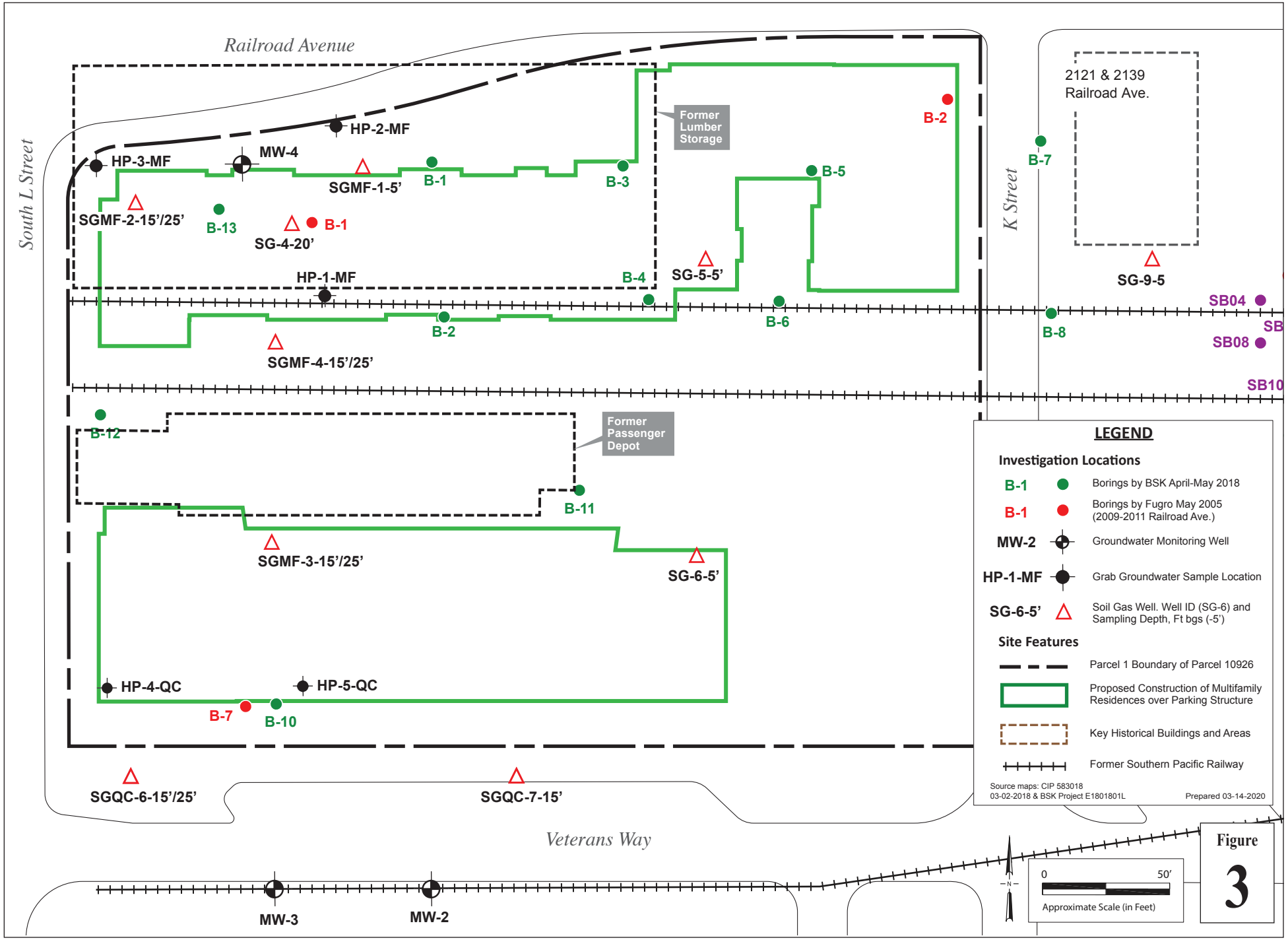


Downtown Core Project Area
Livermore, California

PANGEA

Downtown Core Project Area



Old Train Depot
20, 24 & 24 L Street & 2009-2073 Railroad Avenue
Livermore, California

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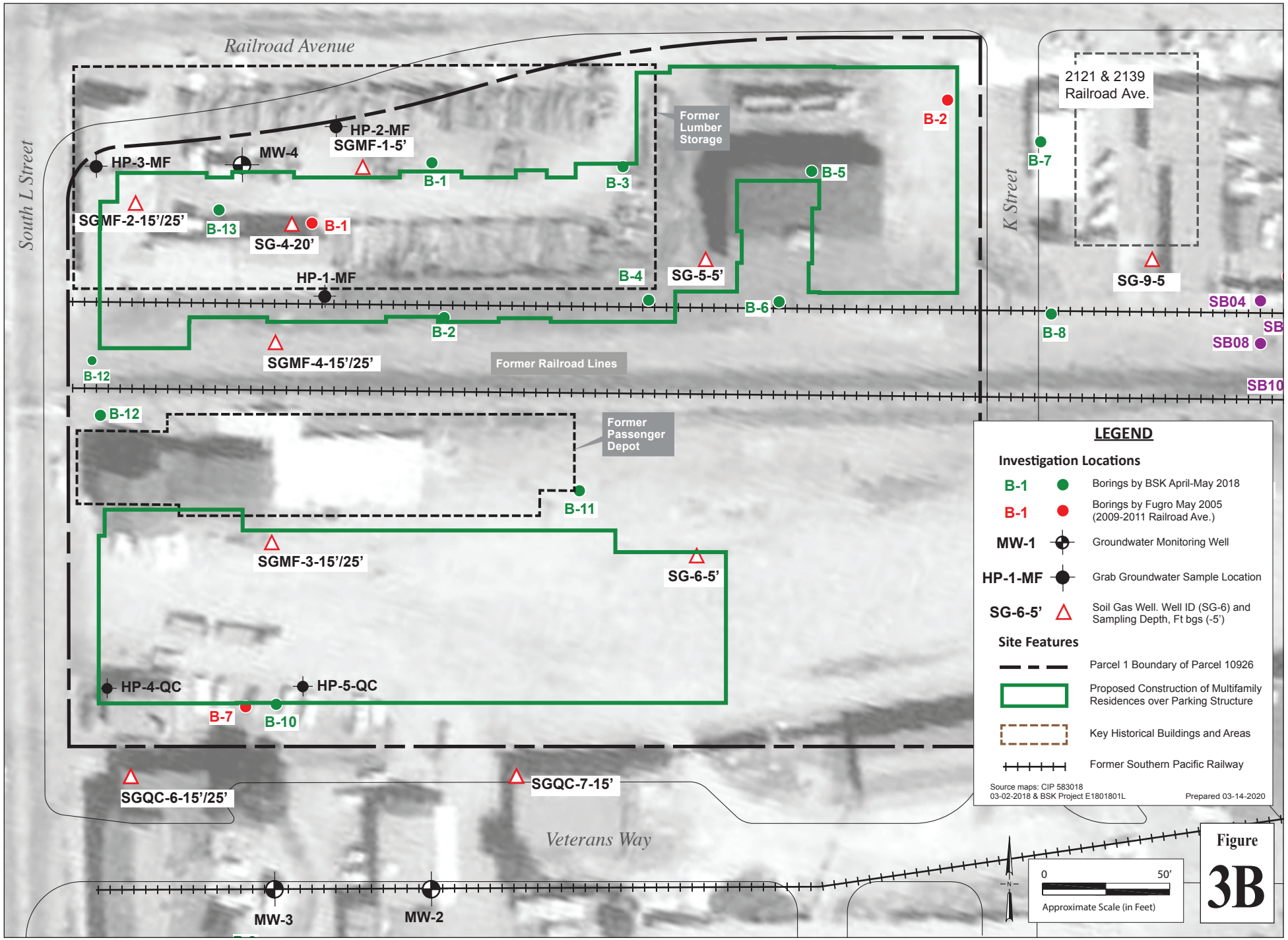
Site Map



Old Train Depot
20, 24 & 24 L Street & 2009-2073 Railroad Avenue
Livermore, California

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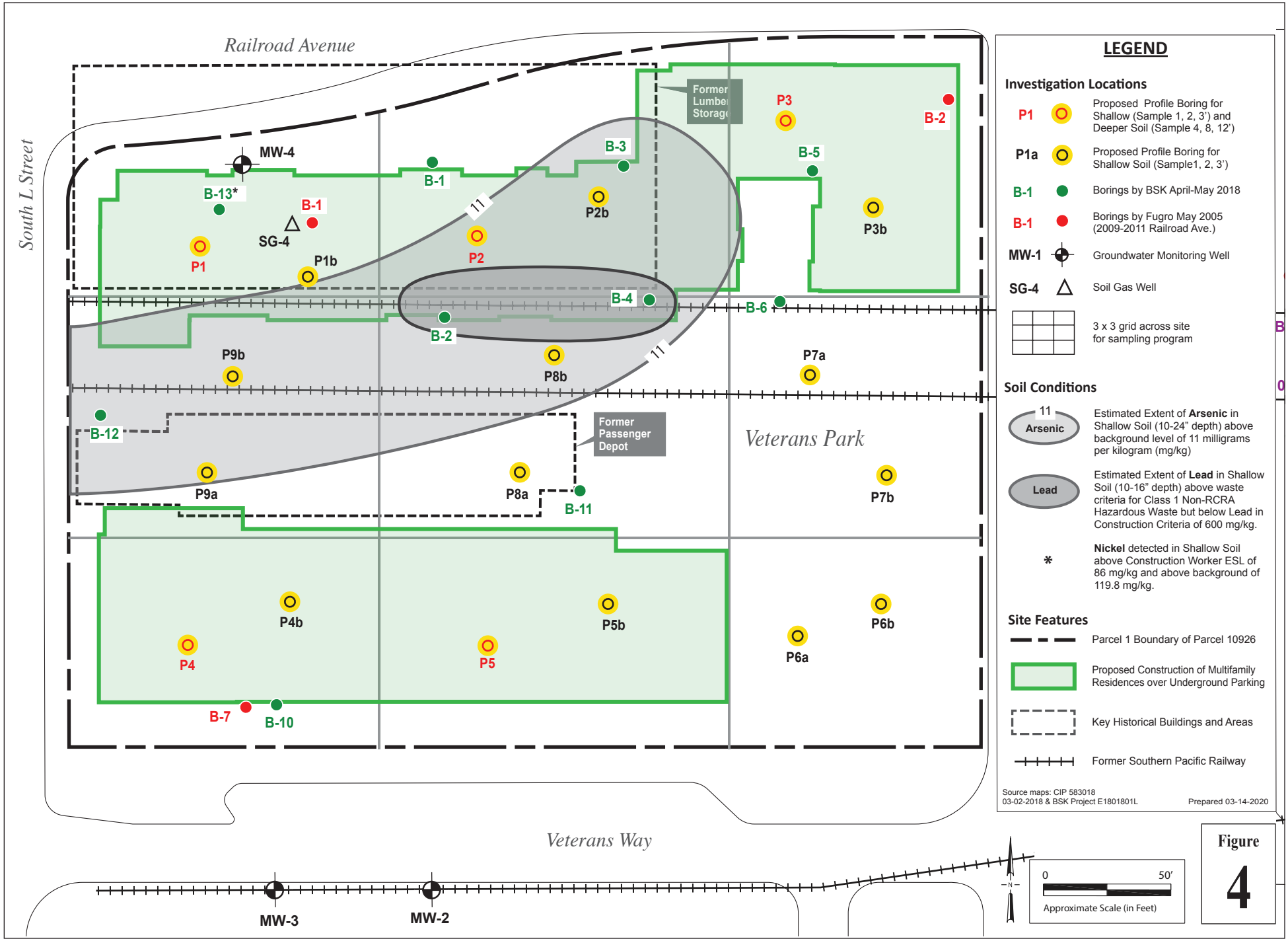
Site Historical Use



Old Train Depot
20, 24 & 24 L Street & 2009-2073 Railroad Avenue
Livermore, California

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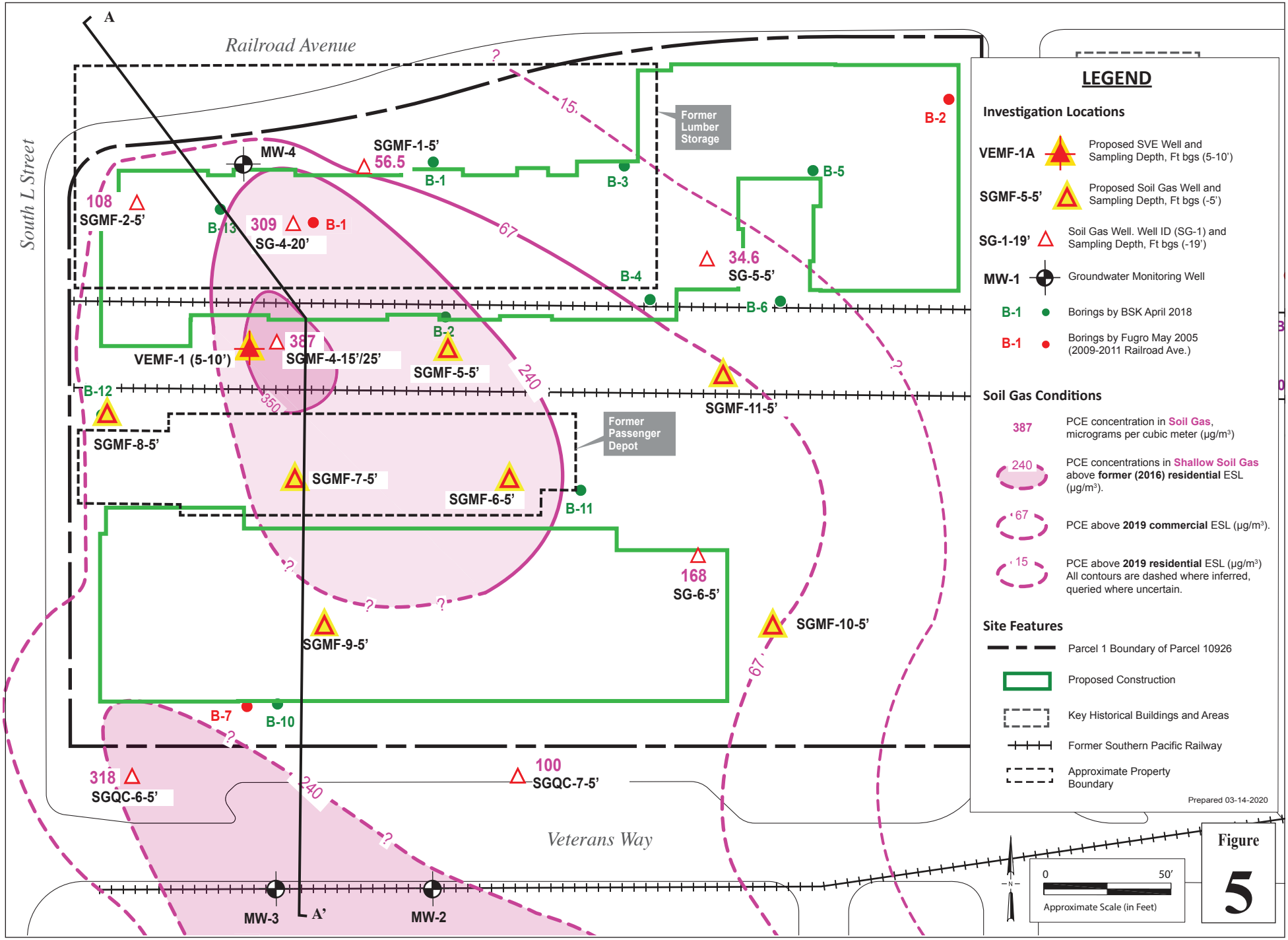
Metals in Shallow Soil and Proposed Assessment



Old Train Depot
20, 24 & 24 L Street & 2009-2073 Railroad Avenue
Livermore, California

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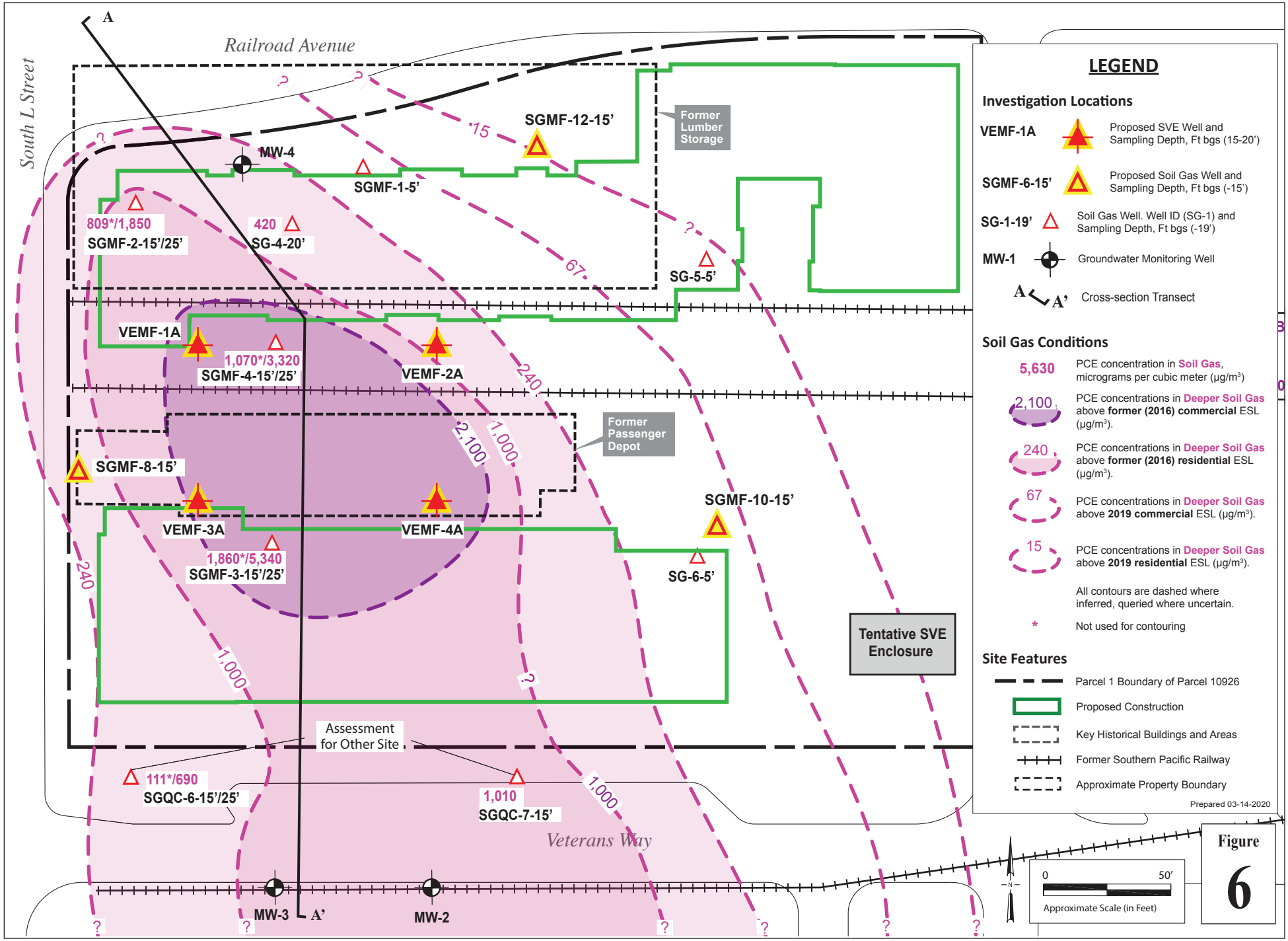
PCE in Shallow Soil Gas (0-10 ft bgs) and Proposed Sampling



Old Train Depot
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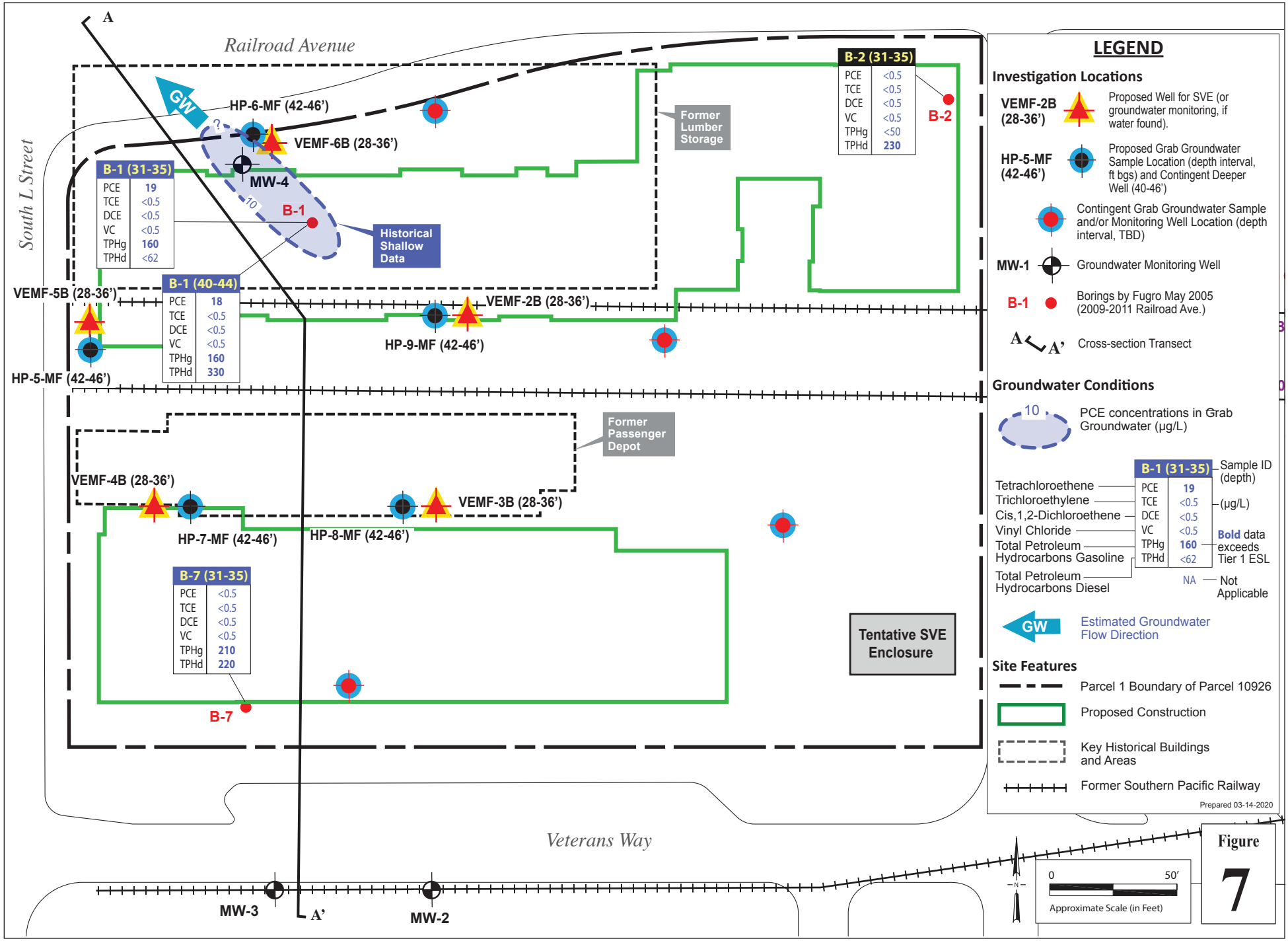
Livermore, California

PANGEA

PCE in Deeper Soil Gas (15-30 ft bgs) and Proposed SVE (15-20' ft bgs)



Old Train Depot
20, 24 & 24 L Street & 2009-2073 Railroad Avenue
Livermore, California

PANGEA

Perched Groundwater Data (31-44 ft bgs) and Proposed SVE (28-36' ft bgs)

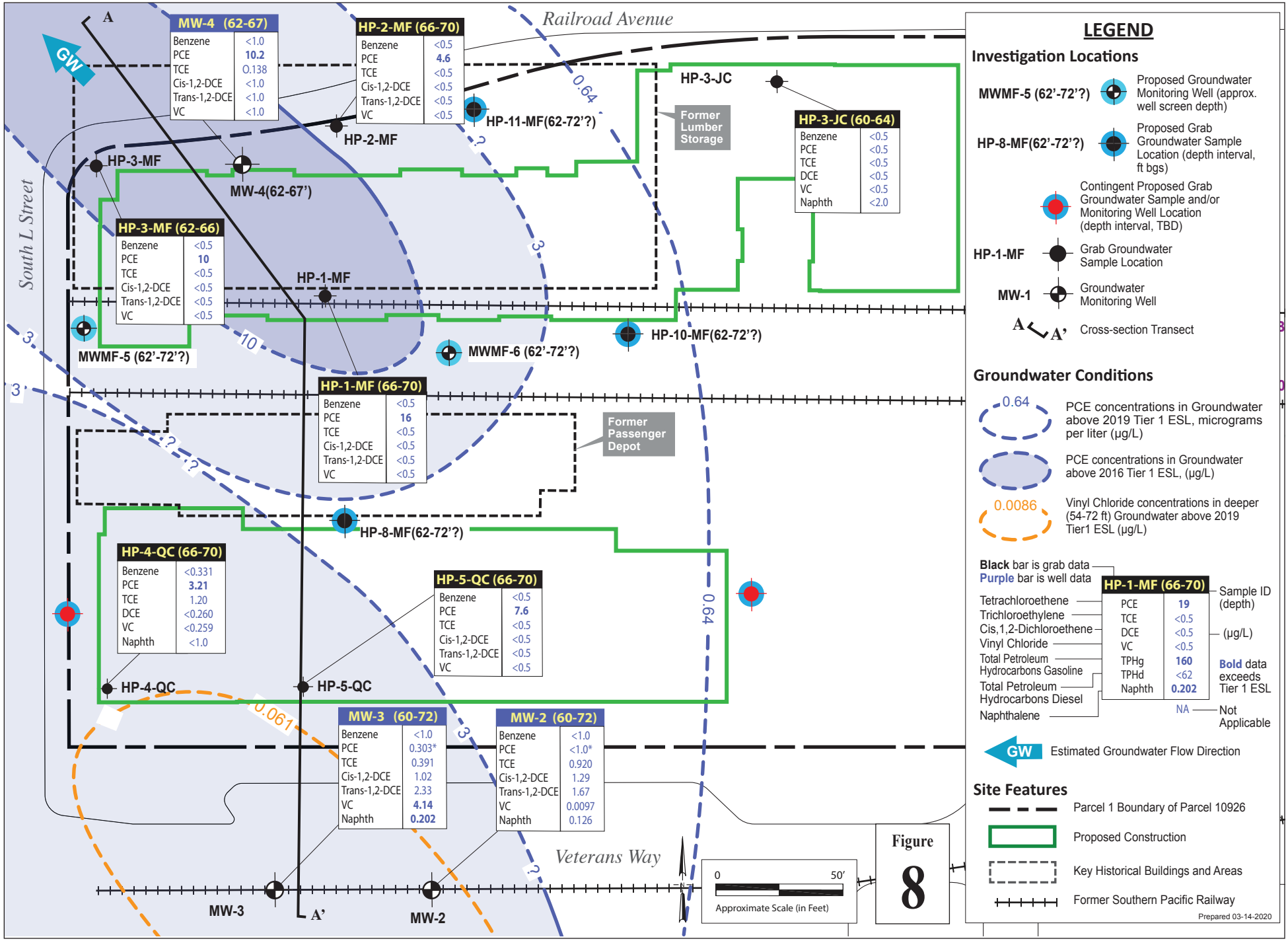
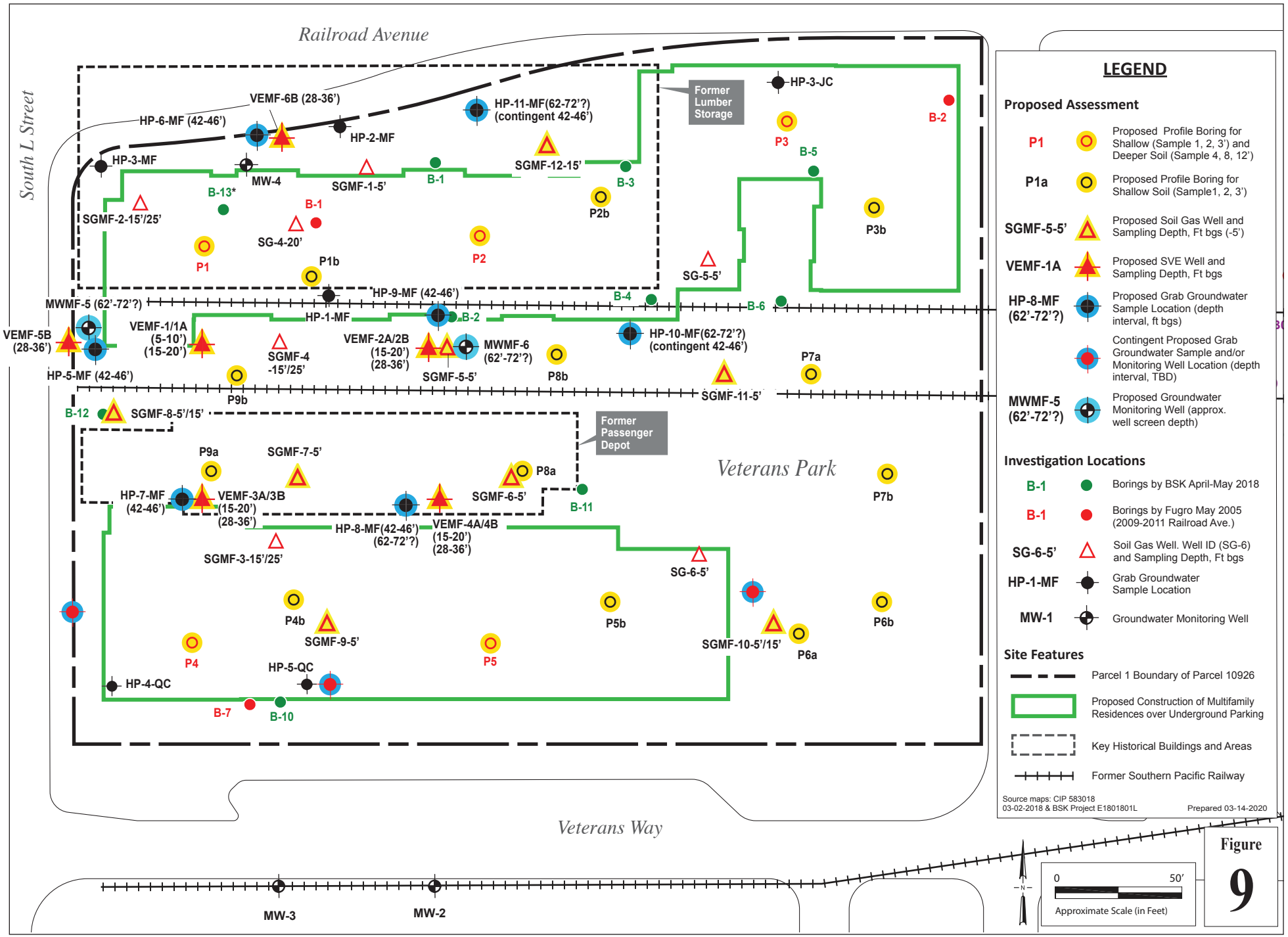


Figure 8

Old Train Depot
20, 24 & 24 L Street & 2009-2073 Railroad Avenue
Livermore, California

PANGEA

Shallow Groundwater Data (60-72 ft bgs)



Old Train Depot
20, 24 & 24 L Street & 2009-2073 Railroad Avenue
Livermore, California

PANGEA

Proposed Assessment Summary

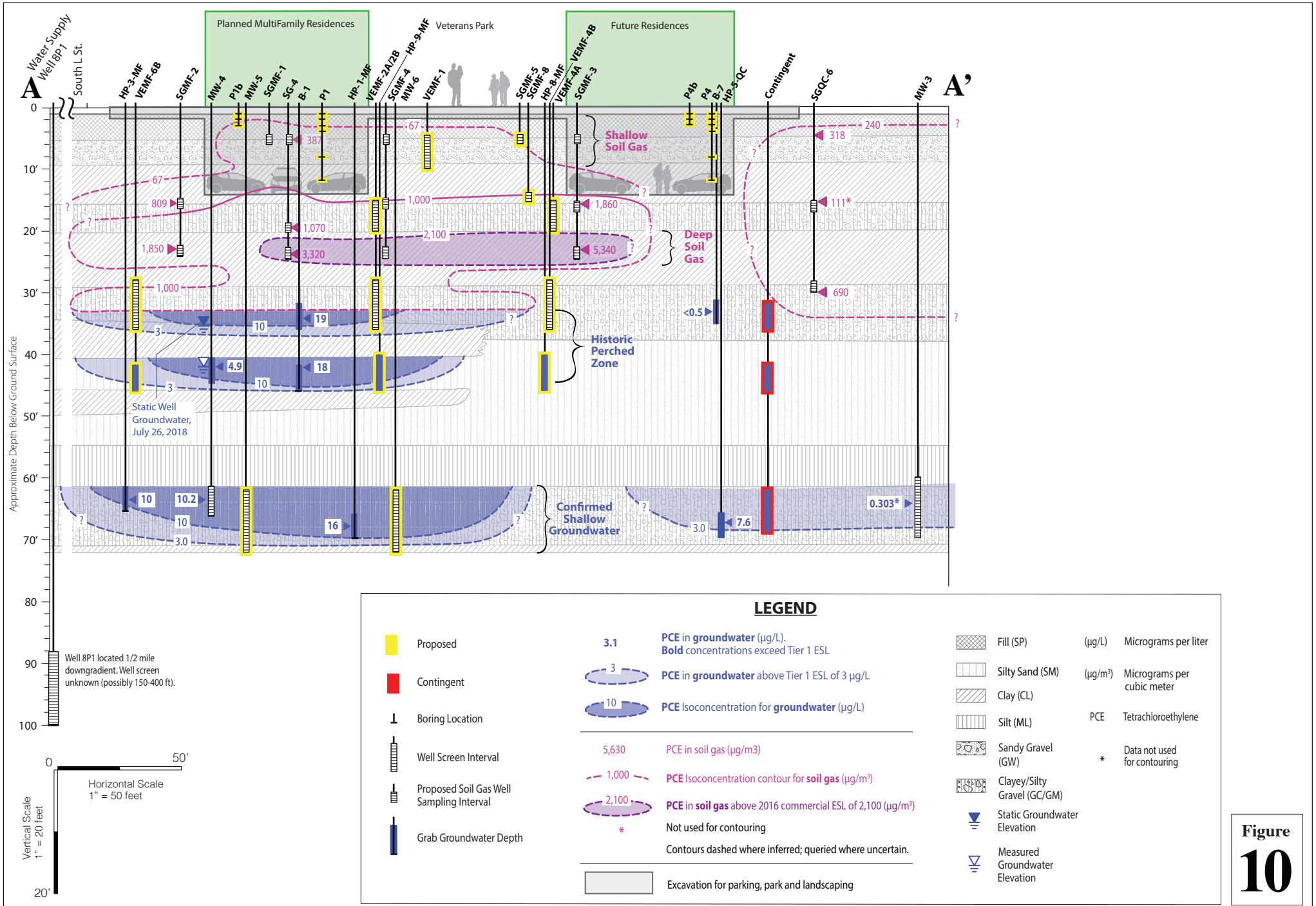


Figure 10

Old Train Depot
20, 24 & 24 L Street & 2009-2073 Railroad Avenue
Livermore, California

PANGEA

PCE Distribution in Cross Section and Proposed Assessment

Table 1. Sampling and Analysis Plan - Old Train Depot, 20, 22, & 24 S. L Street & 2009-2073 Railroad Avenue, Livermore, California

Cell ID	Boring ID	Boring Depth	Basis	Medium	Sample depth/ Sampling Interval	Sample ID	Soil Sample Analysis										Soil Gas	Groundwater	Notes
							TPHg/d/mo	VOCs	Title 22 Metals	SVOCs	PCBs	Pesticides	Asbestos	Pentachloro-phenol	Creosote	Dioxins	VOCs	VOCs	
		(ft bgs)			(ft bgs)		8015	8260B	6010	8270C	8082	8081A	PLM or 191	8270C	8270C	8280A	TO-15	8260B	
SOIL BORINGS																			
1	P1	12	Profiling / Lumberyard Assessment	*Shallow Soil*	*1*	*P1-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 4-pt lab composite of samples from the same depth from each boring in Cells 1 and 2*
					2	*P1-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P1-3*	--	--	--	--	--	--	--	--	--	--	--	--	
			Profiling for Disposal	Deeper Soil	4	P1-4	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	Discrete Samples
					8	P1-8	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	
					12	P1-12	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	
	P1b	3	Profiling / Lumberyard Assessment	*Shallow Soil*	*1*	*P1b-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 4-pt lab composite of samples from the same depth from each boring in cells 1 and 2*
					2	*P1b-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P1b-3*	--	--	--	--	--	--	--	--	--	--	--	--	
2	P2	12	Profiling / Lumberyard Assessment	*Shallow Soil*	*1*	*P2-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 4-pt lab composite of samples from the same depth from each boring in cells 1 and 2*
					2	*P2-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P2-3*	--	--	--	--	--	--	--	--	--	--	--	--	
			Profiling for Disposal	Deeper Soil	4	P2-4	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	Discrete Samples
					8	P2-8	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	
					12	P2-12	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	
	P2b	3	Profiling / Lumberyard Assessment	*Shallow Soil*	*1*	*P2b-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 4-pt lab composite of samples from the same depth from each boring in cells 1 and 2*
					2	*P2b-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P2b-3*	--	--	--	--	--	--	--	--	--	--	--	--	
1+2 COMP	--	--	Profiling / Lumberyard Assessment	Shallow Soil	1	P1,P1b,P2,P2b-1 COMP	**1**	**1**	**1**	--	--	--	--	**1**	**1**	**1**	--	--	Comp (P1-1) + (P1b-1) + (P2-1) + (P2b-1)
					2	P1,P1b,P2,P2b-2 COMP	**1**	**1**	**1**	--	--	--	--	**1**	**1**	**1**	--	--	Comp (P1-2) + (P1b-2) + (P2-2) + (P2b-2)
					3	P1,P1b,P2,P2b-3 COMP	**1**	**1**	**1**	--	--	--	--	**1**	**1**	**1**	--	--	Comp (P1-3) + (P1b-3) + (P2-3) + (P2b-3)
3	P3	12	Profiling for Disposal	*Shallow Soil*	*1*	*P3-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 2-pt lab composite of samples from the same depth from each boring in Cell 3*
					2	*P3-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P3-3*	--	--	--	--	--	--	--	--	--	--	--	--	
			Profiling for Disposal	Deeper Soil	4	P3-4	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	Discrete Samples
					8	P3-8	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	
					12	P3-12	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	
	P3b	3	Profiling for Disposal	*Shallow Soil*	*1*	*P3b-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 2-pt lab composite of samples from the same depth from each boring in Cell 3*
					2	*P3b-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P3b-3*	--	--	--	--	--	--	--	--	--	--	--	--	
3 COMP	--	--	Profiling for Disposal	Shallow Soil	1	P3,P3b-1 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P3-1) + (P3b-1)
					2	P3,P3b-2 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P3-2) + (P3b-2)
					3	P3,P3b-3 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	'--	'--	Comp (P3-3) + (P3b-3)
4	P4	12	Profiling for Disposal	*Shallow Soil*	*1*	*P4-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 4-pt lab composite of samples from the same depth from each boring in Cells 4 and 5*
					2	*P4-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P4-3*	--	--	--	--	--	--	--	--	--	--	--	--	
			Profiling for Disposal	Deeper Soil	4	P4-4	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	Discrete Samples
					8	P4-8	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	
					12	P4-12	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	
	P4b	3	Profiling for Disposal	*Shallow Soil*	*1*	*P4b-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 4-pt lab composite of samples from the same depth from each boring in Cells 4 and 5*
					2	*P4b-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P4b-3*	--	--	--	--	--	--	--	--	--	--	--	--	
5	P5	12	Profiling for Disposal	*Shallow Soil*	*1*	*P5-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 4-pt lab composite of samples from the same depth from each boring in Cells 4 and 5*
					2	*P5-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P5-3*	--	--	--	--	--	--	--	--	--	--	--	--	
			Profiling for Disposal	Deeper Soil	4	P5-4	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	Discrete Samples
					8	P5-8	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	
					12	P5-12	**1**	**1**	**1**	**1**	**1**	**1**	**1**	--	--	--	--	--	
	P5b	3	Profiling for Disposal	*Shallow Soil*	*1*	*P5b-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 4-pt lab composite of samples from the same depth from each boring in Cells 4 and 5*
					2	*P5b-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P5b-3*	--	--	--	--	--	--	--	--	--	--	--	--	
4 + 5 COMP	--	--	Profiling for Disposal	Shallow Soil	1	P4,P4B,P5,P5b-1 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P4-1) + (P4b-1) + (P5-1) + (P5b-1)
					2	P4,P4B,P5,P5b-2 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P4-2) + (P4b-2) + (P5-2) + (P5b-2)
					3	P4,P4B,P5,P5b-3 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P4-3) + (P4b-3) + (P5-3) + (P5b-3)

Table 1. Sampling and Analysis Plan - Old Train Depot, 20, 22, & 24 S. L Street & 2009-2073 Railroad Avenue, Livermore, California

Cell ID	Boring ID	Boring Depth	Basis	Medium	Sample depth/ Sampling Interval	Sample ID	Soil Sample Analysis										Soil Gas	Groundwater	Notes
							TPHg/d/mo	VOCs	Title 22 Metals	SVOCs	PCBs	Pesticides	Asbestos	Pentachloro-phenol	Creosote	Dioxins	VOCs	VOCs	
		(ft bgs)			(ft bgs)		8015	8260B	6010	8270C	8082	8081A	PLM or 191	8270C	8270C	8280A	TO-15	8260B	
6	P6a	12	Profiling for Disposal	*Shallow Soil*	*1*	*P6a-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 4-pt lab composite of samples from the same depth from each boring in Cells 6 and 7*
					2	*P6a-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P6a-3*	--	--	--	--	--	--	--	--	--	--	--	--	
	P6b	3	Profiling for Disposal	*Shallow Soil*	*1*	*P6b-1*	--	--	--	--	--	--	--	--	--	--	--	--	
					2	*P6b-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P6b-3*	--	--	--	--	--	--	--	--	--	--	--	--	
7	P7a	3	Profiling for Disposal	*Shallow Soil*	*1*	*P7a-1*	--	--	--	--	--	--	--	--	--	--	--	--	
					2	*P7a-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P7a-3*	--	--	--	--	--	--	--	--	--	--	--	--	
	P7b	3	Profiling for Disposal	*Shallow Soil*	*1*	*P7b-1*	--	--	--	--	--	--	--	--	--	--	--	--	
					2	*P7b-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P7b-3*	--	--	--	--	--	--	--	--	--	--	--	--	
6 + 7 COMP	--	--	Profiling for Disposal	Shallow Soil	1	P6a,P6b,P7a,P7b-1 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P6a-1) + (P6b-1) + (P7a-1) + (P7b-1)
					2	P6a,P6b,P7a,P7b-2 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P6a-2) + (P6b-2) + (P7a-2) + (P7b-2)
					3	P6a,P6b,P7a,P7b-3 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P6a-3) + (P6b-3) + (P7a-3) + (P7b-3)
8	P8a	3	Profiling for Disposal	*Shallow Soil*	*1*	*P8a-1*	--	--	--	--	--	--	--	--	--	--	--	--	*Collect discretes for 4-pt lab composite of samples from the same depth from each boring in Cells 8 and 9*
					2	*P8a-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P8a-3*	--	--	--	--	--	--	--	--	--	--	--	--	
	P8b	3	Profiling for Disposal	*Shallow Soil*	*1*	*P8b-1*	--	--	--	--	--	--	--	--	--	--	--	--	
					2	*P8b-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P8b-3*	--	--	--	--	--	--	--	--	--	--	--	--	
9	P9a	3	Profiling for Disposal	*Shallow Soil*	*1*	*P9a-1*	--	--	--	--	--	--	--	--	--	--	--	--	
					2	*P9a-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P9a-3*	--	--	--	--	--	--	--	--	--	--	--	--	
	P9b	3	Profiling for Disposal	*Shallow Soil*	*1*	*P9b-1*	--	--	--	--	--	--	--	--	--	--	--	--	
					2	*P9b-2*	--	--	--	--	--	--	--	--	--	--	--	--	
					3	*P9b-3*	--	--	--	--	--	--	--	--	--	--	--	--	
8 + 9 COMP	--	--	Profiling for Disposal	Shallow Soil	1	P8a,P8b,P9a,P9b-1 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P8a-1) + (P8b-1) + (P9a-1) + (P9b-1)
					2	P8a,P8b,P9a,P9b-2 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P8a-2) + (P8b-2) + (P9a-2) + (P9b-2)
					3	P8a,P8b,P9a,P9b-3 COMP	**1**	**1**	**1**	--	--	--	--	--	--	--	--	--	Comp (P8a-3) + (P8b-3) + (P9a-3) + (P9b-3)
SOIL GAS MONITORING WELLS																			
--	***SGMF-1-5***	*Existing*	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-1-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
	SGMF-4-5	*Existing*	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-4-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
	SG-5-5	*Existing*	Shallow Soil Gas	Soil Gas	4.5-5.5	SG-5-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
	SG-6-5	*Existing*	Shallow Soil Gas	Soil Gas	4.5-5.5	SG-6-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	**SGMF-5-5**	5.5	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-5-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	**SGMF-6-5**	5.5	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-6-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	**SGMF-7-5**	5.5	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-7-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	**SGMF-8-5**	5.5	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-8-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	**SGMF-9-5**	5.5	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-9-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	**SGMF-10-5**	5.5	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-10-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	**SGMF-11-5**	5.5	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-11-5	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	***SGMF-2-15/25***	*Existing*	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-2-15 & 25	--	--	--	--	--	--	--	--	--	--	**2**	--	
--	***SGMF-3-15/25***	*Existing*	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-3-15 & 25	--	--	--	--	--	--	--	--	--	--	**2**	--	
--	***SGMF-4-15/25***	*Existing*	Shallow Soil Gas	Soil Gas	4.5-5.5	SGMF-4-15 & 25	--	--	--	--	--	--	--	--	--	--	**2**	--	
--	***SG-4-20***	*Existing*	Shallow Soil Gas	Soil Gas	4.5-5.5	SG-4-20	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	**SGMF-8-15**	15	Deeper Soil Gas	Soil Gas	4.5-5.5	SGMF-8-15	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	**SGMF-10-15**	15	Deeper Soil Gas	Soil Gas	4.5-5.5	SGMF-8-15	--	--	--	--	--	--	--	--	--	--	**1**	--	
--	**SGMF-12-15**	15	Deeper Soil Gas	Soil Gas	4.5-5.5	SGMF-12-15	--	--	--	--	--	--	--	--	--	--	**1**	--	

Table 1. Sampling and Analysis Plan - Old Train Depot, 20, 22, & 24 S. L Street & 2009-2073 Railroad Avenue, Livermore, California

Cell ID	Boring ID	Boring Depth	Basis	Medium	Sample depth/ Sampling Interval	Sample ID	Soil Sample Analysis										Soil Gas	Groundwater	Notes
							TPHg/d/mo	VOCs	Title 22 Metals	SVOCs	PCBs	Pesticides	Asbestos	Pentachloro-phenol	Creosote	Dioxins	VOCs	VOCs	
		(ft bgs)			(ft bgs)		8015	8260B	6010	8270C	8082	8081A	PLM or 191	8270C	8270C	8280A	TO-15	8260B	
SOIL GAS MONITORING/CONTINGENT VAPOR EXTRACTION WELLS																			
--	**VEMF-1**	5-10	Shallow Soil Gas	Soil Gas	5-10	VEMF-1	--	--	--	--	--	--	--	--	--	--	1	--	
--	**VEMF-1A**	15-20	Deeper Soil Gas	Soil Gas	15-20	VEMF-2A	--	--	--	--	--	--	--	--	--	--	1	--	
--	**VEMF-2A**	15-20	Deeper Soil Gas	Soil Gas	15-20	VEMF-3A	--	--	--	--	--	--	--	--	--	--	1	--	
--	**VEMF-3A**	15-20	Deeper Soil Gas	Soil Gas	15-20	VEMF-1A	--	--	--	--	--	--	--	--	--	--	1	--	
	VEMF-4A	15-20	Deeper Soil Gas	Soil Gas	15-20	VEMF-4A	--	--	--	--	--	--	--	--	--	--	1	--	
--	**VEMF-1B**	28-36	Deeper Soil Gas	Soil Gas	28-36	VEMF-1B	--	--	--	--	--	--	--	--	--	--	1	--	
--	**VEMF-2B**	28-36	Deeper Soil Gas	Soil Gas	28-36	VEMF-2B	--	--	--	--	--	--	--	--	--	--	1	--	
--	**VEMF-3B**	28-36	Deeper Soil Gas	Soil Gas	28-36	VEMF-3B	--	--	--	--	--	--	--	--	--	--	1	--	
--	**VEMF-4B**	28-36	Deeper Soil Gas	Soil Gas	28-36	VEMF-4B	--	--	--	--	--	--	--	--	--	--	1	--	
--	**VEMF-5B**	28-36	Deeper Soil Gas	Soil Gas	28-36	VEMF-5B	--	--	--	--	--	--	--	--	--	--	1	--	
--	**VEMF-6B**	28-36	Deeper Soil Gas	Soil Gas	28-36	VEMF-6B	--	--	--	--	--	--	--	--	--	--	1	--	
MONITORING WELLS AND GRAB GROUNDWATER BORINGS																			
--	**HP-5-MF**	46	Perched Groundwater	Groundwater	42-46	HP-5-MF46	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-6-MF**	46	Perched Groundwater	Groundwater	42-46	HP-6-MF46	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-7-MF**	46	Perched Groundwater	Groundwater	42-46	HP-7-MF46	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-9-MF**	46	Perched Groundwater	Groundwater	42-46	HP-8-MF46	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-9-MF**	46	Perched Groundwater	Groundwater	42-46	HP-9-MF46	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-8-MF**	72	Shallow Groundwater	Groundwater	62-72	HP-8-MF72	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-10-MF**	72	Shallow Groundwater	Groundwater	62-72	HP-10-MF72	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-11-MF**	72	Shallow Groundwater	Groundwater	62-72	HP-11-MF72	--	--	--	--	--	--	--	--	--	--	--	1	
--	***MW-4***	*Existing*	Shallow Groundwater	Groundwater	62-67	MW-4	--	--	--	--	--	--	--	--	--	--	--	1	
--	**MWMF-5**	72	Shallow Groundwater	Groundwater	62-72	MWMF-5	--	--	--	--	--	--	--	--	--	--	--	1	
--	**MWMF-6**	72	Shallow Groundwater	Groundwater	62-72	MWMF-6	--	--	--	--	--	--	--	--	--	--	--	1	
--	**MW-5**	72	Shallow Groundwater	Groundwater	62-72	MW-5	--	--	--	--	--	--	--	--	--	--	--	1	
--	**MW-6**	72	Shallow Groundwater	Groundwater	62-72	MW-6	--	--	--	--	--	--	--	--	--	--	--	1	
						Total Quantity:	**30**	**30**	**30**	**30**	**15**	**15**	**15**	**15**	**3**	**3**	**32**	**13**	
CONTINGENT GRAB GROUNDWATER BORINGS																			
--	**HP-10-MF**	46	Perched Groundwater	Groundwater	42-46	HP-10-MF46	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-11-MF**	46	Perched Groundwater	Groundwater	42-46	HP-11-MF46	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-XX-MF**	46	Perched Groundwater	Groundwater	42-46	HP-XX-MF46	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-XX-MF**	46	Perched Groundwater	Groundwater	42-46	HP-XX-MF46	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-XX-MF**	72	Perched Groundwater	Groundwater	62-72	HP-XX-MF72	--	--	--	--	--	--	--	--	--	--	--	1	
--	**HP-XX-MF**	72	Perched Groundwater	Groundwater	62-72	HP-XX-MF72	--	--	--	--	--	--	--	--	--	--	--	1	

Notes:

Italics = Existing Well

ft bgs = feet below grade surface.

TPHg = Total Petroleum Hydrocarbons as gasoline (C6-C12) by EPA Method 8015.

TPHd = Total Petroleum Hydrocarbons as diesel (C10-C23) by EPA Method 8015.

TPHho = Total Petroleum Hydrocarbons (C18-C36) as hydraulic oil by EPA Method 8015.

TPHmo = Total Petroleum Hydrocarbons (C18-C36) as motor oil by EPA Method 8015.

VOCs = Volatile Organic Compounds by EPA Method 8260B for soil and groundwater samples; by TO-15 for soil gas samples.

SVOCs = Semi-Volatile Organic Compounds by EPA Method 8270.

PCBs = Polychlorinated Biphenols by EPA Method 8082 (dry weight).

Pangea

Table 2. Soil Analytical Data - Old Train Depot, Livermore Downtown Core Development, Livermore, California

Boring / Sample ID	Date Sampled	Sample Depth (ft bgs)	TPHg	TPHd	TPHmo	Benzene	Toluene	Ethylbenzene	Total Xylenes	PCE	TCE	Cis-1,2-DCE	Trans-1,2-DCE	Vinyl Chloride	Other VOCs	Arsenic	Total Chromium	Chromium STLC (mg/L)	Lead	Lead STLC (mg/L)	Nickel	Nickel STLC (mg/L)	Other Metals	Chlorinated Herbicides	Notes
			mg/kg																						
Tier 1 ESL:			**100**	**260**	**1,600**	**0.025**	**3.2**	**0.4**	**2.1**	**0.08**	**0.085**	**0.19**	**0.65**	**0.0015**	**varies**	**0.067**	**160**	--	--	**32**	--	**86**	--	varies	varies	
Direct Exposure, Construction Worker ESL			1,800	1,100	54,000	33	4,700	540	2,400	33	130	78	570	3.4	varies	2.00	--	--	--	160	--	86	--	**varies**	**varies**	
Direct Exposure, Residential, Shallow Soil ESL			430	260	12,000	0.33	1,100	5.9	580	0.59	0.95	19	130	0.0083	varies	0.067	--	--	--	80	--	820	--	varies	varies	
Background Levels[1]:			**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**--**	**19.1**	**99.6**	--	--	**16.1**	--	**119.8**	--	**varies**	**--**	
2009-2111 Railroad Ave, Fugro, 2005																									
B-1	5/2/2005	0.5	<1	35	110	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<1	30	--	--	12	--	58	--	+	--	
		3.0	<1	11	40	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<1	--	--	--	11	--	--	--	--	--	
B-7	5/3/2005	0.5	<1	43	99	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<1	32	--	--	**44**	--	60	--	+	+	
		3.0	<1	2.8	6.8	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<1	--	--	--	5.2	--	--	--	--	--	
Various Addresses, BSK, April 2018																									
B-1	4/13/2018	0"-6"	--	5.4	70	--	--	--	--	--	--	--	--	--	--	**7.5**	38	--	**56**	1.8	**81**	--	+	ND	
		10"-16"	--	4.6	24	--	--	--	--	--	--	--	--	--	--	**6.2**	39	--	**65**	2.7	**77**	--	+	ND	
		18"-24"	--	13	60	--	--	--	--	--	--	--	--	--	--	**8.1**	40	--	**100**	3.9	**74.0**	--	+	ND	
B-2	4/13/2018	0"-6"	--	6.2	22	--	--	--	--	--	--	--	--	--	--	**2.8**	30	--	19	--	**68**	--	+	ND	
		10"-16"	--	33	200	--	--	--	--	--	--	--	--	--	--	**55 a**	13	--	**170 b**	9.5	**23**	--	+	ND	
		18"-24"	--	16	78	--	--	--	--	--	--	--	--	--	--	**11**	21	--	**93**	2.1	**46**	--	+	ND	
B-3	4/13/2018	0"-6"	--	6.4	40	--	--	--	--	--	--	--	--	--	--	**20 a**	41	--	**89**	3.0	**96**	--	+	ND	
		10"-16"	--	4.7	32	--	--	--	--	--	--	--	--	--	--	**5.9**	47	--	**120**	1.6	**120 c**	--	+	ND	
		18"-24"	--	8.1	22	--	--	--	--	--	--	--	--	--	--	**8.4**	37	--	**140**	4.3	**90**	--	+	ND	
B-4	4/13/2018	0"-6"	--	4.6	23	--	--	--	--	--	--	--	--	--	--	**5.0**	56	<0.50	**58**	2.1	**110**	--	+	ND	
		10"-16"	--	29	120	--	--	--	--	--	--	--	--	--	--	**28 a**	30	--	**200 b**	7.3	**66**	--	+	ND	
		18"-24"	--	2.3	<2.0	--	--	--	--	--	--	--	--	--	--	**6.4**	36	--	**130**	2.8	**86**	--	+	ND	
B-5	4/13/2018	0"-6"	--	60	280	--	--	--	--	--	--	--	--	--	--	**7.1**	43	--	**41**	--	**98**	--	+	ND	
		10"-16"	--	3.9	24	--	--	--	--	--	--	--	--	--	--	**5.0**	52	<0.50	22	--	**130 c**	--	+	ND	
		18"-24"	--	4.6	16	--	--	--	--	--	--	--	--	--	--	**7.7**	45	--	27	--	**130 c**	--	+	ND	
B-6	4/16/2018	0"-6"	--	3.0	18	--	--	--	--	--	--	--	--	--	--	**4.6**	62	<0.50	11	--	**140 c**	--	+	ND	
		10"-16"	--	9.0	24	--	--	--	--	--	--	--	--	--	--	**8.4**	44	--	**43**	--	**100**	--	+	ND	
		18"-24"	--	11	34	--	--	--	--	--	--	--	--	--	--	**7.5**	38	--	**41**	--	**94**	--	+	ND	
B-10	4/16/2018	0"-6"	--	3.0	19	--	--	--	--	--	--	--	--	--	--	**2.6**	32	--	<6.3	--	**43**	--	+	--	
		10"-16"	--	<1.0	<2.0	--	--	--	--	--	--	--	--	--	--	**3.2**	76	<0.20	8.8	--	**160 c**	--	+	--	
		18"-24"	--	2.6	6.0	--	--	--	--	--	--	--	--	--	--	**3.0**	57	<0.50	9.0	--	**370 c**	1.9	+	--	
B-11	4/17/2018	0"-6"	--	17	120	--	--	--	--	--	--	--	--	--	--	**7.3**	36	--	**63**	1.6	**74**	--	+	--	
		10"-16"	--	14	72	--	--	--	--	--	--	--	--	--	--	**5.1**	30	--	**120**	3.8	**46**	--	+	--	
		18"-24"	--	5.3	15	--	--	--	--	--	--	--	--	--	--	**3.6**	18	--	**55**	1.4	**32**	--	+	--	
B-12	4/17/2018	0"-6"	--	6.1	53	--	--	--	--	--	--	--	--	--	--	**3.2**	25	--	<6.3	--	**53**	--	+	--	
		10"-16"	--	37	130	--	--	--	--	--	--	--	--	--	--	**48 a**	67	<0.50	7.3	--	**120 c**	--	+	--	
		18"-24"	--	37	100	--	--	--	--	--	--	--	--	--	--	**18**	52	<0.50	7.0	--	**140 c**	--	+	--	
B-13	4/17/2018	0"-6"	--	12	18	--	--	--	--	--	--	--	--	--	--	**2.6**	30	--	<6.3	--	**55**	--	+	--	
		10"-16"	--	<1.0	<2.0	--	--	--	--	--	--	--	--	--	--	**2.9**	55	<0.50	9.0	--	**160 c**	--	+	--	
		18"-24"	--	3.1	42	--	--	--	--	--	--	--	--	--	--	**3.4**	52	<0.50	<6.3	--	**140 c**	--	+	--	
Multifamily Residences Area, Pangea, 2018																									
SG-4-3	6/20/2018	3.0	<1.0	<1.0	<5.0	--	--	--	--	--	--	--	--	--	--	**4.0**	54	0.18	7.1	--	**140**	--	+	--	
SG-4-6	6/20/2018	6.0	<1.0	<1.0	<5.0	--	--	--	--	--	--	--	--	--	--	**3.3**	50	<0.10	4.7	--	**110**	--	+	--	
SG-4-12	6/20/2018	12.0	<1.0	<1.0	<5.0	--	--	--	--	--	--	--	--	--	--	**4.3**	48	--	5.3	--	**120**	--	+	--	
SGMF-2-23	11/14/2018	23.0	--	--	--	<3.8	<3.8	<3.8	<7.6	<3.8	<3.8	<3.8	<3.8	<3.8	<3.8	--	--	--	--	--	--	--	--	--	

Notes and Abbreviations:

TPH = total petroleum hydrocarbons as gasoline (TPHg), diesel (TPHd), and/or motor oil (TPHmo) range

PCE = tetrachloroethene

TCE = trichloroethene

DCE = dichloroethene

Other VOCs = volatile organic compounds not otherwise listed

ft bgs = feet below ground surface

mg/kg = milligrams per kilogram

< n = Chemical not present at a concentration in excess of detection limit shown.

+ = chemicals detected at relatively low concentrations. See laboratory reports for details.

-- = not applicable

ND = Not Detected at levels above laboratory reporting limits. Limits vary by constituent.

ESL = Environmental Screening Level, from California Regional Water Quality Control Board - San Francisco Bay Region, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, January 2019 (Revision 2).

1 = background levels taken from *Analysis of Background Distributions of Metals in the Soil at Lawrence Berkeley National Laboratory* - revised April 2009.

BOLD = Analyte detected above Tier 1 ESL.

GREY HIGHLIGHT = Analyte concentration exceeds construction worker ESL and background level if applicable (see notes a, b, c).

RED HIGHLIGHT = Analyte concentration exceeds criteria for waste soil classification as Class I Non-RCRA (California) hazardous waste.

a = 95UCL concentration of arsenic (14 mg/kg) for the April 2018 BSK data set is below local background concentration of 19.1 mg/kg.

b = 95UCL concentration of lead (75 mg/kg) for the April 2018 BSK data set is below construction worker ESL of 160 mg/kg.

c = 95 UCL concentration of nickel (110 mg/kg) for the April 2018 BSK data set is below local background concentration of 119.8 mg/kg.

Pangea

Table 3. Groundwater Analytical Data - Old Train Depot, Livermore Downtown Core Development, Livermore, California

Sample / Boring ID *(TOC Elevation)*	Date Sampled	Sample Depth / Screened Interval (ft bgs)	Depth to Water (feet bTOC)	Groundwater Elevation (feet amsl)	TPHg	TPHd	TPHmo	Benzene	Naphthalene	PCE	TCE	Cis-1,2-DCE	Trans-1,2-DCE	Vinyl Chloride	Chloroform	Other VOCs	Notes
					µg/L												
				Tier 1 ESL:	**100**	**100**	**--**	**0.42**	**0.17**	**0.64**	**1.2**	**6.0**	**10**	**0.0086**	**0.81**	**--**	
2009-2111 Railroad Ave, Fugro, May 2005																	
B-1	5/2/2005	31-35	--	--	**160**	<62	<62	<0.5	--	**19**	<0.5	<0.5	<0.5	<0.5	<0.5	ND	Grab data
	5/2/2005	40-44	--	--	**160**	**330**	480	<0.5	--	**18**	<0.5	<0.5	<0.5	<0.5	<0.5	ND	Grab data
B-2	5/2/2005	31-35	--	--	<50	**230**	72	<0.5	--	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	ND	Grab data
B-3	5/2/2005	31-35	--	--	**160**	<56	<56	<0.5	--	**6.8**	<0.5	<0.5	<0.5	<0.5	<0.5	ND	Grab data
B-4	5/2/2005	31-35	--	--	**170**	<57	<57	<0.5	--	**34**	1.0	<0.5	<0.5	<0.5	<0.5	ND	Grab data
B-6	5/2/2005	31-35	--	--	**170**	<56	<56	<0.5	--	**31**	0.91	<0.5	<0.5	<0.5	0.54	<0.5	Grab data
B-7	5/2/2005	31-35	--	--	**210**	**220**	130	<0.5	--	<0.5	<0.5	<0.5	<0.5	<0.5		+	Grab data
Quality Control Samples																	
Duplicate-1(B-1)	5/2/2005	31-35	--	--	**160**	--	--	<0.5	--	**21**	<0.5	--	--	--	--	ND	Grab data. Control sample.
Duplicate-2(B-3)	5/2/2005	31-35	--	--	**150**	<54	56	<0.5	--	**4.8**	<0.5	--	--	--	--	ND	Grab data. Control sample.
Duplicate-3(B-4)	5/2/2005	31-35	--	--	**160**	<59	<59	<0.5	--	**32**	0.88	--	--	--	--	ND	Grab data. Control sample.
Monitoring Well, Pangea, 2018																	
MW-4 *484.31*	7/26/2018	62-67	36.71	447.60	**--**	--	--	<0.102	0.117	**10.2**	0.138	<0.114	<0.104	<0.129	0.708	<3.45	Well sample after development.
Grab Groundwater Samples, Pangea, 2018																	
MW-4	7/11/2018	41-45	41.00	--	**--**	--	--	<0.50	<0.50	**4.9**	<0.50	<0.50	<0.50	<0.50	**1.3**	a	Perched zone grab data.
HP-1-MF	11/12/2018	66-70	50.10	--	**--**	--	--	<0.5	<2.0	**16**	<0.5	<0.5	<0.5	<0.5	0.60	<1.0	Grab data
HP-2-MF	11/13/2018	66-70	46.80	--	**--**	--	--	<0.5	<0.5	**4.6**	<0.5	<0.5	<0.5	<0.5	0.77	<0.5	Grab data
HP-3-MF	11/13/2018	62-70	52.00	--	**--**	--	--	<0.5	<0.5	**10**	<0.5	<0.5	<0.5	<0.5	0.72	<0.5	Grab data
HP-4-QC	11/8/2018	66-70	52.00	--	**--**	--	--	<0.331	<1.0	**3.21**	1.20	<0.260	<0.396	<0.259		--	Upgradient of Old Train Depot
HP-5-QC	11/12/2018	66-70	45.30	--	**--**	--	--	<0.5	<2.0	**7.6**	<0.5	<0.5	<0.5	<0.5		+	Upgradient of Old Train Depot

Notes & Abbreviations:

TOC Elevation - Top of casing elevation surveyed on October 5, 2018 by Virigl Chvez Land Surveying using NAVD 88 benchmark elevation. Reported in feet above mean sea level.

TPH = Total petroleum hydrocarbons as gasoline (TPHg), diesel (TPHd), and/or motor oil (TPHmo) range

PCE = Tetrachloroethene

TCE = Trichloroethene

DCE = Dichloroethene

Other VOCs = Volatile organic compounds not otherwise listed

ft bgs = Feet below ground surface

µg/L = Micrograms per liter

< n = Chemical not present at a concentration in excess of detection limit shown.

-- = Nt applicable or not available

ND = Not Detected at levels above laboratory reporting limits. Limits vary by constituent.

ESL = Environmental Screening Level, from California Regional Water Quality Control Board - San Francisco Bay Region, Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater, January 2019 (Revision 2).

a= Bromodichloromethane detected at 0.57 ug/L, below its Tier 1 ESL of 0.87 ug/L.

BOLD = Analyte detected above Tier 1 ESL.

Pangea

Table 4. Soil Gas Analytical Data - Old Train Depot, Livermore Downtown Core, Livermore, CA

Boring / Sample ID	Date Sampled	Sample Depth (ft bgs)	PCE	TCE	cis-1,2-DCE	trans-1,2-DCE	Vinyl Chloride	Benzene	Ethylbenzene	TPH (Low Fraction)	2-Propanol (Leak Check)	Other VOCs	Notes	
			µg/m³											
		Tier 1 ESL:	**15**	16	280	2,800	0.32	3.2	37	--	--	--		
		Residential ESL for Vapor Intrusion Human Health Risk:	**15**	16	280	2,800	0.32	3.2	37	--	--	--		
		Commercial ESL for Vapor Intrusion Human Health Risk:	**67**	100	1,200	12,000	5.2	14	160	--	--	--		
Multifamily, Pangea, June 2018														
SG-4-5	6/22/2018	5.0	**309**	<1.07	<0.793	<0.793	<0.511	0.997	2.35	551	5.04	a		
SG-4-20	6/22/2018	20.0	**420**	<1.07	<0.793	<0.793	<0.511	2.70	0.954	1,900	<3.07	a		
SG-5-5	6/21/2018	5.0	**34.6**	<1.07	<0.793	<0.793	<0.511	0.676	<0.867	512	4.70	a		
SG-6-5	6/21/2018	5.0	**168**	<1.07	<0.793	<0.793	<0.511	<0.639	1.27	329	242	a		
Shroud	6/22/2018	--	--	--	--	--	--	--	--	--	219,000	---		
MultiFamily, Pangea, November 2018														
SGMF-1-5	11/27/2018	4.5-5.5	**56.5**	<1.07	<0.908	<0.908	<0.511	<0.639	2.18	<207	7.11	a		
SGMF-2-5	11/27/2018	4.5-5.5	**108**	<1.07	<0.793	<0.793	<0.511	<0.639	<0.867	<207	38.9	a		
SGMF-2-15	11/27/2018	14.5-15.5	**809**	<1.07	<0.793	<0.793	<0.511	1.92	<0.867	960	<3.07	a		
SGMF-2-25	11/27/2018	24.5-25.5	**1,850**	3.9	<0.793	<0.793	<0.511	**58**	1.1	3,870	8.23	a		
SGMF-3-15	11/28/2015	14.5-15.5	**1,860**	1.4	<0.793	<0.793	<0.511	2.1	<0.867	2,130	28.7	a		
SGMF-3-25	11/28/2015	24.5-25.5	**5,340**	7.2	<0.793	<0.793	<0.511	**5.0**	<0.867	3,680	4.86	a		
SGMF-4-5	11/28/2015	4.5-5.5	**387**	<1.07	<0.793	<0.793	<0.511	0.863	4.19	611	14.5	a		
SGMF-4-15	11/28/2015	14.5-15.5	**1,070**	<1.07	<0.793	<0.793	<0.511	**3.55**	10.6	1,540	96.1	a		
SGMF-4-25	11/28/2015	24.5-25.5	**3,320**	12	<0.793	0.826	<0.511	**14.1**	22.1	4,080	7.87	a		
SGQC-6-5	11/9/2018	4.5-5.5	**318**	<1.07	<0.793	<0.793	<0.511	**27.1**	43.6		8.90	a	TPH = 4,060	Short equilibration time ~ 4 hr
SGQC-6-15	11/9/2018	14.5-15.5	**111**	<1.07	<0.793	<0.793	<0.511	**115**	115		160	a	TPH = 10,200	Short equilibration time ~ 2 hr
SGQC-6-30	11/9/2018	29.5-30.5	**690**	27.8	<0.793	4.39	0.802	**86.5**	110		<3.07	a	TPH = 8,890	Short equilibration time ~ 2 hr
SGQC-7-5	11/9/2018	4.5-5.5	**100**	<1.07	<0.793	<0.793	<0.511	**2.65**	3.01		9.12	a	TPH = 360	
SGQC-7-15	11/9/2018	14.5-15.5	**1,010**	<1.07	<0.793	<0.793	<0.511	**11.6**	3.11		59.8	a	TPH = 1,400	
SHROUD	11/12/2018	--	--	--	--	--	--	--	--		2,150,000	--		
	11/28/2018	--	--	--	--	--	--	--	--	--	150,000	---		

Notes and Abbreviations:

PCE = Tetrachloroethene

TCE = Trichloroethene

DCE = Dichloroethene

Other VOCs = Volatile organic compounds by EPA Method TO-15 or EPA Method 8260.

µg/m3 = Micrograms per cubic meter of air results calculated by laboratory from parts per billion results using normal pressure and temperature (NPT).

ft bgs = feet below ground surface.

< n = Chemical not present above laboratory detection limit.

--- = Not analyzed

Bold = Concentrations above ESLs for Residential Land Use for shallow soil gas (SG samples).

ESL = Environmental Screening Level, from California Regional Water Quality Control Board - San Francisco Bay Region, *Screening for Environmental Concerns at Sites with Contaminated Soil and Groundwater,* January 2019 (Revision 2).
a= Other analytes detected below Tier 1 ESLs, if established, including acetone, bromodichloromethane, carbon disulfide, ethanol, MEK, trichloroflouromethane, dichloroflouromethane, propene, toluene, xylenes, 1,1,1-trichloroethane, 1,2,4-trimethylbenzene, n-hexane, and methylene chloride.

Appendix A

Agency Correspondence

February 9, 2021
File No. 01S0831 (ekw)
Cost Recovery ID 2020842

City of Livermore
Attn: Rick Teczon
1052 South Livermore Avenue
Livermore, CA 94550
rteczon@cityoflivermore.net

Subject: Approval of Site Assessment and Summary Report and Site History Technical Report and Request for Data Gap Workplan and Interim Remedial Action Plan – Old Train Depot, 20, 22 & 24 S. L Street & 2009 to 2073 Railroad Ave, Livermore, Alameda County

Dear Mr. Lanphier:

This letter approves the April 18, 2020, Site Assessment and Summary Report (Site Assessment) and May 22, 2020, Site History Technical Report (Report) submitted by the City of Livermore (City) in response to the Regional Water Board's April 24,2020, directive letter. As explained below, we request the City submit a Data Gap Assessment Workplan and an Interim Remedial Action Plan for the Old Train Depot (Site).

Background

The Site is located within the Livermore Downtown Core Development project area and historically was used as a lumber yard and a train depot with multiple railroad lines. Prospective development of the Site consists of multiple residential and commercial buildings and a Veteran's park.

Soil, groundwater, and soil vapor sampling were conducted at the Site to assess the presence of chemicals from operations at and nearby the Site. Nearby properties historically included a dry cleaner, auto body operations, and other commercial and industrial uses. Results of investigations conducted since 2009 identified select metals in soil, petroleum hydrocarbons in soil and groundwater, and volatile organic compounds, including tetrachloroethene (PCE) and its breakdown products, in groundwater and soil vapor. The Deep Zone groundwater (approximately 100 to 390 feet below ground surface [bgs]) is used by the California Water Service for drinking water. The closest water supply well is located approximately ½ mile downgradient of the Site and is reportedly screened from 22 to 192 feet bgs. The Report concludes the following:

- Soil containing metals at concentrations greater than environmental screening levels will require management during site grading and use.

- Additional action, focused on soil vapor and groundwater, is warranted to assess, remediate, and/or mitigate PCE and its breakdown products at the Site.

Comments

- Water Board staff concur with the Report's conclusions that soil management will be necessary during Site development and that additional assessment is needed to further characterize the extent of PCE and its breakdown products in soil vapor and groundwater.
- Water Board staff request additional evaluation be conducted to assess whether operations as a lumber yard could have impacted the Site. Chemicals historically used to treat lumber (e.g., pentachlorophenol, dioxin) could potentially have been released if treated lumber was stored at the Site or if lumber was treated onsite.
- Prior to construction and Site redevelopment, a Site Management Plan that has been reviewed and approved by the Water Board will be necessary to address handling, management, and disposal of contaminated media during construction activities.

Request for Data Gap Assessment Workplan and Interim Remedial Action Plan

The Water Board requests the City submit the following two reports:

1. Data Gap Assessment Workplan (Workplan)
2. Interim Remedial Action Plan (IRAP).

No deadline is set for submittal of these documents; however, we request the City work with the Water Board case manager to submit the reports in a reasonable timeframe.

The Workplan should propose soil, groundwater, and/or soil vapor sampling to collect data that will fill identified data gaps and develop a robust conceptual site model (CSM) considering the proposed future use of the Site. The Workplan should include the rationale for the proposed investigative activities, sampling locations, sampling methods, and analytical testing methods.

The IRAP should present the results of the investigation conducted under the Workplan, including, but not limited to maps showing sampling locations and chemical concentration data, tabulated data, lithologic logs, and analytical laboratory reports. In addition, the IRAP should include the updated CSM and describe the remedial alternatives evaluated, remedial alternative selected, and proposed implementation method and timeframe.

The City is required to submit all documents in electronic format to the State Water Resources Control Board's GeoTracker database, pursuant to the California Code of Regulations (Title 23, Section 3890, et seq.). See Electronic Submittal of Information for guidance on submitting documents to GeoTracker. Please note that this requirement includes all analytical data, monitoring well information (latitudes, longitudes, elevations, and water depth), site maps, and boring logs.

Basis for Request
The information required in these reports is needed to further understand the extent of site contamination and identify remedial options that can reduce or eliminate future impacts to human health or water quality from site contamination. The City is named in its capacity as the current landowner.

If you have any questions, please contact me at elizabeth.wells@waterboards.ca.gov.

Sincerely,

Elizabeth Wells
Senior Water Resource Control Engineer

Copy by email:
Joel Waxdeck, City of Livermore, jhwaxdeck@cityoflivermore.net
Paul Spence, City of Livermore, prspence@cityoflivermore.net
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Bob Clark-Riddell, Pangea Environmental Services, Inc., briddell@pangeaenv.com
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Appendix B

Standard Operating Procedures

STANDARD OPERATING PROCEDURE FOR "MICROPURGE" LOW FLOW GROUNDWATER SAMPLING

1.0 PURPOSE

This standard operating procedure (SOP) describes the procedures for conducting "micropurge" low flow groundwater sampling. This SOP is based on Puls and Barcelona, 1996.

2.0 EQUIPMENT

- Low-flow purging/sampling pump. Equipment to be used may include (in decreasing order of preference): dedicated bladder or Grundfos Rediflo pump, peristaltic pump (shallow water table only), non-dedicated bladder or Grundfos Rediflo pump
- pH meter
- EC meter
- Digital thermometer
- Flow-through cell and DO meter (optional, depending on site requirements)
- Sample vials and preservatives appropriate for analytical methods
- Sample labels
- Cooler with bagged ice
- Record-keeping materials
- Latex or nitrile gloves

3.0 WATER LEVEL MEASUREMENTS

1. Remove all well caps. Do NOT sound the total depth of the wells until after completion of sampling (this step may stir up sediment).
2. Allow each well to equilibrate to atmospheric pressure for at least 30 minutes (this step is not necessary for stovepipe wells with vented casings).
3. During equilibration, take water levels at approximately 10-minute intervals to assess the water level stability. Note changes and stability of the water level. Allow additional time for equilibration at any wells that do not exhibit stable readings over a 10-minute interval.
4. Record final water level after water level has stabilized.

4.0 EQUIPMENT CALIBRATION

Calibrate all meters according to manufacturer's instructions prior to sampling. Record calibration in field notes.

5.0 WELL PURGING

The validity of the micropurging method is based on strict adherence to the following purging and sampling requirements:

- Mixing of the water column within the well prior to and during purging and sampling is minimized by not inserting pumps and bailers into the well (or minimizing insertion).
- The pump intake (or suction tubing) for both purging and sampling is positioned at the target sampling depth within the water column, and not so deep as to agitate sediment near the bottom of the well.
- Drawdown within the well is minimized by pumping at low rates (typically 0.1 to 0.5 liters per minute [0.025 to 0.125 gpm]).
- Purge volume is determined by the stabilization of indicator parameters (primarily electric conductivity [EC], pH and dissolved oxygen [DO] or turbidity) within specific criteria.

1. **Pump Insertion.** If a dedicated pump is installed in the well, take care not to move the pump up or down within the water column. If no dedicated pump is present, lower the pump or peristaltic suction tube **slowly** to the specific sampling depth required (generally within the upper half of the screened section) and secure. Do not allow the pump to drop into the bottom half of the water column.
2. **Purging.** Initiate purging at a rate no greater than 0.5 liters per minute [0.125 gpm]. Monitor the water level during purging and reduce the flow rate if the drawdown below static water level approaches 0.3 feet. The objective is to not exceed 0.33 feet of drawdown during purging. Periodically record water depth and volume measurements.
3. **Stabilization.** At a minimum, monitor EC, pH, and either DO or turbidity, preferably using a flow-through cell. ORP may also be monitored. Stabilization has been reached when three successive readings taken 3 to 5 minutes apart are within the following tolerances for ALL parameters (EC $\pm$3%, pH $\pm$0.1, DO or turbidity $\pm$10%, ORP $\pm$10mv).
4. **Sampling.** Sampling should be conducted as soon as stabilization has been reached or a maximum purge volume of 3 casing volumes for a 4" well, or 5 casing volumes for a 2" well has been reached. Collect samples by disconnecting the flow-through cell and directing the pump tubing outlet flow directly into the sample containers.
5. **Shipment.** Place samples in a cooler with bagged ice and ship under chain-of-custody to the project laboratory.

REFERENCE

Puls, R.W. and Barcelona, M.J., 1996, Low-flow (minimal drawdown) ground-water monitoring procedures, U.S. Environmental Protection Agency Superfund Technology Support Center for Ground Water, National Risk Management Research Laboratory, Subsurface Protection and Remediation Division, EPA/540/S-95/504, April.

STANDARD FIELD PROCEDURES FOR MONITORING WELLS

This document describes Pangea Environmental Services' standard field methods for drilling, installing, developing and sampling groundwater monitoring wells. These procedures are designed to comply with Federal, State and local regulatory guidelines. Specific field procedures are summarized below.

Well Construction and Surveying

Groundwater monitoring wells are installed in soil borings to monitor groundwater quality and determine the groundwater elevation, flow direction and gradient. Well depths and screen lengths are based on groundwater depth, occurrence of hydrocarbons or other compounds in the borehole, stratigraphy and State and local regulatory guidelines. Well screens typically extend 10 to 15 feet below and 5 feet above the static water level at the time of drilling. However, the well screen will generally not extend into or through a clay layer that is at least three feet thick.

Well casing and screen are flush-threaded, Schedule 40 PVC. Screen slot size varies according to the sediments screened, but slots are generally 0.010 or 0.020 inches wide. A rinsed and graded sand occupies the annular space between the boring and the well screen to about one to two ft above the well screen. A two feet thick hydrated bentonite seal separates the sand from the overlying sanitary surface seal composed of Portland type I, II cement.

Well-heads are secured by locking well-caps inside traffic-rated vaults finished flush with the ground surface. A stovepipe may be installed between the well-head and the vault cap for additional security. The well top-of-casing elevation is surveyed with respect to mean sea level and the well is surveyed for horizontal location with respect to an onsite or nearby offsite landmark.

Well Development

Wells are generally developed using a combination of groundwater surging and extraction. Surging agitates the groundwater and dislodges fine sediments from the sand pack. Wells may be surged prior to installation of the well seal to ensure that there are no voids in the sand pack. Development occurs 48 to 72 hours after seal installation to ensure that the Portland cement has set up correctly. After about ten minutes of surging, groundwater is extracted from the well using bailing, pumping and/or reverse air-lifting through an eductor pipe to remove the sediments from the well. Surging and extraction continue until at least ten well-casing volumes of groundwater are extracted and the sediment volume in the groundwater is negligible.

All equipment is steam-cleaned prior to use and air used for air-lifting is filtered to prevent oil entrained in the compressed air from entering the well. Wells that are developed using air-lift evacuation are not sampled until at least 72 hours after they are developed.

Groundwater Sampling

Depending on local regulatory guidelines, three to four well-casing volumes of groundwater are purged prior to sampling. Purging continues until groundwater pH, conductivity, and temperature have stabilized. Groundwater samples are collected using bailers or pumps and are decanted into the appropriate containers supplied by the analytic laboratory. Samples are labeled, placed in protective foam sleeves, stored on crushed ice at or below 4°C, and transported under chain-of-custody to the laboratory. Laboratory-supplied trip blanks accompany the samples and are analyzed to check for cross-contamination. An equipment blank may be analyzed if non-dedicated sampling equipment is used.

STANDARD FIELD PROCEDURES FOR SOIL BORINGS

This document describes Pangea Environmental Services' standard field methods for drilling and sampling soil borings, used to facilitate for soil sampling, grab groundwater sampling, or well installation. These procedures are designed to comply with Federal, State and local regulatory guidelines. Specific field procedures are summarized below.

Objectives

Soil samples are collected to characterize subsurface lithology, assess whether the soils exhibit obvious hydrocarbon or other compound vapor odor or staining, estimate ground water depth and quality, and to submit samples for chemical analysis.

Soil Classification/Logging

All soil samples are classified according to the Unified Soil Classification System by a trained geologist, scientist or engineer working under the supervision of a California Registered Engineer, California Registered Geologist (RG) or a Certified Engineering Geologist (CEG). The following soil properties are noted for each soil sample:

- Principal and secondary grain size category (i.e. sand, silt, clay or gravel)
- Approximate percentage of each grain size category,
- Color,
- Approximate water or product saturation percentage,
- Observed odor and/or discoloration,
- Other significant observations (i.e. cementation, presence of marker horizons, mineralogy), and
- Estimated permeability.

Soil Boring and Sampling

Soil borings are typically drilled using hollow-stem augers or hydraulic-push technologies. At least one and one half ft of the soil column is collected for every five ft of drilled depth. Additional soil samples are typically collected near the water table and at lithologic changes and observed zones of potential contamination. With hollow-stem drilling, samples are collected using brass/stainless steel tubes lining a split-barrel or equivalent samplers driven into undisturbed sediments beyond the bottom of the borehole. With hydraulic-push drilling, soil samples are typically collected using acetate liners. Sampling tubes or cut acetate liners chosen for analysis are trimmed of excess soil and capped with Teflon tape and plastic end caps. Soil samples can also be collected using a TerraCore sampling device in accordance with EPA Method 5035. Terracore soil sampling involves the collection of an approximately 5-g soil sample which is placed in a pre-weighed vial with a septum-sealed screw cap that contains a sodium bisulfate or methanol preservation solution.

The vertical location of each soil sample is determined by measuring the distance from the middle of the soil sample tube to the end of the drive rod used to advance the split barrel sampler or the acetate tube. All sample depths use the ground surface immediately adjacent to the boring as a datum. The horizontal location of each boring is measured in the field from an onsite permanent reference using a measuring wheel or tape measure.

Drilling and sampling equipment is steam-cleaned prior to drilling and between borings to prevent cross-contamination. Sampling equipment is washed between samples with trisodium phosphate or an equivalent EPA-approved detergent.

Sample Storage, Handling and Transport

Soil samples are labeled and stored at or below 4°C on either crushed or dry ice, depending upon local regulations. Samples are transported under chain-of-custody to a State-certified analytical laboratory.

Field Screening

Soil samples collected during drilling will be analyzed in the field for ionizable organic compounds using a photo-ionization detector (PID) with a 10.2 eV lamp. The screening procedure will involve placing an undisturbed soil sample in a sealed container (either a zip-lock bag, glass jar, or a capped soil tube). The container will be set aside, preferably in the sun or warm location. After approximately fifteen minutes, the head space within the container will be tested for total organic vapor, measured in parts per million on a volume to volume basis (ppmv) by the PID. The PID instrument will be calibrated prior to boring using hexane or isobutylene. PID measurements are used along with the field observations, odors, stratigraphy and ground water depth to select soil samples for analysis.

Water Sampling

Water samples collected from borings are either collected from the open borehole, from within screened PVC inserted into the borehole, or from a driven Hydropunch-type sampler. Groundwater is typically extracted using a bailer, check valve and/or a peristaltic pump. The ground water samples are decanted into the appropriate containers supplied by the analytic laboratory. Samples are labeled, placed in protective foam sleeves, stored on crushed ice at or below 4°C, and transported under chain-of-custody to the laboratory.

Pangea often performs electrical conductivity (EC) logging and/or continuous coring to identify potential water-bearing zones. Hydropunch-type sampling is then performed to provide discrete-depth grab groundwater sampling within potential water-bearing zones for vertical contaminant delineation. Hydropunch-type sampling typically involves driving a cylindrical sheath of hardened steel with an expendable drive point to the desired depth within undisturbed soil. The sheath is retracted to expose a stainless steel or PVC screen that is sealed inside the sheath with Neoprene O-rings to prevent infiltration of formation fluids until the desired depth is attained. The groundwater is extracted using tubing inserted down the center of the rods into the screened sampler.

Duplicates and Blanks

Blind duplicate water samples are collected usually collected only for monitoring well sampling programs, at a rate of one blind sample for every 10 wells sampled. Laboratory-supplied trip blanks accompany samples collected for all sampling programs to check for cross-contamination caused by sample handling and transport. These trip blanks are analyzed if the internal laboratory QA/QC blanks contain the suspected field contaminants. An equipment blank may also be analyzed if non-dedicated sampling equipment is used.

Grouting

If the borings are not completed as wells, the borings are filled to the ground surface with cement grout poured or pumped through a tremie pipe. For borings used as wells, wells are constructed in the borehole and grouted in accordance with well specifications.

Waste Handling and Disposal

Soil cuttings from drilling activities are usually stockpiled onsite on top of and covered by plastic sheeting. At least four individual soil samples are collected from the stockpiles for later compositing at the analytic laboratory. The composite sample is analyzed for the same constituents analyzed in the borehole samples. Soil cuttings are transported by licensed waste haulers and disposed in secure, licensed facilities based on composite analytic results.

Ground water removed during sampling and/or rinsate generated during decontamination procedures are stored onsite in sealed 55 gallon drums. Each drum is labeled with the drum number, date of generation, suspected contents, generator identification and consultant contact. Disposal of the water is based on the analytic results for the well samples. The water is either pumped out using a vacuum truck for transport to a licensed waste treatment/disposal facility or the individual drums are picked up and transported to the waste facility where the drum contents are removed and appropriately disposed.

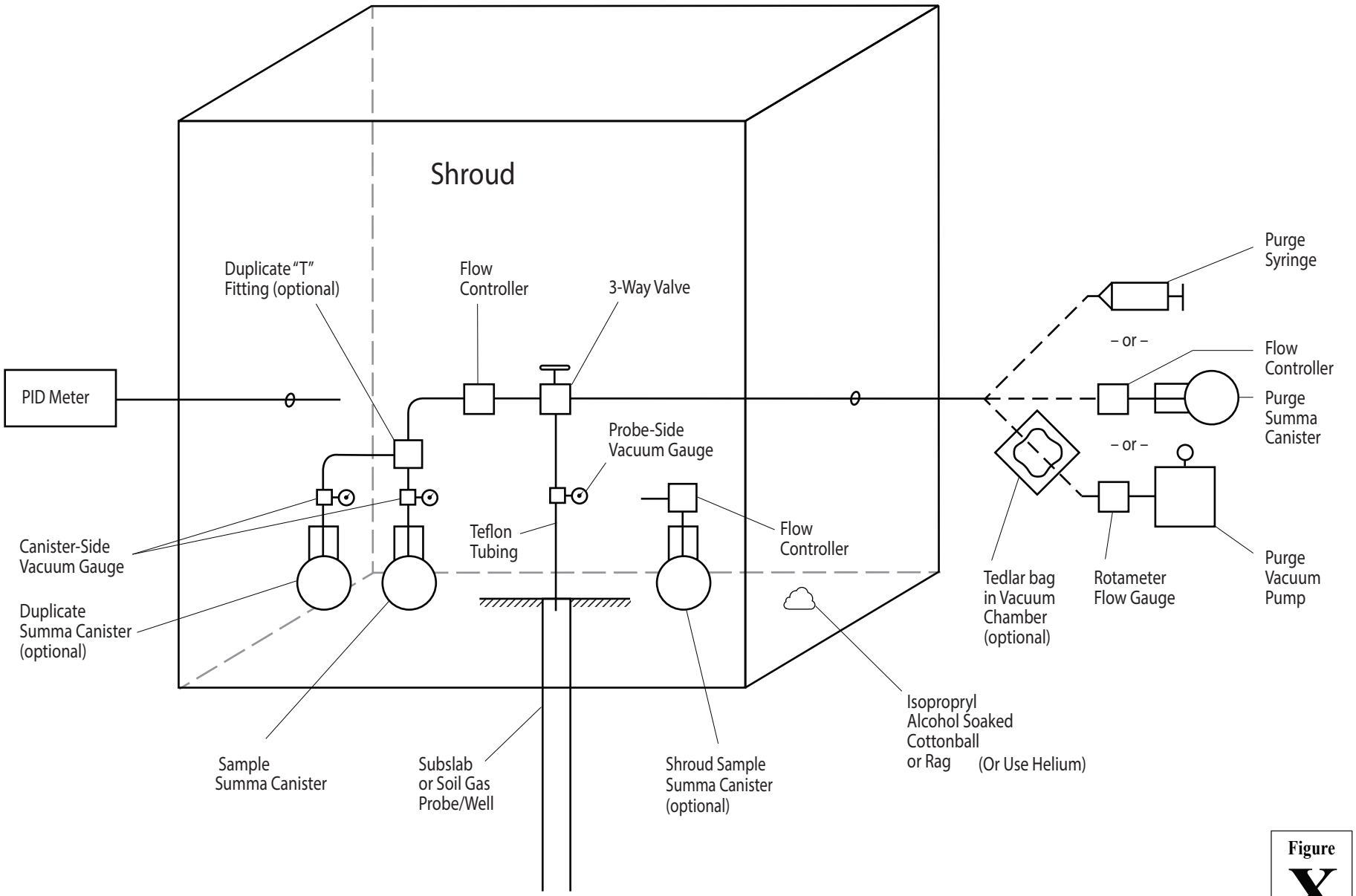

Figure X

PANGEA

Subslab and Soil Gas Sampling Apparatus Schematic