Mr. Keith Nowell
Alameda County Environmental Health
Department of Environmental Health
1131 Harbor Bay Parkway, 2nd Floor
Alameda, CA 94502-6577

RECEIVED

9:34 am, Jul 19, 2012

Alameda County
Environmental Health

Re: Former Exxon Station
5175 Broadway
Oakland, California
ACEH File No. 139
SFRWQCB Site No. 01-0958
UST Fund Claim No. 3406

Dear Mr. Nowell:

I, Mr. Ernie Nadel, have retained Pangea Environmental Services, Inc. (Pangea) as the environmental consultant for the project referenced above. Pangea is submitting the attached report on my behalf.

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

Sincerely,

Ernie Nadel
Rockridge Heights, LLC

July 16, 2012

VIA ALAMEDA COUNTY FTP SITE

Mr. Keith Nowell
Alameda County Environmental Health
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577

Re: **Revised Soil Gas Sampling Workplan**
Former Exxon Station
5175 Broadway Street
Oakland, California
ACEH Fuel Leak Case No. RO0000139

Dear Mr. Nowell:

On behalf of Rockridge Heights, LLC, Pangea Environmental Services, Inc. has prepared this *Revised Soil Gas Sampling Workplan* for the subject site. This report revises soil gas sampling proposed in Pangea's *Groundwater Monitoring and Remediation Report — Fourth Quarter 2012* dated March 6, 2012. This revised workplan and an associated underground utility survey were requested during a conference call with your agency on July 6, 2012 and confirmed via email on July 10, 2012.

The primary purpose of the proposed soil gas sampling is to determine if additional remediation is required to abate subsurface hydrocarbons. Concurrent with this soil gas sampling, Pangea is performing its second quarterly post-remediation groundwater monitoring event. Pangea understands if hydrocarbon concentrations in soil gas from this proposed sampling (and from up to four post-remediation groundwater monitoring events) are below levels of agency concern, that your agency will likely review the case for closure.

You indicated your agency would review this workplan within 2 to 3 weeks of receipt, and possibly sooner. Following agency approval Pangea will expedite soil gas sampling and report preparation. If you have any questions or would like to meet at the site, please call me at (510) 435-8664.

Sincerely,
Pangea Environmental Services, Inc.

Bob Clark-Riddell, P.E.
Principal Engineer

Attachment: *Revised Soil Gas Sampling Workplan*

cc: Rockridge Heights, LLC, C/O Ernie Nadel, 6100 Pinewood Road, Oakland, California 94611
Vera Stanovich, 1956 Stratton Circle, Walnut Creek, California 94598
SWRCB Geotracker (Electronic copy)

REVISED SOIL GAS SAMPLING WORKPLAN

Former Exxon Station
5175 Broadway
Oakland, California

July 16, 2012

Prepared for:

Rockridge Heights, LLC
C/O Ernie Nadel
6100 Pinewood Road
Oakland, California 94611

Prepared by:

Pangea Environmental Services, Inc.
1710 Franklin Street, Suite 200
Oakland, California 94612

Written by:

Morgan Gillies
Project Manager

Bob Clark-Riddell, P.E.
Principal Engineer

INTRODUCTION

On behalf of Rockridge Heights, LLC, Pangea Environmental Services, Inc. has prepared this *Revised Soil Gas Sampling Workplan* for the subject site. This report revises soil gas sampling proposed in Pangea's *Groundwater Monitoring and Remediation Report — Fourth Quarter 2012* dated March 6, 2012. This revised workplan and an associated underground utility survey were requested during a conference call with your agency on July 6, 2012 and confirmed via email on July 10, 2012. The primary purpose of the proposed soil gas sampling is to determine if additional remediation is required to abate subsurface hydrocarbons. The site background, underground utility survey, and proposed soil gas sampling are described below.

SITE BACKGROUND

Site Location and Description

The subject property is located at 5175 Broadway Street, at the southwest corner of the intersection of Broadway and Coronado Avenue in Oakland, California in Alameda County (Figure 1). The site is approximately 0.6 miles south-southeast of Highway 24 and approximately 2.3 miles east of Interstate 80 and the San Francisco Bay. The property is relatively flat lying, with a slight slope to the south-southwest, and lies at an elevation of approximately 160 feet above mean sea level. Topographic relief in the area surrounding the site also slopes generally towards the south-southwest. The western site boundary is the top of an approximately 10 foot high retaining wall that separates the site from an adjacent apartment complex.

The property has been vacant since 1979 and was formerly occupied by an Exxon Service Station used for fuel sales and automobile repair. The site is approximately 13,200 square feet in area with about 10% of the area occupied by a vacant station/garage structure. The majority of the ground surface is paved with concrete and/or asphalt. Land use to the west and northwest is residential, including apartment buildings and single family homes. Properties to the northeast, east and south of the site are commercial. The site and adjacent properties are shown on Figure 2.

Initial Site Environmental Investigation

Environmental compliance work commenced in January 1990 when three 8,000-gallon steel single-walled USTs, associated piping, and a 500-gallon steel single-walled waste oil tank were removed from the subject site. Tank Protect Engineering, Inc. (TPE) conducted the tank removal and observed holes in all four tanks. Groundwater was reportedly observed to stabilize in the UST excavation between 10.5 and 11 feet bgs. Approximately 700 tons of contaminated soil was excavated during tank removal and was subsequently remediated and reused for onsite backfill by TPE. In April 1990, TPE installed and sampled monitoring wells MW-1, MW-2 and MW-3. In June 1991, Soil Tech Engineering (STE), subsequently renamed Environmental

Soil Tech Consultants (ESTC), installed monitoring wells STMW-4 and STMW-5. Groundwater monitoring was conducted on the site intermittently until October 2002. Golden Gate Tank Removal (GGTR) performed additional assessment in January and February 2006, including collection of soil and/or groundwater samples from ten onsite soil borings. In June 2006, the property was purchased by Rockridge Heights, LLC. Pangea commenced quarterly groundwater monitoring at the site in July 2006. Additional assessment was performed by Pangea in January, March and April 2007, including the destruction of four monitoring wells and installation of twelve new wells to help define the vertical and lateral extent of groundwater contamination, as reported in Pangea's *Site Investigation Report* dated July 17, 2007.

Prior Soil Gas Investigation

In September 2007, Pangea conducted soil gas sampling from five temporary probe locations to evaluate shallow subsurface gas conditions near and/or beneath the adjacent offsite buildings at 5151 Broadway and 5230 Coronado Avenue. The sampling locations included three shallow soil gas locations (SG-1 through SG-3) and two subslab gas locations (SS-1 and SS-2). Temporary soil gas probe (SGP) SG-2 was installed adjacent to the eastern side of the apartment building at 5230 Coronado Avenue, west of the site near impacted onsite well MW-8A. Probes SG-1 and SG-3 were installed immediately north and south, respectively, of the commercial building located south of the site at 5151 Broadway. Subslab gas probes SS-1 and SS-2 were located inside the commercial building at 5151 Broadway on the northern side of the building near impacted onsite wells MW-7B and MW-7C. Soil gas sampling procedures and results are detailed in the *Soil Gas Sampling and Well Installation Report* dated October 23, 2007.

In June 2008, Pangea conducted soil gas sampling from four shallow soil gas probes (SG-4 through SG-7) to further evaluate shallow subsurface gas conditions near the offsite residential building at 5230 Coronado Avenue. During this investigation Pangea also resampled subslab gas probes SS-1 and SS-2 within the building at 5151 Broadway. This sampling was documented in *Additional Soil Gas Sampling Report* dated July 14, 2008.

Historic soil gas and subslab gas sampling locations are shown on Figure 2. Historic sample depth intervals and soil gas analytical results are summarized on Table 1. As shown on Table 1, select soil gas results from 5230 Coronado from 2007 and 2008 (before remediation) exceeded Environmental Screening Levels (ESLs) established by the San Francisco Regional Water Quality Control Board (RWQCB). Benzene and ethylbenzene concentrations exceeded applicable residential ESLs in only one soil gas sample (SG-4) from approximately 4 ft bgs (and near groundwater). TPHg concentrations also exceeded applicable residential ESLs in three probes (SG-2, SG-4, and SG-6), but TPHg concentrations in SG-2 and SG-6 (14,000 and 13,000 $ug/m^{3,}$ respectively) only slightly exceeded the conservative ESL of 10,000 ug/m^3. Therefore, probe location SG-4 was the primary soil gas location of concern.

Completed Site Remediation

In April 2007, Pangea conducted a dual phase extraction/air sparging test (DPE/AS) to evaluate potentially applicable remedial alternatives for remediating residual site contaminants. In a June 2009 letter, ACEH approved insitu site remediation using DPE/AS. Operation of the DPE system began on December 8, 2010 and operation of the AS system began on March 16, 2011. As documented in quarterly groundwater monitoring and remediation reports, the DPE/AS system has very effectively reduced hydrocarbon concentrations in site groundwater. Based on low influent soil vapor concentrations and improved groundwater conditions, Pangea discontinued site remediation in late January 2012 having completed approximately 13 months of DPE (10 months with concurrent AS). Remediation progress is described in periodic monitoring reports.

Post-Remediation Groundwater Monitoring

The first quarterly post-remediation groundwater monitoring event was performed in March 2012. The second quarterly post-remediation groundwater monitoring event was just performed on July 12 and 13, 2012, and will be reported shortly. (This sampling was originally planned in June 2012 but was postponed to await agency direction on proposed site work). Post-remediation monitoring will help determine if significant contaminant mass remains in the site subsurface and if hydrocarbons rebound significantly in site groundwater. The monitoring will also help decide if the system should remain off for a full year (4 quarters) of post-remediation groundwater monitoring, which your agency prefers to better justify regulatory case closure. To provide comprehensive site data for evaluation of remedial effectiveness and site conditions, Pangea sampled all twenty-three site wells for TPHd by EPA Method 8015 and for TPHg/BTEX/MTBE by EPA Method 8015/8021.

As discussed during our July 6, 2012, Pangea recommends evaluation of the second post-remediation groundwater monitoring results and additional soil gas sampling results before considering resumption of site remediation. If additional remediation is deemed appropriate after this evaluation, we recommend restarting the DPE/AS system. If deemed beneficial, we may also provide more a very specific pilot test program for enhanced remediation using the bio-organic catalyst (“NONTOX”), which your agency requested prior to further consideration of NONTOX use (initially proposed in January 2012).

UNDERGROUND UTILITY SURVEY AND RESIDENTIAL BUILDING CONSTRUCTION

During the July 6, 2012 discussion, the ACEH requested evaluation of potential conduits for migration of hydrocarbon vapors (e.g., underground utilities) toward the adjacent residential building at 5230 Coronado Avenue. ACEH also requested relevant information about the construction and layout of the residential building. Based on our additional assessment of underground utility locations and building construction, Pangea revises our proposed soil gas sampling as described below.

Building Construction and Layout at 5230 Coronado

On July 12, 2012, Pangea again met with the adjacent property owner and gained access to the ground floor at 5230 Coronado Avenue. The residential building at 5230 Coronado Avenue consists of three residential units on the upper two floors. The bottom ground floor consists of a small laundry room (about 100 square feet), two small adjacent small areas (laundry room entrance area and a stairway to the upper floor), and a large vented crawl space (approximately 2,200 square feet) occupying almost the entirety of the ground floor. The crawl space has a concrete floor, is well ventilated by six vents, and is used for storage. The storage crawl space is approximately 6 ft high at the southern entrance, and slopes upward toward the laundry room until approximately 3 ft clearance from the ceiling. A retaining wall (approximately 8 ft tall in the rear of the property) shortens toward the north and ends near the northern edge of the building. The ground floor layout is shown on Figure 2. Photographs of the building are included in Appendix A.

Additional Underground Utility Survey Information

To first evaluate the potential for contaminant migration via preferential pathways, Golden Gate Tank Removal of San Francisco, California surveyed subsurface utilities in the vicinity of the site and compared utility depths to groundwater depth in site monitoring wells several years ago. The survey was reported in their *Workplan for Additional Site Characterization* dated September 12, 2005. The report concluded that no utilities likely serve as preferential pathways for migration of hydrocarbon-impacted *groundwater*.

As requested by ACEH on July 6, 2012, Pangea performed additional surveying of underground utilities to evaluate potential migration pathways of hydrocarbon vapors toward the adjacent residential building at 5230 Coronado Avenue. On July 12, 2012, Pangea met with the property owner of 5230 Coronado Avenue and GeoTech Utility Locating LLC of El Cerrito, California to survey the location of underground utilities on and near 5230 Coronado. The identified utilities are shown on Figure 2.

No conduits were identified running directly between both properties, which are separated by a retaining wall for most of the common property boundary. No conduits were also identified that intersect groundwater.

The sanitary sewer locations were clearly visible within the vented crawl space at 5230 Coronado, and exit the crawl space in the center of the building under the laundry room and then toward Coronado. The sanitary sewer is about 2 to 3 feet below grade surface as it exits the building, and is about 6.5 feet bgs beneath Coronado Avenue. GeoTech Utility Locating identified natural gas and water piping entering the northeastern corner of the residential building, adjacent the crawl space and open area outside the laundry room. These natural gas and water piping enter Coronado Avenue near where shallow conduits (sanitary sewer and water) exit the 5175 Broadway site, as shown on Figure 2. Other underground utilities/conduits at 5175 Broadway include shallow electrical service (exiting the northeastern corner of the site) and shallow remediation piping located across most of the site, but not near the laundry room. The remediation system trench layout is shown on Figure 3.

Based on the above information, Pangea concludes the following:

- The ground floor at 5230 Coronado is comprised of a ventilated crawl space (with concrete floor), open areas, and a small laundry room. The residential units are above this ground floor.
- No subsurface conduits run directly between the two properties of concern.
- Shallow conduits exit the northwestern portion of 5175 Broadway where shallow conduits head toward the laundry room at 5230 Coronado Avenue.
- Potential migration pathways for hydrocarbon vapors include (1) trench material within shallow conduits entering the northeastern edge of 5230 Coronado and terminating underground near or beneath the laundry room, and (2) volatilization from soil and/or groundwater into the laundry room and/or ventilated crawl space.

PROPOSED SOIL (SUBSLAB) GAS SAMPLING

To evaluate the potential vapor migration pathways identified above and to re-evaluate conditions at 5151 Broadway, Pangea proposes the following subslab gas sampling locations (shown on Figure 2):

- Existing subslab probes SS-1 and SS-2 at 5151 Broadway,
- Proposed subslab probe SS-3 in the ground floor laundry room at 5230 Coronado, and
- Proposed subslab probes SS-4 and SS-5 in the ground floor crawl space/storage room at 5230 Coronado.

If subslab gas concentrations exceed ESLs, Pangea will collect ‘indoor air’ samples from within the laundry room, crawl space, and outdoor ambient air in accordance with DTSC guidelines (DTSC, 2011).

To prepare for the subslab gas sampling, Pangea will coordinate access with the owners of the adjacent offsite private properties. Fieldwork will be performed by Pangea staff under the supervision of Bob Clark-Riddell, a California Registered Professional Civil Engineer.

The subslab soil gas sampling will be conducted in general accordance with procedures described in Pangea's Standard Operating Procedures (SOPs) for Subslab Soil Gas Sampling (Appendix B). The subslab gas sampling procedure involves using a rotohammer to drill a 1 ½-inch diameter, 4-inch deep hole in the approximately 6-inch thick concrete slab of the building, drilling a ½-inch diameter hole through the remaining concrete, installing a rubber stopper with stainless steel tubing (capped on one end with a Swagelok fitting) and placing a bentonite seal from the top of the stopper to within an inch of the surface. A second rubber stopper will be placed over the subslab probe to protect it and the probes will be allowed to equilibrate for two weeks, prior to sampling. Prior to sampling a subslab probe, at least two hours is typically allowed to pass to allow the materials to cure and the subsurface to equilibrate (DTSC, 2011). Subslab probes will remain in place to facilitate additional subslab gas sampling, if required.

An analytical laboratory will provide sampling assemblies and certified Summa canisters for sampling and purging. The Summa canisters will come under a complete vacuum of approximately 30 inches of mercury. Prior to sample collection a vacuum/leak test will be conducted on the sampling assembly with the purging summa canister to confirm no leak and the maintenance of the initial vacuum (approximately 30 inches of mercury) in the sampling manifold system. After a minimum of 10 minutes of vacuum/leak testing, the sampling summa canister will be opened for sample collection. The pre-set valve will regulate the vapor flow to approximately 100 to 150 milliliters of air per minute, which equates to approximately 7 to 10 minutes to fill the 1-liter canister. Sample collection is typically discontinued when the vacuum decreases to below 5 inches of mercury but not below 1 inch of mercury. To further evaluate potential leakage within the sampling system, a leak-check enclosure will be placed over the sampling assembly, and an absorbent material will be lightly moistened with isopropyl alcohol and placed within the leak-check enclosure. A photo-ionization detector (PID) will be used to monitor the concentration of isopropyl alcohol within the enclosure during sample collection. This method allows Pangea to calculate the volume of air from within the enclosure (if any) that enters the sample summa canister by dividing the concentration of isopropyl alcohol in the sample canister by the concentration detected in the leak check Summa canister, and multiplying the resultant ratio by the volume of the sample canister.

ATTACHMENTS

Figure 1 – Site Location Map
Figure 2 – Proposed Soil Gas Sampling Locations and Utility Map
Figure 3 – Remediation System Trench Layout

Table 1 – Soil Gas Analytical Results

Appendix A – Photographs
Appendix B – Standard Operating Procedures

REFERENCES

California Environmental Protection Agency, Department of Toxic Substance Control (DTSC, 2011), *FINAL Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air,* October 2011

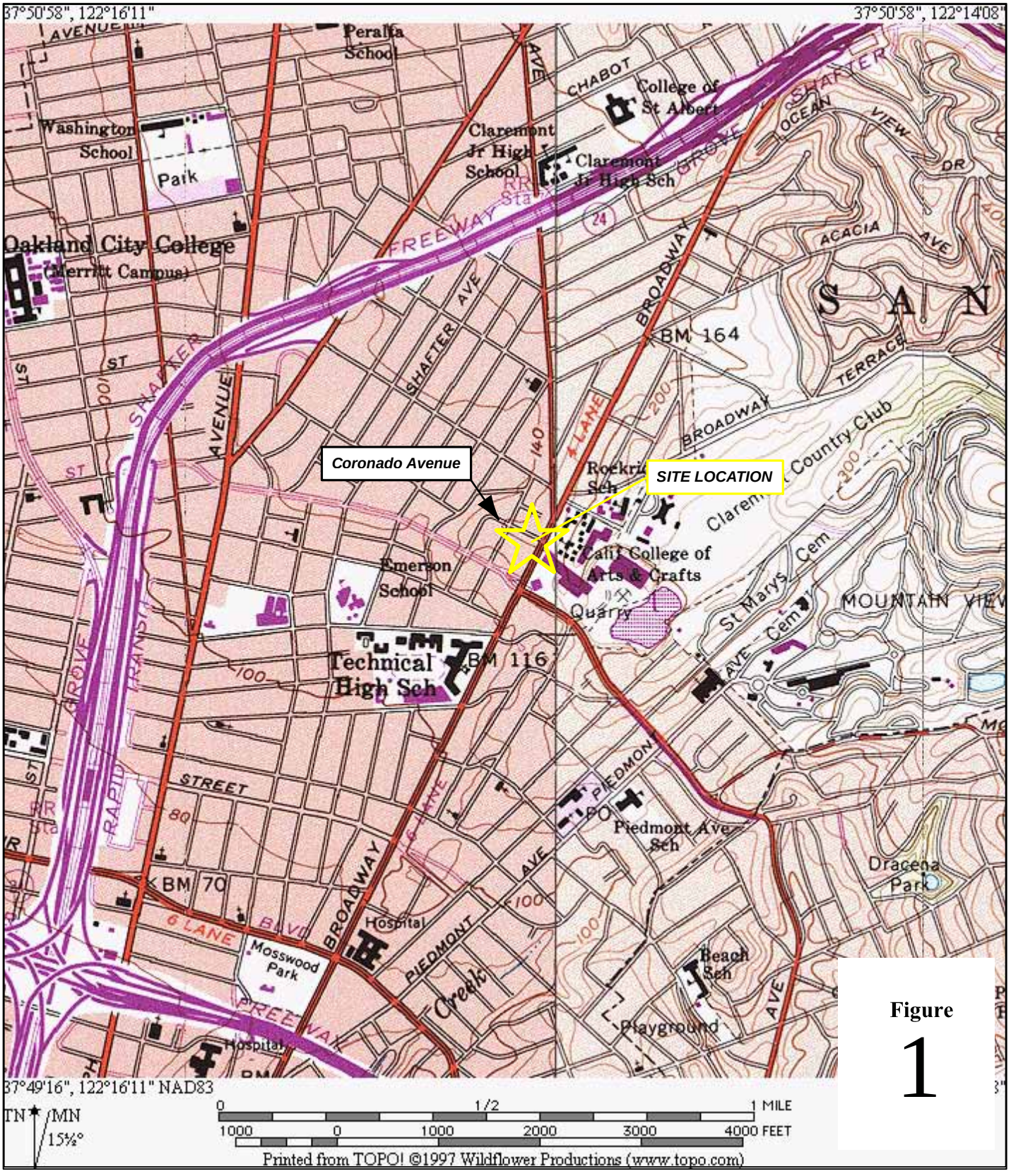

Figure 1

Former Exxon Station
5175 Broadway
Oakland, California

PANGEA

Site Location Map

FeinerBroadway site loc.ai 8/30/06

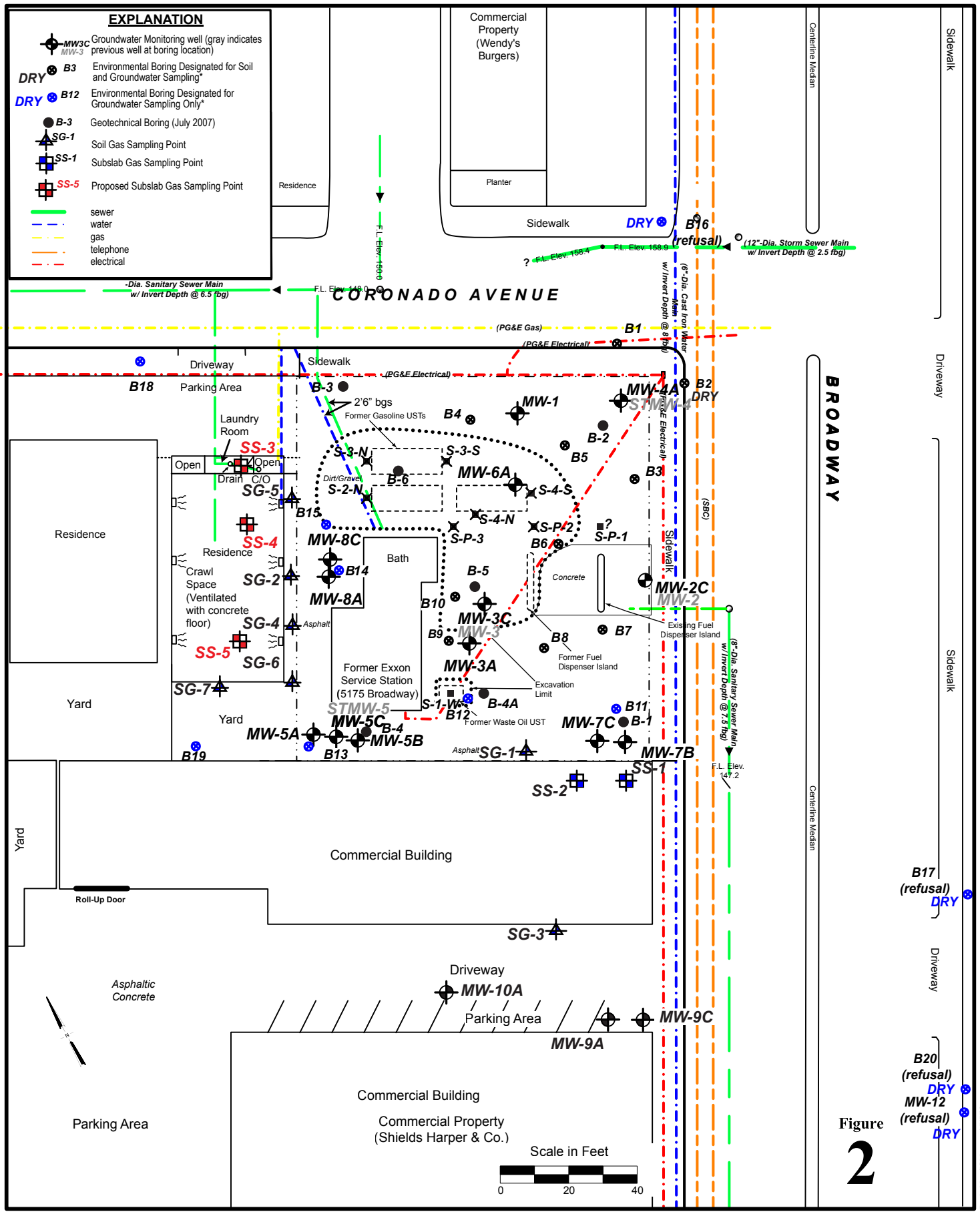

Figure 2

Former Exxon Station
5175 Broadway
Oakland, California

Proposed Soil Gas Sampling and Utility Map

PANGEA

Rockridge SCM map.ai 7/7/08

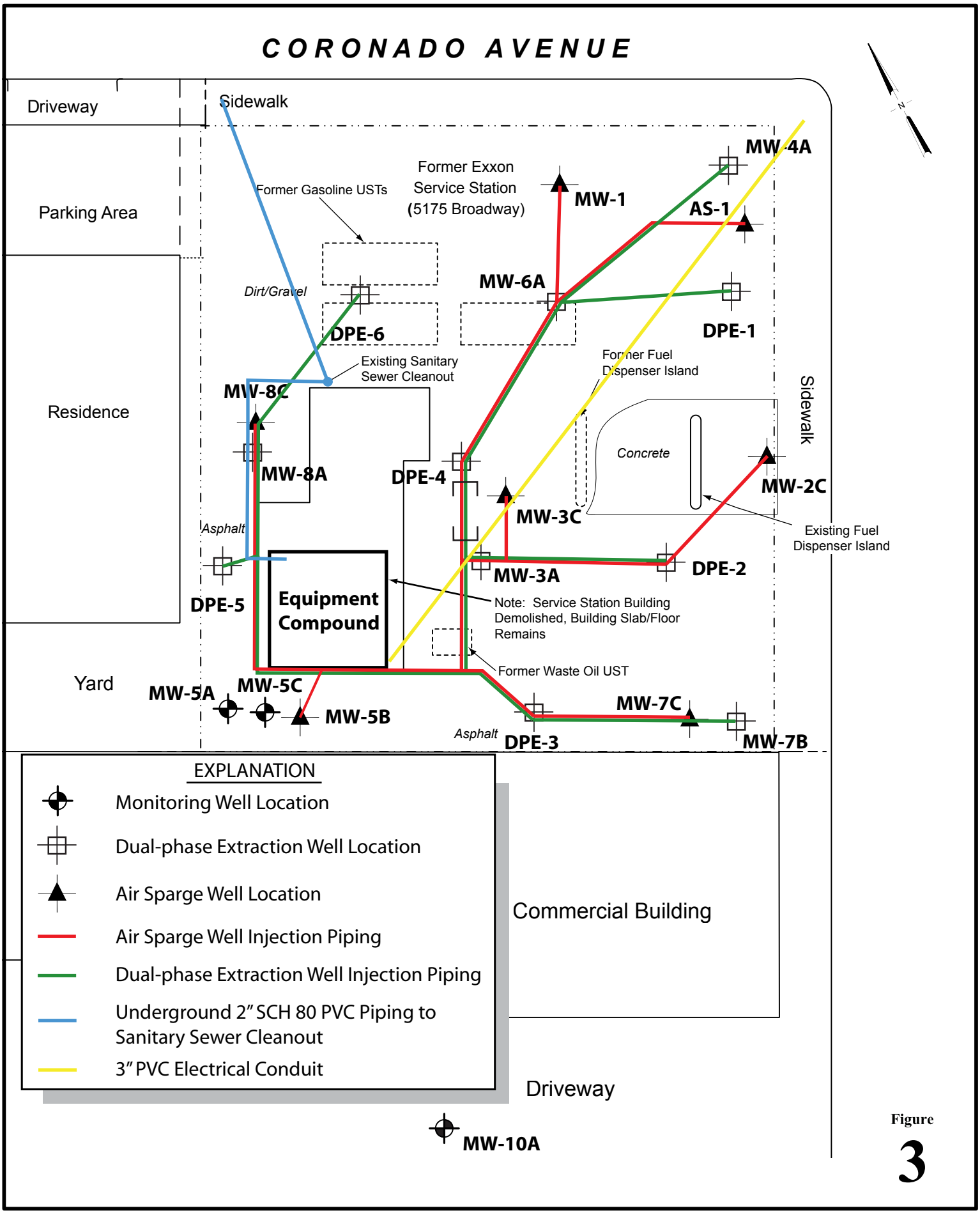

Figure
3

Former Exxon Station
5175 Broadway
Oakland, California

PANGEA

Remediation System
Trenching Layout

Pangea

Table 1. Soil Gas Analytical Data - Rockridge Heights, 5175 Broadway, Oakland, California

Boring/ Sample ID	Date Sampled	Sample Depth (ft - ft bgs)	Benzene	Toluene	Ethylbenzene	Xylene (M+P)	Xylene (O)	TPH Gasoline (C2-C10)	Isopropanol	Notes
			ug/m^3							
Residential ESL for shallow **soil gas**:			**84**	**63,000**	**980**	**21,000**	**21,000**	**10,000**	--	
Commercial ESL for shallow **soil gas**:			280	180,000	3,300	58,000	58,000	29,000	--	
Soil Gas Probe Samples										
SG-1	9/12/2007	3.8-4.0	16.0	294	6.21	19.6	5.91	<2000	85.4	
SG-2	9/12/2007	3.8-4.0	**174**	200	93.6	77.2	<21.7	**14,000**	70.1	
SG-3	9/12/2007	2.5-2.7	<128	151	<174	<174	<174	<2000	21,300	Isoproponal = 0.7% of total sample volume*
SG-4	6/17/2008	4.0-4.5	**5,930**	<754	**17,200**	15,600	<868	**830,000**	<983	
SG-5	6/17/2008	4.5-5.0	12.9	7.08	61.4	57.2	<4.34	<10,000	<492	
SG-6	6/17/2008	3.5-4.0	<63.9	<75.4	97.9	<86.8	<86.8	**13,000**	<490	
SG-7	6/17/2008	3.5-4.0	25.6	10.8	<4.34	4.78	<4.34	<10,000	<492	
Subslab Gas Samples										
SS-1	9/12/2007	0.5-0.7	24.1	187	5.38	16.8	5.91	<2000	11.2	
SS-2	9/12/2007	0.5-0.7	<3.19	5.24	<4.34	<4.34	<4.34	<2000	<4.92	Leak Check Sample not analyzed - no detected Isopropanol.
SS-1	6/17/2008	0.5-0.7	<3.19	<3.77	<4.34	<4.34	<4.34	<700	<492	
SS-2	6/17/2008	0.5-0.7	<3.19	<3.77	<4.34	<4.34	<4.34	<700	<492	
Leak Check Samples										
SS-1 Check	9/12/2007	--	--	--	--	--	--	--	622,000	
SG-1 Check	9/12/2007	--	--	--	--	--	--	--	5,900,000	
SG-2 Check	9/12/2007	--	--	--	--	--	--	--	1,070,000	
SG-3 Check	9/12/2007	--	--	--	--	--	--	--	3,020,000	

Abbreviations:

SG-1 = Soil Gas Sample

SS-1 = Subslab Sample

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

ft - ft bgs = Depth interval below ground surface (bgs) in feet.

Volatile organic compounds by EPA Method TO-15 (partial list), uses GC/MS scan.

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

MRL = Method reporting limit. Laboratory reporting limit based on parts per billion on volume to volume basis (ppbv/v) and converted to ug/m3.

ESL = Environmental Screening Level for Shallow Soil Gas with Residential and Commercial/Industrial Land Use, for samples less than five feet below a building foundation or ground surface (Table E).

ESL established by the SFBRWQCB, Interim Final - February 2005, and amended in November 2006.

DPE = Dual phase extraction.

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

* = Since the air flow regulators on the sampling and leak check summa canisters were setup identically, the percentage of sample that leaked from ambient air within the leak-check enclosure into the sample probe can be determined by dividing the concentration of isopropanol in the sample canister by the concentration of isopropanol in the leak-check canister.

APPENDIX A

Photographs

Front of Residential Apartment Building
5320 Coronado (facing South)

Eastside of Apartment Adjacent to Site
5320 Coronado (Note retaining wall and vents)

Laundry Room, Ground Floor
5320 Coronado (Concrete Slab on Grade)

Crawl Space at 5320 Coronado
(Vented and Concrete Lined)

Back of Apartment Building at 5320 Coronado
(Note vent and unimproved ground surface)

West Side of Apartment Building at 5320
Coronado (Note vents and unimproved ground)

APPENDIX B

Standard Operating Procedures

STANDARD OPERATING PROCEDURE FOR SUBSLAB VAPOR SAMPLING

1.0 PURPOSE

This standard operating procedure (SOP) describes the procedures for collecting subslab vapor samples using evacuated, stainless-steel Summa canisters for the purpose of assessing risk to building occupants. The SOP is modified from procedures and information presented in Cal/EPA 2004; DiGiulio and others, 2006; DiGiulio, 2003; and discussions (September 2006) with K Prime (Santa Rosa, California) laboratory staff.

2.0 REQUIRED EQUIPMENT

- Hammer drill with 1" bit and smaller bits (slightly larger than vapor probe tip)
- Tubing for cleaning boring
- Stainless-steel or Teflon vapor probe tubing with Swagelok threaded compression fitting and vapor-tight cap.
- Rubber stopper or Teflon disk
- Powdered bentonite or expanding Portland cement
- 6-Liter Summa canister (evacuated with approximately 30" Hg vacuum) with vacuum gauge for purging and leak testing
- 6-Liter Summa canister with vacuum gauge for each sample (including duplicates)
- 1-Liter Summa canister for leak-check compound
- K Prime Inc. stainless-steel sampling manifold (see Figure 2) (request that laboratory leak-check manifold prior to mobilization)
- Leak-check compound (e.g. isopropyl alcohol) and absorbent material (e.g. gauze)
- Photoionization detector (PID)
- Isobutylene for PID calibration
- Tedlar bags for sampling leak-check compound
- Leak-check enclosure (plastic container with flexible weatherstripping and openings for vapor probe tubing and for sampling enclosure atmosphere)
- Record-keeping materials
- Latex or nitrile gloves

3.0 PROCEDURES

3.1 Boring Clearance

Prior to installing subslab vapor probes, ensure that a utility clearance has been conducted to ensure that subsurface utility and rebar locations have been identified and marked.

3.2 Vapor Probe Construction

1. To protect interior surfaces, lay plastic sheeting around the probe location.
2. Use a rotary hammer drill to create an approximately 2-inch deep, 1 1/2 -inch diameter hole that *partially* penetrates the slab. Use a piece of flexible tubing to blow or vacuum concrete debris and dust from the hole. Do not blow or vacuum after the slab has been completely penetrated.
3. Drill a smaller diameter *inner hole* in the center of the outer hole, periodically blowing dust and debris from the hole until the slab is penetrated. The diameter of the inner hole

should exceed the diameter of the vapor probe tip by approximately 1/16". The inner hole should be drilled completely through the slab and several inches into the subslab material (baserock or soil) to form a cavity (see Figure 1).

4. Place a tightly fitting rubber stopper or a Teflon disk with a pass-through for the vapor probe at the bottom of the outer hole. The purpose of the stopper is to stop moisture from the annular seal from leaking into subslab materials. If a lubricant is needed, use only high-vacuum silicone grease.
5. Insert the capped vapor probe tubing through the stopper. The fitting may either be constructed flush, or may protrude above the slab, depending on location and susceptibility to damage. The vapor probe tubing should be cut prior to insertion so that the tip does not protrude below the concrete slab.
6. Mix quick-drying Portland expanding cement with water and backfill the annulus of the vapor probe boring to the surface with the cement mixture. A hydrated bentonite mixture (mix bentonite and water outside the hole) may be used in lieu of cement if the probe is temporary and will not be disturbed prior to sampling

3.3 Vapor Sampling

During vapor sampling, record all valve open/close times and canister/manifold vacuum readings at each step.

Setup

1. Ensure that at least two weeks have elapsed since installation of the subslab vapor probe(s) and that at least 5 days have elapsed since measurable precipitation or irrigation of areas adjacent to the building.
2. Calculate and record the volume of the sampling assembly, tubing and vapor probe.

   Volume =3.14 x (1/2*ID) x (1/2*ID) *L,

   where ID = tubing or manifold inside diameter and L = length of tubing/manifold segment.
3. Wear latex or nitrile gloves while handling sampling equipment. Change gloves whenever a new sample is collected and after handling leak-check compound.
4. Replace the vapor probe cap with a closed Swagelok valve. Connect the sampling manifold to the vapor probe, sample Summa canister and purge Summa canister using Swagelok fittings and stainless-steel, Teflon or Tygon tubing. Check all fittings for tightness (do not overtighten).
5. Close all valves. Record pre-test vacuum readings on both canisters.

Flow and Leak Check

1. Open both manifold valves and valve on purge Summa canister. Do *not* open valve on sample port. Allow manifold/tubing vacuum to stabilize at approximately 30" Hg.
2. Close purge canister valve and wait at least 10 minutes. Monitor manifold vacuum gauge to test for leaks. If the vacuum decreases, rectify the leak before proceeding.
3. If vacuum is stable, open purge canister valve and open vapor probe valve. After approximately *5 seconds*, close the canister valve and estimate flow rate by recording the elapsed time after valve closure for manifold vacuum to drop to 5" vacuum, as indicated on the following chart (specific to K-Prime sampling manifold)

K PRIME, INC. SOIL GAS MANIFOLD FLOW RATE AND VACUUM LEVEL ESTIMATES

T (seconds)	PV	F (ml/minute)
5	0	135
10	5	115
15	10	90
30	15	60
120	20	40
480	25	20

Source: K Prime, Inc. – July 24, 2006

NOTES:
T = Time duration from full vacuum to less than 5" vacuum after closing purge canister.
PV = Approximate vapor probe vacuum level based on measured T
F = Approximate sampling Flow rate based on measured T

4. This procedure should also be conducted several times at the beginning of sampling to ensure that flow rate is sufficient. If no significant flow is attained, either the sampling line is plugged or the vapor probe is positioned in an impermeable or saturated layer. Such a situation should be rectified before sample collection.
5. Place absorbent materials (e.g., gauze) *lightly* moistened (e.g., five drops) with leak-check compound (isopropyl alcohol) inside the leak-check enclosure. Do not allow liquid to come in direct contact with tubing or sampling assembly.
6. Place leak-check enclosure over vapor probe and seal to floor using weatherstripping or duct tape. Ensure that PID has been calibrated with isobutylene gas. Note that the isopropyl alcohol response factor is approximately 5.6 (i.e. a reading of 2 ppm on the PID indicates 5.6 x 2 = 11.2 ppm of isopropyl alcohol in the sample). Record both the observed PID reading and the calculated isopropyl alcohol concentration. If the PID reading is below 10 ppm, slowly reapply leak-check compound.
7. Record PID reading for leak-check enclosure at least once every 5 minutes during purging and sampling. Slowly reapply leak-check compound if PID reading drops more than 20% below initial readings in an attempt to return to the initial readings.

Purge and Sample

1. Open purge canister valve and vapor probe valve and purge approximately 3 to 5 purge volumes of the tubing and sampling assembly (DeGiulio and others, 2006). Do *not* over-purge. Include the purging conducted during the leak-check step above in the purge volume.
2. Close purge canister valve and open sample canister valve. Sampling should take approximately 30 minutes for a 6-liter Summa canister.
3. Sampling volume for a 6-liter canister can be estimated based on the following table.

Relationship between Final Canister Vacuum and Volume Sampled

Final Vacuum ("Hg)	0	2.5	5	7.5	10	12.5	15	17.5	20
Volume Sampled (L)	6	5.5	5	4.5	4	3.5	3	2.5	2

Source: Air Toxics, Inc.

4. Close sampling canister valve when vacuum decreases to between 3" and 5" mercury. Do *not* allow vacuum to fall below this range.
5. Use a 1-liter Summa canister to collect a sample from the leak-check enclosure. Submit canister for analysis of leak-check compound only if leak-check compound is detected in the sample canister.
6. Disassemble sampling assembly, and cap (or remove and restore) vapor sampling point.
7. Fill out chain-of-custody form, including analysis for chemicals of concern and leak-check compound. Also analyze for oxygen, carbon dioxide and methane. Include final vacuum reading and serial numbers of canister and flow restrictor.
8. Collect at least one duplicate sample per site per sampling event from the sampling point with the anticipated highest vapor concentrations. The duplicate sample should be attached to the manifold prior to equipment vacuum testing so its connections can be tested. Collect a sample without further purging, using the same sampling procedures used for the original sample.

9. Decontamination

10. Use separate sampling assembly and tubing for each sample location. Return equipment to laboratory for decontamination.

REFERENCES

Cal/EPA, 2004, Interim final guidance for the evaluation and mitigation of subsurface vapor intrusion to indoor air, California Environmental Protection Agency, Department of Toxic Substances Control,December 15 (revised February 7, 2005).

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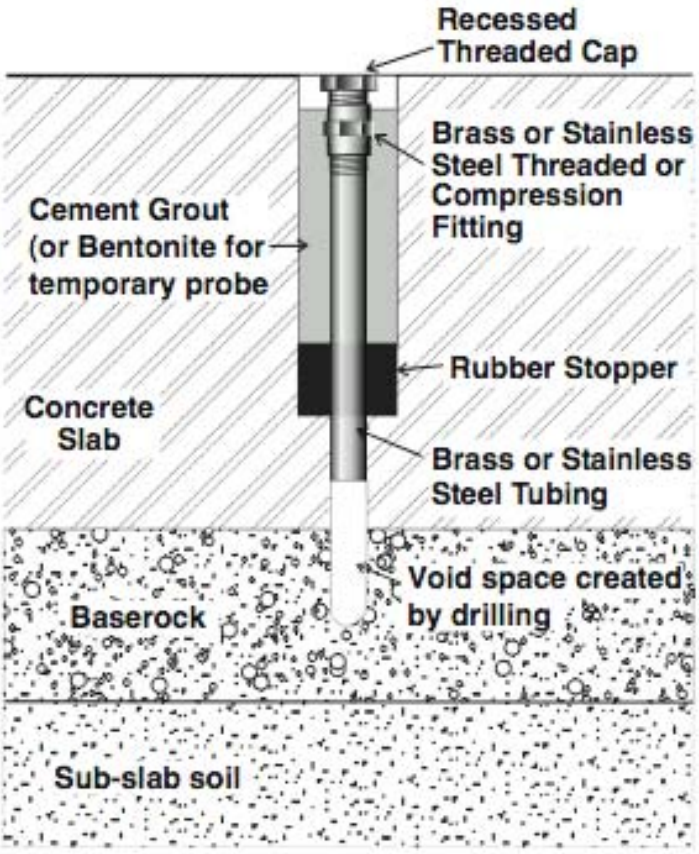

Figure
1

Subslab Vapor Probe Schematic

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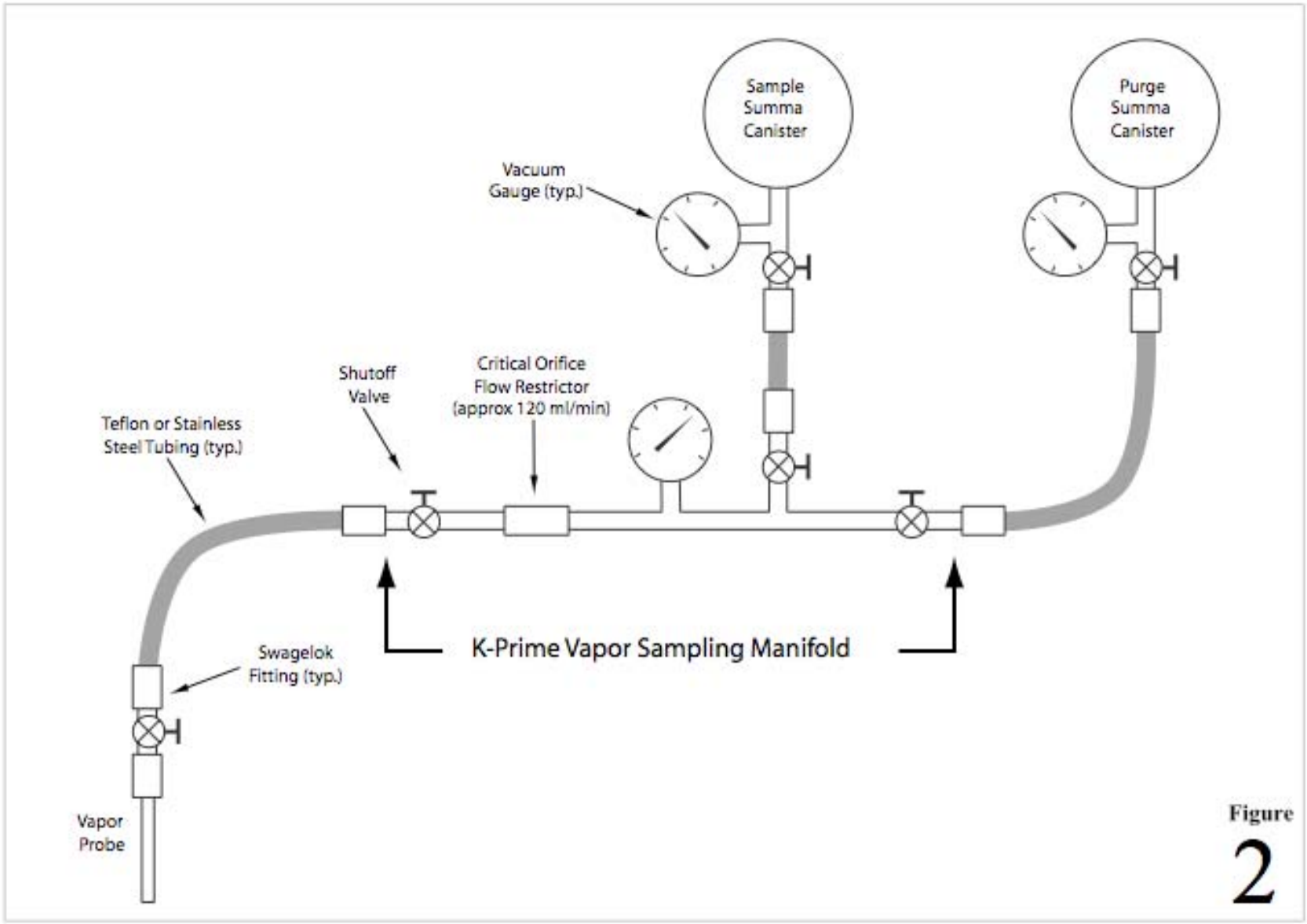

Figure
2

Subslab and Soil Vapor Sampling Manifold Schematic

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