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Alameda County
Environmental Health

ConocoPhillips
76 Broadway
Sacramento, California 95818

December 15, 2008

Jerry Wickham
Alameda County Health Agency
1131 Harbor Bay parkway, Suite250
Alameda, California 94502-577

Re: ***Work Plan—Additional Site Investigation***
76 Service Station # 1156
4276 MacAuthur Blvd
Oakland, CA

Dear Mr. Wickham:

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

If you have any questions or need additional information, please call me at (916) 558-7666.

Sincerely,

Terry L. Grayson
Site Manager
Risk Management & Remediation

SUSTAINABLE STRATEGIES FOR GLOBAL LEADERS

DELTA

December 15, 2008

Mr. Jerry Wickham
Alameda County Health Care Services Agency
1131 Harbor Bay Parkway, Suite 250
Alameda, California 94502

RE: Work Plan – Additional Site Investigation and Soil Vapor Survey
76 Service Station No. 1156
4276 MacArthur Boulevard
Oakland, California
Fuel Leak Case No. RO0000409

Dear Mr. Wickham:

On behalf of Conoco Phillips Company (COP), Delta Consultants (Delta), has prepared this work plan proposing the advancement of three soil borings and the installation of one additional monitoring well to further assess the horizontal and vertical extent of the petroleum hydrocarbon concentrations in soil and groundwater down-gradient of the former underground storage tank (UST) basin and in the vicinity of monitoring well MW-1 at the above referenced site. In addition, soil vapor samples will be collected for field screening and evaluation of potential vapor intrusion into the on-site station building and the neighboring office buildings. The site location is shown on Figure 1. This work plan has been prepared as requested by the Alameda County Health Care Services Agency (ACHCSA) in their letter to COP dated September 24, 2008. A copy of the letter is presented as Attachment A.

SUMMARY OF PROPOSED ASSESSMENT ACTIVITIES

Based on data collected during the most recent site investigation (November 2007) the highest concentrations of total purgeable petroleum hydrocarbons (TPPH) and benzene in groundwater were found in the vicinity of the former UST basin and down-gradient of monitoring well MW-1. In addition, based on data from the most recent quarterly groundwater monitoring event (fourth quarter 2008), highest concentrations of TPPH and benzene were reported in the groundwater sample collected and submitted for analysis from monitoring well MW-1.

Delta is proposing the advancement of three soil borings to a depth of approximately 30 feet below the ground surface (bgs) and the installation of one additional monitoring well (MW-9). Soil and groundwater samples will be collected from each boring as necessary to determine the horizontal and vertical extent of the petroleum hydrocarbon impact to the soil and groundwater down-gradient of the former UST basin and in the vicinity of monitoring well MW-1. The proposed location of these borings and monitoring well are shown on Figure 2.

Delta is also proposing seven borings will be advanced to a depth of approximately 5 feet bgs in the vicinity of the station building for the purpose of collecting soil vapor samples for field screening and evaluation of potential vapor intrusion. The proposed boring locations are shown on Figure 2.

SITE DESCRIPTION

The site is located at the northeast corner of MacArthur Boulevard and High Street in Oakland, California. Two 12,000-gallon gasoline USTs are present in the southwestern portion of the site and two dispenser islands are present at the site (one to the northwest and one to the east of the USTs). A station building is present in the northern portion of the site. There are currently eight groundwater monitoring wells (MW-1 through MW-8) and one tank backfill well (TP-1) located at and in the vicinity of the site. Property use in the immediate vicinity of the site is a mix of commercial and residential.

PREVIOUS ASSESSMENT

In 1997, Pacific Environmental Group Inc. (PEG) advanced 5 soil-gas probes in the vicinity of the USTs, dispenser islands, and product lines to depths ranging from 3 to 15 feet bgs. Elevated soil vapor concentrations of total petroleum hydrocarbons as gasoline (TPHg), benzene, and methyl tertiary butyl ether (MTBE) were reported at concentrations up to 4,700 micrograms per liter (μg/L), 70 μg/L, and 140 μg/L, respectively.

In 1998, Tosco Marketing Company (now COP) removed one 280-gallon used-oil UST and removed and replaced two 10,000-gallon gasoline USTs, associated piping, and fuel dispensers. The new USTs were installed in a separate excavation. Total petroleum hydrocarbons as diesel (TPHd), TPHg, benzene, and total recoverable petroleum hydrocarbons (TRPH) were reported in the soil sample collected from the used-oil UST excavation at concentrations of 78,000 milligrams per kilogram (mg/kg), 130 mg/kg, 0.55 mg/kg, and 8,400 mg/kg, respectively. Following the over-excavation of approximately 4.6 tons of soil from the used-oil UST excavation, concentrations of TPHd, TPHg, benzene, and TRPH were reported in soil samples collected from the used-oil UST excavation at concentrations up to 560 mg/kg, 81 mg/kg, 0.64 mg/kg, and 360 mg/kg, respectively. TPHg and benzene were reported in the soil samples collected from the gasoline UST excavation, dispenser islands, and product lines at concentrations up to 1,200 mg/kg and 1.6 mg/kg, respectively. A groundwater sample collected from the gasoline UST excavation contained TPHg and MTBE at 41,000 μg/L and 1,800 μg/L, respectively. Benzene was below the laboratory's indicated reporting limit in the groundwater sample collected for analysis.

In 1999, Environmental Resolutions Inc. (ERI) conducted a soil and groundwater assessment which included the installation of four on-site groundwater monitoring wells (MW-1 through MW-4). Analytical data from soil samples collected from the borings at 10.5 feet bgs indicated TPHg, benzene, and MTBE were present at concentrations up to 6,800 mg/kg, 2.6 mg/kg, and 0.71 mg/kg, respectively. The soil sample from MW-1, near the former used-oil UST, was also analyzed for TPHd and TRPH and contained TPHd and TRPH at concentrations of 140 mg/kg and 73 mg/kg, respectively.

Analytical data from an additional soil sample collected at a depth of 20.5 feet bgs from the MW-4 boring indicated that TPHg, benzene, and MTBE were below the laboratory's indicated reporting limits. Quarterly groundwater monitoring and sampling activities commenced in July 1999 and are currently ongoing.

In July 2001, ERI installed a UST pit backfill well (TP-1) and initiated monthly purging of groundwater from the UST excavation. Bi-weekly groundwater purging was conducted at the site using wells TP-1 and MW-1 from July 2001 through December 2004.

In addition, during June 2004, the biweekly purging events included monitor well MW-7. Approximately 1,600 gallons of groundwater were removed from monitoring well MW-7. Through December 2004 a cumulative total of approximately 476,015 gallons removed from the site from wells TP-1, MW-1, and MW-7.

In August 2001, ERI installed three off-site monitoring wells (MW-5 though MW-7). Analytical data from soil samples collected from these well borings indicated TPHg and MTBE were not present above the laboratory's indicated reporting limits. Benzene was present in one soil sample collected at a depth of 10 feet bgs from MW-7 at a concentration of 0.18 mg/kg.

During the first quarter 2007 monitoring and sampling event, groundwater samples were collected from monitoring wells MW-2 and MW-4 for heterotrophic plate count (HPC). The HPC analytical data indicated that dissolved oxygen (DO) in the groundwater in the vicinity of monitoring well MW-2 is depleted, thus limiting the growth of natural bacterial populations. The HPC analytical data indicated that DO in the groundwater in the vicinity of monitoring well MW-4 is also depleted, but to a lesser extent than in the vicinity of monitoring well MW-2. Therefore, if oxygen were introduced into the groundwater, via ozone or oxygen injection, the increased oxygen would likely stimulate the growth of natural bacterial populations, thus increasing the degradation of the petroleum hydrocarbons in the groundwater.

In November 2007, Delta advanced six soil borings at the site and installed one off-site monitoring well (MW-8) down-gradient of the former waste-oil UST location.

SENSITIVE RECEPTORS

2001 – A GeoTracker database search was conducted which indicated that four public water supply wells owned by the East Bay Regional Park District (Park District) were present within a one-half mile radius of the site. Representatives from the Park District reported having no knowledge or records of any wells located in this area and indicated that the wells may have belonged to the East Bay Municipal Utility District (EBMUD); however, EBMUD also reported no knowledge or records of any wells located in this area.

2001 – A Department of Water Resources (DWR) database search was conducted which indicated four water supply wells belonging to Mills College were present within the one-half mile radius search area. A representative from Mills College indicated that all wells associated with Mills College had been destroyed and Mills College was now connected to a municipal water supply. The DWR search also indicated a well was located at 3397 Arkansas Street, approximately 880 feet outside of the search area. No other wells, surface water bodies, or potentially sensitive environmental habitats were identified during ERI's field receptor search.

2006 – A survey including a visit to the DWR office in Sacramento was conducted to examine well log records and identify domestic wells within the survey area. The DWR survey provided two potential receptors within one mile of the site; one irrigation well located 0.9 miles northwest of the site and one domestic/irrigation well located 1.0 mile northeast of the site. Two additional potential receptors were identified during the visit to the DWR, however, the specific addresses could not be located.

SITE GEOLOGY AND HYDROGEOLOGY

The subject site is located in the San Francisco Bay region in the north-central Coast Range and is underlain by what is mapped as Older Alluvial Fan Deposits. These deposits are assigned to the Early Pleistocene Santa Clara Formation, which is described as weakly consolidated, poorly sorted silt and gravel. These deposits grade south of the site into younger fluvial and alluvial basin fill deposits.

Based on data obtained during the advancement of borings SB-1 through SB-6 and the installation of monitoring well MW-8, soils encountered in these borings are composed of unconsolidated deposits of sand and silt in a clay matrix with some fine-grained gravels.

Historical monitoring data indicates static depth to water (DTW) on-site varies from approximately 1 to 6 feet bgs. The groundwater flow direction has predominately been west with variations to the southwest. The average historical gradient is 0.06 foot per foot (ft/ft) with a most recent gradient of 0.06 ft/ft. Historical groundwater flow directions are shown on a rose diagram presented as Figure 3.

Based on data obtained during previous investigations, it appears that groundwater beneath the site is under confined conditions. Fetter (1988), defines a confined aquifer as follows: "an aquifer that is overlain by a confining bed. The confining bed has a significantly lower hydraulic conductivity than the aquifer". The boring logs from the site investigation conducted by Delta in November 2007 indicate that the subsurface lithology beneath the site is predominately clay from the ground surface to depths ranging from 13 feet to 20 feet bgs in borings SB-1 through SB-6 and MW-8. The clay unit is underlain by a clayey sand unit. Generally, first groundwater was encountered at the interface between these two units.

In addition, based on boring logs, groundwater in the boring for MW-8 as well as the borings for MW-1 through MW-4 was first encountered at depths ranging from 23 feet to 24 feet bgs. During the second quarter 2008 quarterly monitoring event, static groundwater in these monitoring wells was reported between 0.55 feet below top of casing (btoc) in monitoring MW-8 and 5.69 feet btoc in monitoring well MW-3. This differential between first encountered groundwater and static groundwater indicates that the groundwater is under pressure from the overlying confining bed, another indication that the groundwater beneath the site is under confined conditions. First encountered groundwater was not noted on the boring logs from the MW-5 through MW-7 borings.

PROPOSED ACTIVITIES

Permitting, Utility Notification and Borehole Clearance

Before commencing field operations Delta will prepare a Health and Safety Plan specific to the site and work being performed in accordance with Title 8, Section 5192 of the California Code of Regulations. The will contain a list of emergency contacts, as well as a hospital route map to the nearest emergency facility, and was reviewed daily by field personnel.

In addition, drilling permits will be obtained for the borings from the Alameda County Public Works Agency (ACPWA). Prior to drilling, Underground Service Alert (USA) will be notified as required and a private utility locator will be contracted to clear the proposed drilling locations for underground utilities.

Soil Borings and Grab Groundwater Samples

Delta proposes to advance three (3) exploratory borings, SB-7 through SB-9 down-gradient of the former UST basin and in the vicinity of monitoring well MW-1 using a drill-rig equipped with 8-inch outside diameter hollow-stem augers. The soil borings will be advanced to the base of the course grained unit below the upper clay unit or a maximum depth of approximately 40 feet bgs. Down-hole drilling tools will be decontaminated between borings to avoid cross contamination. The decontamination process will consist of multiple wash and rinse cycles using potable water and a non-phosphate detergent.

Soil samples will be logged using the Unified Soil Classification System (USCS) for lithologic interpretation and field screened for the presence of volatile organic compounds by headspace analysis using a pre-calibrated photo-ionization detector (PID). Soil samples will be collected continuously for lithologic interpretation and field screening beginning at a depth of 5 feet bgs to the final depth of the boring. At a minimum, soil samples with the highest PID readings, indications of changes in lithology, just above first water, and the bottom of the borehole from each boring will be submitted for analysis. A chain-of-custody will accompany the samples during transportation to the laboratory. The selected soil samples will be submitted to a California-certified laboratory, for analyses of TPHd by Environmental Protection Agency (EPA) Method 8015M (silica-gel treated) and TPPH, benzene, toluene, ethyl-benzene, and total xylenes (collectively BTEX) and MTBE, di-isopropyl ether (DIPE), ethyl tertiary butyl ether (ETBE), tertiary amyl methyl ether (TAME), tertiary butyl alcohol (TBA), 1,2-dichloroethane (1,2-DCA), ethanol, and ethylene di-bromide (EDB) - (8 oxygenates) by EPA Method 8260B.

Groundwater samples will be collected at first water and from the bottom of the borehole. Depth discrete grab groundwater samples will be obtained using a Hydropunch® sampling tool. Single-use disposable sampling equipment will be used where possible and non-disposable sampling equipment will be decontaminated between samples in a non-phosphate detergent and double rinsed with potable water.

Groundwater samples obtained from the borings will be decanted into properly labeled sample bottles and placed on ice, as noted above, pending transportation to the laboratory. A chain-of-custody will accompany the samples during transportation to the laboratory. The collected groundwater samples will be analyzed for TPHd by EPA Method 8015M (silica-gel treated) and TPPH, BTEX, and 8 oxygenates by EPA Method 8260B.

Once the sampling has been completed, the borings will be backfilled to the surface with bentonite grout.

Monitoring Well Installation

The boring for proposed monitoring well (MW-9) will be advanced to a depth of approximately 25 feet bgs using a drill-rig equipped with 8-inch outside diameter hollow-stem augers. Soil samples will be logged using the USCS for lithologic interpretation and field screened for the presence of volatile organic compounds by headspace analysis using a pre-calibrated photo ionization detector (PID). Soil samples will be collected continuously for lithologic interpretation and field screening beginning at a depth of 5 feet bgs. The soil sample exhibiting the highest PID reading from the boring as well as the soil samples collected from just above first water will be submitted for analysis. A chain-of-custody will accompany the samples during transportation to the laboratory. The soil samples retained for analysis will be analyzed for TPHd by EPA Method 8015M (silica-gel treated) and TPPH, BTEX, and 8 oxygenates by EPA Method 8260B.

The boring will be converted to groundwater monitoring well by installing a 2-inch diameter schedule 40 polyvinyl chloride (PVC) well casing with a screened interval based on the lithology encountered during well installation. The screen interval is anticipated to be between 15 and 25 feet bgs, to correspond with the depth at which first water is anticipated to be encountered. The perforation size in the screen interval will be 0.020-inch. A sand pack of RMC Lonestar Sand # 2/12 or equivalent will be installed into the annular space and extend approximately one (1) foot above the top of the screen interval. Perforation size and sand pack material may be modified in the field based on soil conditions.

A two (2) foot thick bentonite seal will be placed on top of the sand pack. The wells will be surged prior to the placement of the bentonite seal to promote settling of the sand pack. The remainder of the annular space will be filled with neat cement and the wells will be fitted with a locking cap and encased in a traffic-rated protective vault placed at existing ground level. Proposed well construction details are presented as Figure 4.

Well Development, Monitoring, and Sampling

The monitoring well will be developed a minimum of 72 hours after construction. A minimum of 10 casing volumes of groundwater will be removed from the monitoring well during the development process.

Subsequent to the installation and development, the newly installed monitoring well will be incorporated into a quarterly sampling schedule and be monitored and sampled a minimum of 48 hours after well development.

Groundwater samples collected for analysis from the monitoring well will be analyzed for TPHd by EPA Method 8015M (silica-gel treated) and TPPH, BTEX, and 8 oxygenates by EPA Method 8260B.

Wellhead Survey

Following the completion of the new monitoring wells, a California licensed surveyor will survey the northing and easting of the monitoring well. The monitoring well position and elevation will be surveyed using the same references used to survey the existing site monitoring wells in January, 2008 (NAD 83 and NAD 88) with an accuracy of +/- 0.01 foot. At a minimum, the elevation of the newly installed well will be verfied to ensure consistency with elevation data from existing site monitoring wells. A global positioning system (GPS) will also be used to survey in the latitude and longitude of the wells to be uploaded into California's Geo Tracker database system. The survey of the well locations will be to sub-meter accuracy.

PROPOSED SOIL VAPOR SURVEY

To evaluate potential soil vapor in the vicinity of the station building the advancement of five borings to a depth of 5 feet bgs and the collection of one (1) soil vapor sample from each boring is proposed. The boring will be completed as a temporary soil vapor sampling point. Please note that the boring depth may change if shallow groundwater is encountered. The proposed locations are shown on Figure 2.

Soil vapor samples will be collected at approximately 4.5 to 5 feet bgs from the borings. To evaluate if a potential risk to human health exists, the analytical results will be compared to the commercial San Francisco Bay Regional Water Quality Control Board Environmental Screening Levels (ESLs) for shallow soil gas based on the potential receptors associated with the sample points.

The proposed soil vapor survey investigation described below is in accordance with protocols identified in the *Interim Guidance for Active Soil Gas Investigations* (RWQCB-LA Region, 1997) and the *Advisory-Active Soil Gas Investigations* (Department of Toxic Substances Control, 2003).

Pre-Field Activities

Prior to initiation of field activities, Delta will prepare a HASP specific to the site and work being performed in accordance with Title 8, Section 5192 of the California Code of Regulations. The will contain a list of emergency contacts, as well as a hospital route map to the nearest emergency facility, and was reviewed daily by field personnel.

Underground Utility Location

The proposed boring location will be marked prior to drilling, and Underground Service Alert (USA) will be notified as required and a private utility locator will contracted to clear the proposed boring locations to further minimize the risk of damaging underground utilities.

Soil Gas Sampling

Soil vapor samples will be collected from the probes in compliance with the California Environmental Protection Agency-Department of Toxic Substances Control (Cal-

EPA/DTSC) 2003 *Advisory-Active Soil Gas Investigations*, as detailed in the attached Standard Operating Procedures (SOP) presented as Attachment B.

- **Soil Vapor Sampling Point Installation:**

  Soil vapor sampling points will be hand augered to five (5) feet bgs for utility clearance. This borehole will be backfilled as follows: sand from 3.5 to five (5) feet bgs, hydrated bentonite granules from 3.5 to 2.5 feet bgs, thick bentonite mixture from just below existing asphalt to 2.5 feet bgs, and thin layer of cold patch asphalt to grade.

  Prior to backfill, one soil sample will be collected from the bottom (total depth) of each borehole. The soil samples retained for analysis will be analyzed for TPHd by EPA Method 8015M (silica-gel treated) and TPPH, BTEX, and 8 oxygenates by EPA Method 8260B.

  The borehole (temporary sampling point) will be allowed to stabilize for approximately two weeks in the absence of measurable precipitation.

- **Soil Vapor Sampling:**

  A boring will be advanced, using direct push technology, to place a soil vapor sampling tip into the previously installed sand zone (approximately 3.5 to five feet bgs). A soil vapor sample will be collected from this zone and and field analyzed using mobile equipment. Once a valid soil vapor sample has been collected and analysis is completed, the borehole will be backfilled with neat cement to the surface and dyed to match the surrounding concrete/asphalt.

Laboratory Analysis

The soil vapor samples will be analyzed by a California-certified mobile analytical laboratory for TPHg, BTEX, and MTBE by EPA Method 8260B. The samples will additionally be analyzed for oxygen (O_2), carbon dioxide (CO_2), and methane (CH_4) by ASTM Method D-1946, and the tracer compound to evaluate potential ambient air intrusion and for leak check purposes. Delta will ensure that the laboratory reporting limits for these gases are below the concentrations of each gas in the atmosphere.

The laboratory analytical procedures are also described in the attached SOP.

Disposal of Drill Cuttings and Wastewater

Drill cuttings and decontamination water generated during the soil boring advancement and the soil vapor sampling activities will be placed into properly labeled 55-gallon Department of Transportation (DOT) approved steel drums and stored on the property. Samples of the drill cuttings and wastewater will be collected, properly labeled and placed on ice for submittal to a California-certified laboratory and analyzed for TPPH, BTEX, and MTBE by EPA Method 8260B and CAM 17 metals by EPA Method 6010B. A chain-of-custody will accompany the samples during transportation to the laboratory. Subsequent to receiving the laboratory analytical results, the drummed drill cuttings and wastewater will be profiled, transported, and disposed of at a COP approved facility.

Reporting

Following completion of the field work and receipt of analytical results, a site investigation report will be prepared and submitted within 60 days. The report will present the details of the boring activities, including copies of boring permits, and details of disposal activities and copies of disposal documents. Required electronic submittals will be uploaded to the State Geotracker database.

DISCUSSION OF TIMEFRAME FOR ENVIRONMENTAL ACTIVITIES

The ACHCSA in their letter dated September 24, 2008 requested that a timeline be prepared and submitted with this work plan detailing each step of investigation, evaluation, development of cleanup goals, risk-based analysis, and reporting for this site up to implementation of remediation. The proposed timeline is presented as Attachment C. Please note that completion times for each individual tasks begin once Agency concurrence/approval is received for that particular task. Due to the variability of Agency review and response timing, definitive calendar dates are not provided.

The primary tasks identified in this timeline are as follows:

- Investigation Phase – 120 days
- Preparation of a Corrective Action Plan (CAP) – 90 days
- Preparation of a feasibility work plan – 60 days
- Performance of a feasibility test –120 days
- Preparation of a Remedial Action Plan (RAP) – 90 days - and
- Implementation of that RAP, including design, permitting, installation, and start-up – 150 days.

If additional assessment activities are required to complete the soil and groundwater assessment, etc. certain phases may have to be repeated.

DISCUSSION

A review of previous petroleum hydrocarbon mass calculations was performed. Mass calculations were performed using the average of the known petroleum hydrocarbon concentrations across the site and not isolated areas. These calculations indicated that the mass of petroleum hydrocarbons in the soil was approximately 8,300 pounds. A review of this data indicates this number is likely overestimated. Based on data obtained during the most recent investigation (December 2007) soil appears to contain petroleum hydrocarbons to depths ranging from approximately 12 feet bgs in boring SB-2 to 17 feet bgs in boring SB-5. Additionally, the soil does not appear to be significantly impacted in the vicinity of borings SB-3, SB-4, and MW-8. This indicates that the extent of the petroleum hydrocarbon impact to the soil is predominately located on-site in the vicinity of the former USTs, the current USTs, and down-gradient of the station building and do not encompass the entire site. Therefore, the mass calculations for the petroleum hydrocarbons in soil were recalculated and are included in this work plan as Attachment D.

The petroleum hydrocarbons found in soil beneath the site are predominately within the confining unit (clay) and are likely sorbed onto clay. Due to the sorbed petroleum hydrocarbons in the clay, the only remediation technique that may remove the sorbed petroleum hydrocarbons from the soil is excavation. However, since this is an active site with fueling and automobile repair facilities this is not a feasible option.

The introduction of ozone/oxygen into the subsurface, recommended in the corrective action plan, was only intended to address the petroleum hydrocarbon impact to the groundwater. Groundwater containing petroleum hydrocarbons, predominately MTBE, appears to have migrated off-site across MacArthur Boulevard and beneath the former Shell Station. Even though there does not appear to be any sensitive receptors that will likely be impacted by this migration, additional assessment may be necessary.

The ozone/oxygen will be introduced into the subsurface to stimulate biological activity in the groundwater. Ozone/oxgen injection typically increases the DO concentration in the groundwater to further increase biological activity. The increased biological activity should increase biodegradation and reduce petroleum hydrocarbon concentrations in groundwater and decrease off-site petroleum hydrocarbon migration. In addition, ozone will react with the petroleum hydrocarbons causing oxidation of the hydrocarbons.

RECOMMENDATIONS

Therefore, Delta recommends that an ozone/oxygen injection well be installed in the vicinity of monitoring well MW-1 and feasibility testing be conducted. The injection well will be screened based on the lithology encountered during installation. The anticipated screen interval is from 15.5 feet bgs to 17 feet bgs, based on the lithology, clayey sand unit, encountered in the SB-6 boring advanced during the November 2007 site investigation. Upon agency concurrence, a work plan will be prepared under a separate cover describing the proposed work. The data from the feasibility testing will be evaluated and a remedial action plan will be prepared for the site.

REMARKS/SIGNATURES

The recommendations contained in this report represent Delta's professional opinions based upon the currently available information and are arrived at in accordance with currently acceptable professional standards. This report is based upon a specific scope of work requested by the client. The Contract between Delta and its client outlines the scope of work, and only those tasks specifically authorized by that contract or outlined in this report will be performed. This report is intended only for the use of Delta's Client and anyone else specifically listed on this report. Delta will not and cannot be liable for unauthorized reliance by any other third party. Other than as contained in this paragraph, Delta makes no express or implied warranty as to the contents of this report.

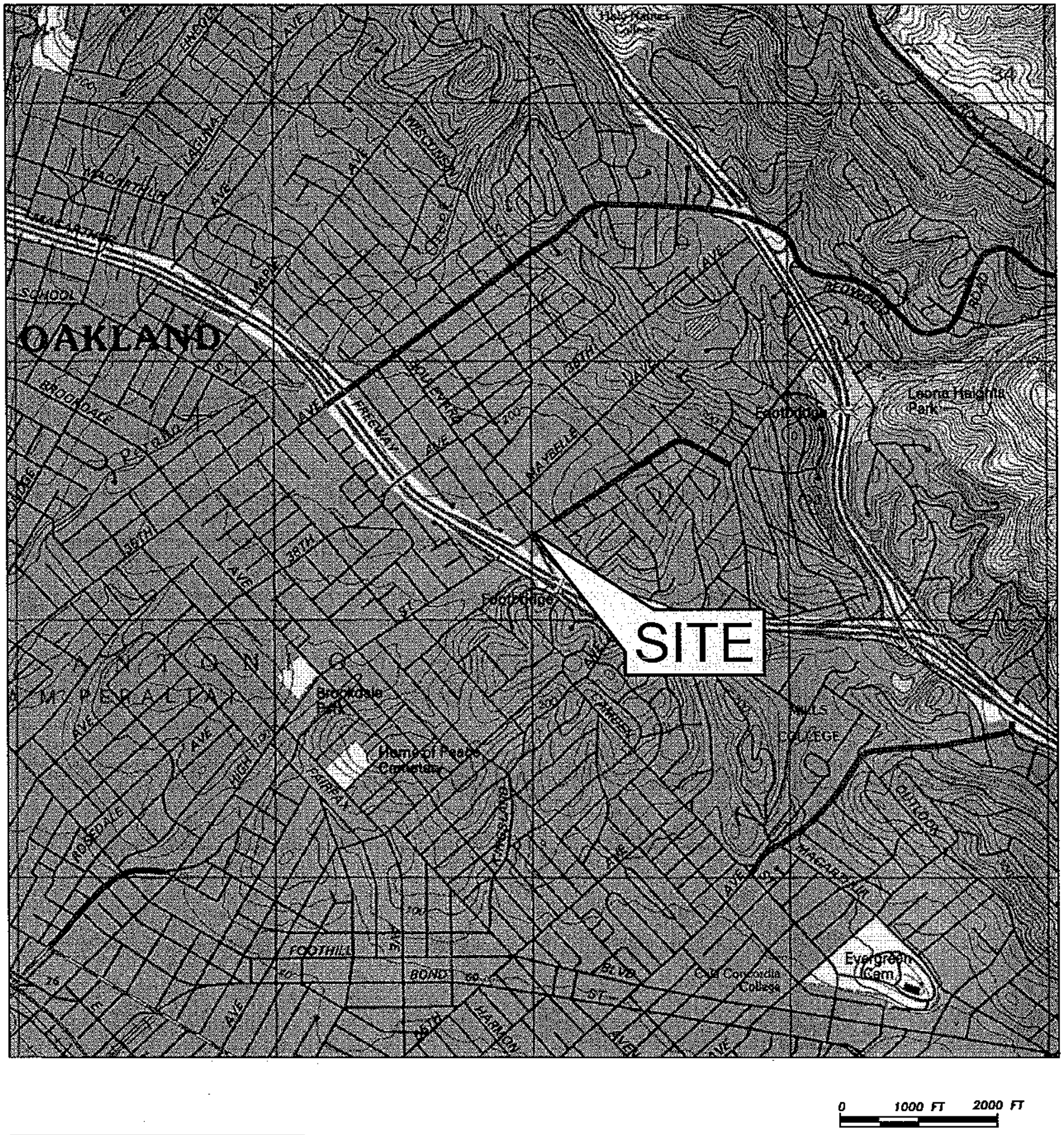
If you have any questions regarding this project, please contact me at (916) 503-1261 or Mr. Terry Grayson of COP at (916) 558-7666.

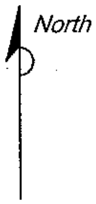
Sincerely,
DELTA CONSULTANTS

Dennis S. Dettloff

Dennis S. Dettloff, P.G.
Senior Project Manger
California Registered Professional Geologist No. 7480

DENNIS SHANNON
DETTLOFF
No. 7480





SOURCE: USGS 7.5 MINUTE TOPOGRAPHIC MAP, OAKLAND EAST QUADRANGLE, 1967

FIGURE 1
SITE LOCATOR MAP

76 SERVICE STATION NO. 1156
4276 MACARTHUR BOULEVARD
OAKLAND, CALIFORNIA

PROJECT NO. C101-156	DRAWN BY JH 03/01/07
FILE NO. Site Locator	PREPARED BY MC
REVISION NO.	REVIEWED BY

DELTA

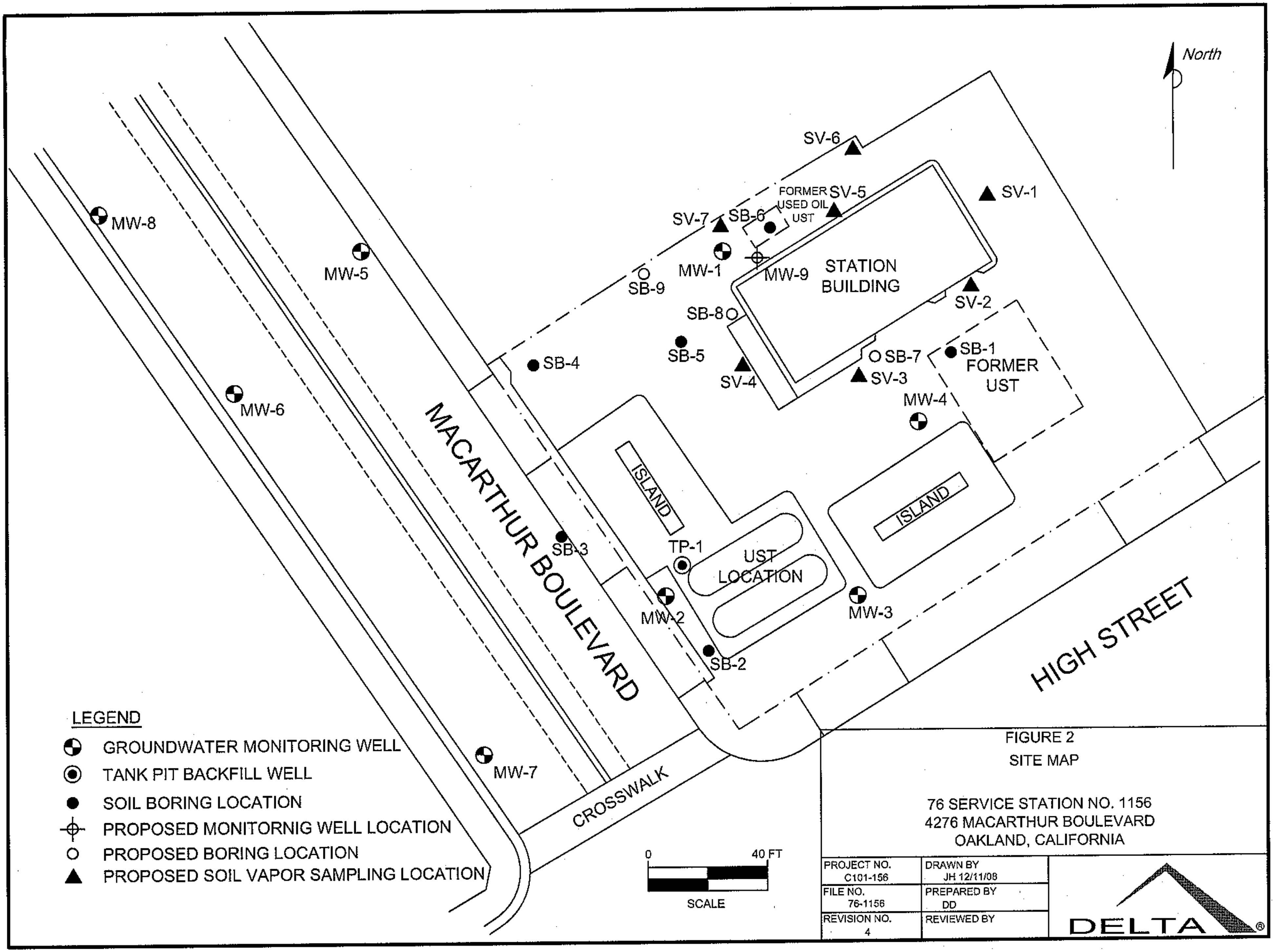


FIGURE 2
SITE MAP

76 SERVICE STATION NO. 1156
4276 MACARTHUR BOULEVARD
OAKLAND, CALIFORNIA

PROJECT NO. C101-156	DRAWN BY JH 12/11/08
FILE NO. 76-1156	PREPARED BY DD
REVISION NO. 4	REVIEWED BY

DELTA®

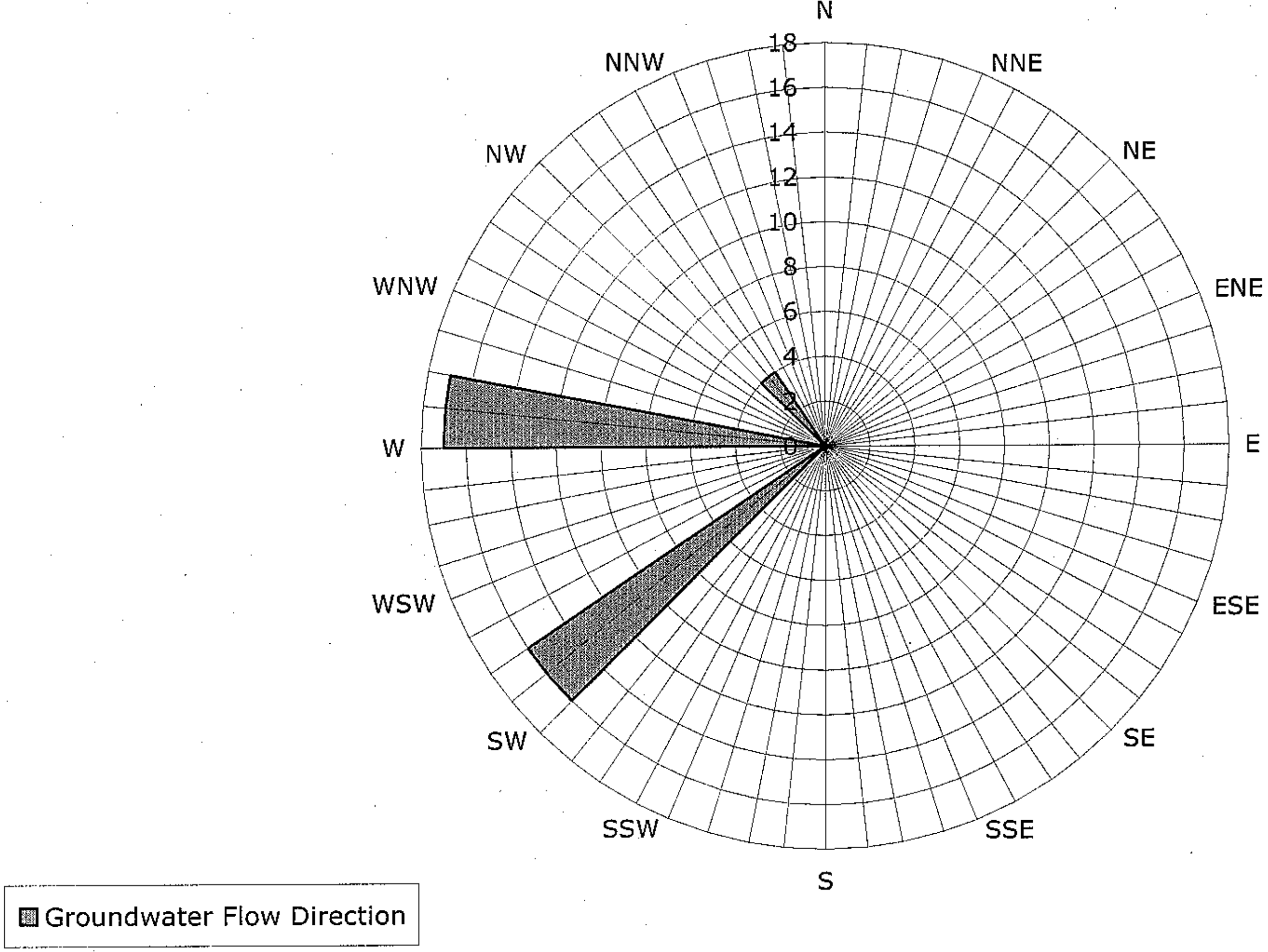
Figure 3

Historic Groundwater Flow Directions

ConocoPhillips Site No. 1156

4276 MacArthur Boulevard

Oakland, California



Legend
Concentric circles represent
quarterly montoring events
Third Quarter 1999 through
Fourth Quarter 2008
37 data points shown

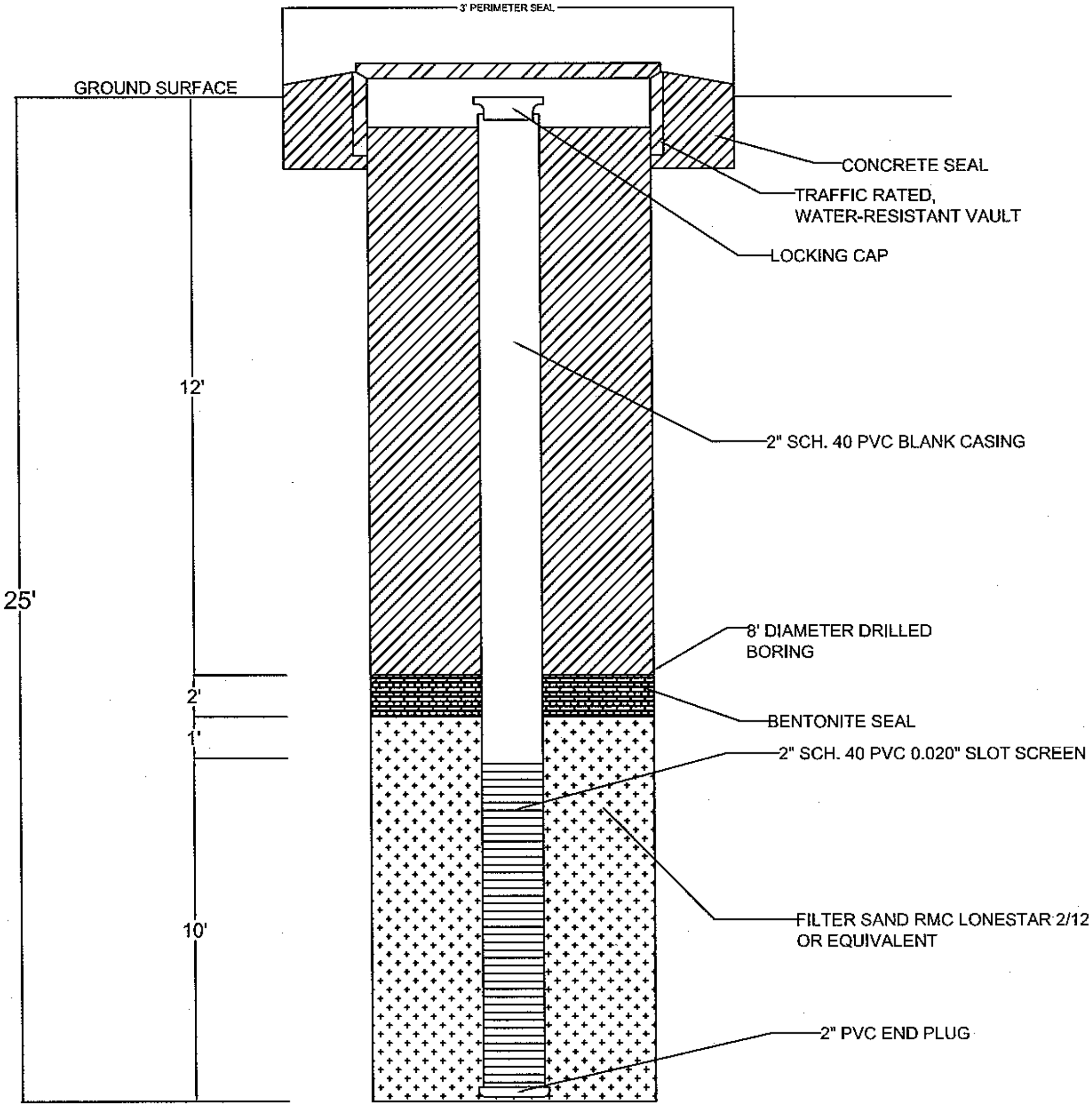


FIGURE 4

PROPOSED GROUNDWATER MONITORING WELL CONSTRUCTION DETAIL

76 STATION NO. 1156
4276 MACARTHUR BOULEVARD
OAKLAND, CALIFORNIA

PROJECT NO. C101156	DRAWN BY JH 12/11/08
FILE NO. 1156-WELLDETAIL	PREPARED BY DD
REVISION NO.	REVIEWED BY

DELTA®

Figures:

- Figure 1 – Site Location Map
- Figure 2 – Site Plan
- Figure 3 – Historic Groundwater Flow Directions
- Figure 4 – Proposed Well Construction

Attachments:

- Attachment A – ACHCSA letter dated September 24, 2008
- Attachment B – EPA/DTSC 2003 *Advisory-Active Soil Gas Investigations* SOP
- Attachment C – Proposed Timeline
- Attachment D – Revised Mass Calculations

cc: Mr. Terry Grayson, COP (electronic copy only)
Mr. James Yoo, ACPWA (1 copy)

Figures

Attachment A

ACHCSA Letter
Dated
September 24, 2008

ALAMEDA COUNTY
HEALTH CARE SERVICES
AGENCY
DAVID J. KEARS, Agency Director

RECEIVED
OCT 01 2008

ENVIRONMENTAL HEALTH SERVICES
ENVIRONMENTAL PROTECTION
1131 Harbor Bay Parkway, Suite 250
Alameda, CA 94502-6577
(510) 567-6700
FAX (510) 337-9335

September 24, 2008

Terry Grayson
ConocoPhillips
76 Broadway
Sacramento, CA 95818

Carole Quick and Lorraine Mudget
P.O. Box 2165
Gearheart, OR 97138

Rajan Goswamy
4276 MacArthur Boulevard
Oakland, CA 94619

Subject: Fuel Leak Case No. RO0000409 and Geotracker Global ID T0600102279, Unocal #1156, 4276 MacArthur Boulevard, Oakland, CA 94619

Dear Mr. Borgh, Ms. Quick, Ms. Mudget, and Mr. Goswamy:

Alameda County Environmental Health (ACEH) staff has reviewed the fuel leak case file for the above-referenced site, including the recently submitted document entitled, "*Revised Corrective Action Plan*," dated July 30, 2008 (Revised CAP), which was prepared on behalf of ConocoPhillips by Delta Environmental. The CAP was revised from a previous April 24, 2008 Draft CAP version in response to ACEH correspondence dated June 18, 2008 that indicated the Draft CAP did not include sufficient evaluation of remedial alternatives to meet the minimum requirements for a corrective action plan.

The "*Revised Corrective Action Plan*," dated July 30, 2008 does not adequately address our technical comments and also does not meet the minimum requirements for a corrective action plan. The Revised CAP recommends ozone/oxygen injection on a pilot test scale and conducting additional site investigation consisting of investigation of the area near well MW-1 and a soil vapor survey.

We are concerned with the lack of progress in moving this case into the cleanup phase. In ACEH correspondence dated January 24, 2008, we concurred with Delta's recommendation to prepare a corrective action plan (Site Investigation Report dated December 28, 2007). We have received two corrective action plans since January 24, 2008 which do not meet the minimum requirements for a corrective action plan. As discussed in technical comments 2 and 3, we do not concur with the proposal to conduct a pilot test for ozone/oxygen injection. Moreover, it is disappointing that additional investigation is now recommended following the preparation of two corrective action plans. The Revised CAP discusses several possible future actions including risk-based modeling prior to considering the feasibility of remediation. Extending the corrective action plan process over a multi-year period is not acceptable. In the Work Plan requested below, we request that you clearly outline each proposed step of investigation, evaluation, development of cleanup goals, risk-based analysis, and reporting for this site with definite timeframes up to implementation of remediation. Moreover, future data collection must be focused on completing the site investigation and moving to the cleanup phase. We request that you submit a Work Plan that addresses the technical comments below **no later than November 21, 2008.**

TECHNICAL COMMENTS

1. **Proposed Cleanup Levels.** The Revised CAP indicates that cleanup goals cannot be established at this time and proposes using a risk-based approach to develop cleanup goals at an undefined date in the future. Although we do not concur that cleanup goals cannot be established at this time, the development of cleanup goals may be deferred until a schedule for completion of the CAP is established. As previously discussed in this correspondence, we request that you outline each proposed step of investigation, evaluation, and reporting with definite timeframes up to implementation of remediation. This outline is to be included in the Work Plan requested below.

2. **Confined Groundwater Conditions and Ozone/Oxygen Injection.** The Revised CAP concludes that groundwater beneath the site is under confined conditions. In our June 18, 2008 correspondence, we requested that you evaluate the potential effects of confined groundwater conditions on the effectiveness of proposed ozone/oxygen injection. We did not see this evaluation in the Revised CAP. Since the estimate of contaminant mass in the Revised CAP indicates that more than 98 percent of the fuel hydrocarbons are in soil above the confining layer, it is not clear how the injection of ozone or oxygen below the confining layer will clean up the site. We request that you include a site conceptual model to show this relationship in the Work Plan requested below.

3. **Recommended Ozone/Oxygen Corrective Action.** Based on the issues discussed in technical comment 2, we do not concur with the recommendation to proceed with a pilot test of ozone/oxygen injection at this time.

4. **Recommendations for Additional Investigation.** In the Work Plan requested below, please present your plans for conducting additional site investigation in the area of well MW-1 and a soil vapor survey.

5. **Quarterly Groundwater Monitoring.** Please continue quarterly groundwater monitoring and present the results in the Quarterly Reports requested below.

TECHNICAL REPORT REQUEST

Please submit technical reports to Alameda County Environmental Health (Attention: Jerry Wickham), according to the following schedule:

- **November 21, 2008** – Work Plan
- **30 days following end of each quarter** – Quarterly Groundwater Monitoring Report

These reports are being requested pursuant to California Health and Safety Code Section 25296.10. 23 CCR Sections 2652 through 2654, and 2721 through 2728 outline the responsibilities of a responsible party in response to an unauthorized release from a petroleum UST system, and require your compliance with this request.

ELECTRONIC SUBMITTAL OF REPORTS

ACEH's Environmental Cleanup Oversight Programs (LOP and SLIC) require submission of reports in electronic form. The electronic copy replaces paper copies and is expected to be used for all public information requests, regulatory review, and compliance/enforcement activities. Instructions for submission of electronic documents to the Alameda County Environmental Cleanup Oversight Program FTP site are provided on the attached "Electronic Report Upload Instructions." Submission of reports to the Alameda County FTP site is an addition to existing requirements for electronic submittal of information to the State Water Resources Control Board (SWRCB) Geotracker website. In September 2004, the SWRCB adopted regulations that require electronic submittal of information for all groundwater cleanup programs. For several years, responsible parties for cleanup of leaks from underground storage tanks (USTs) have been required to submit groundwater analytical data, surveyed locations of monitoring wells, and other data to the Geotracker database over the Internet. Beginning July 1, 2005, these same reporting requirements were added to Spills, Leaks, Investigations, and Cleanup (SLIC) sites. Beginning July 1, 2005, electronic submittal of a complete copy of all reports for all sites is required in Geotracker (in PDF format). Please visit the SWRCB website for more information on these requirements (http://www.swrcb.ca.gov/ust/cleanup/electronic_reporting).

PERJURY STATEMENT

All work plans, technical reports, or technical documents submitted to ACEH must be accompanied by a cover letter from the responsible party that states, at a minimum, the following: "I declare, under penalty of perjury, that the information and/or recommendations contained in the attached document or report is true and correct to the best of my knowledge." This letter must be signed by an officer or legally authorized representative of your company. Please include a cover letter satisfying these requirements with all future reports and technical documents submitted for this fuel leak case.

PROFESSIONAL CERTIFICATION & CONCLUSIONS/RECOMMENDATIONS

The California Business and Professions Code (Sections 6735, 6835, and 7835.1) requires that work plans and technical or implementation reports containing geologic or engineering evaluations and/or judgments be performed under the direction of an appropriately registered or certified professional. For your submittal to be considered a valid technical report, you are to present site specific data, data interpretations, and recommendations prepared by an appropriately licensed professional and include the professional registration stamp, signature, and statement of professional certification. Please ensure all that all technical reports submitted for this fuel leak case meet this requirement.

UNDERGROUND STORAGE TANK CLEANUP FUND

Please note that delays in investigation, later reports, or enforcement actions may result in your becoming ineligible to receive grant money from the state's Underground Storage Tank Cleanup Fund (Senate Bill 2004) to reimburse you for the cost of cleanup.

AGENCY OVERSIGHT

If it appears as though significant delays are occurring or reports are not submitted as requested, we will consider referring your case to the Regional Board or other appropriate agency, including the County District Attorney, for possible enforcement actions. California Health and Safety Code, Section 25299.76 authorizes enforcement including administrative action or monetary penalties of up to $10,000 per day for each day of violation.

If you have any questions, please call me at (510) 567-6791 or send me an electronic mail message at jerry.wickham@acgov.org.

Sincerely,

Jerry Wickham

Jerry Wickham, California PG 3766, CEG 1177, and CHG 297
Senior Hazardous Materials Specialist

Enclosure: ACEH Electronic Report Upload (ftp) Instructions

cc: Leroy Griffin, Oakland Fire Department, 250 Frank H. Ogawa Plaza, Ste. 3341, Oakland, CA 94612-2032

Dennis Dettloff, Delta Environmental Consultants, Inc., 3164 Gold Camp Drive, Suite 200
Rancho Cordova, CA 95670

Donna Drogos, ACEH
Jerry Wickham, ACEH
File

Attachment B

EPA/DTSC 2003 Advisory Active Soil Gas Investigations SOP

Gray Davis, Governor
Winston H. Hickox, Agency Secretary
California Environmental Protection Agency

Department of Toxic Substances Control
Edwin F. Lowry, Director
1011 N. Grandview Avenue
Glendale, California 91201
Phone (818) 551-2800
FAX (818) 551-2832
www.dtsc.ca.gov

California Regional Water Quality Control Board
Los Angeles Region
320 W. 4th Street, Suite 200
Los Angeles, California 90013
Phone (213) 576-6600
FAX (213) 576-6640
www.swrcb.ca.gov/rwqcb4

January 28, 2003

To: Interested Parties

ADVISORY – ACTIVE SOIL GAS INVESTIGATIONS

In a coordinated effort, the Department of Toxic Substances Control (DTSC) and the California Regional Water Quality Control Board – Los Angeles Region (LARWQCB) have jointly developed the "Advisory – Active Soil Gas Investigations" (see the attached). This document is to ensure that consistent methodologies are applied during active soil gas investigations to produce high quality data for regulatory decision-making. The document has been reviewed by other government organizations and by the soil gas consulting community. Their comments have been considered and, where appropriate, incorporated in the document. This is an on-going effort to streamline the characterization of gas phase contaminant sites. As additional knowledge and experience are obtained, this Advisory may be modified as appropriate.

This document is issued by DTSC and LARWQCB as an Advisory subject to review and revision as necessary. The information in this Advisory should not be considered as regulations. Mention of trade names or commercial products does not constitute the Agency's endorsement or recommendation.

If you have any questions regarding this document, please contact the joint-agency project coordinator Mr. Joe Hwong, of DTSC, at (714) 484-5406.

Sincerely,

Edwin F. Lowry

Edwin F. Lowry
Director
Department of Toxic Substances Control

Dennis A. Dickerson
Executive Officer
California Regional Water Quality Control Board
Los Angeles Region

Enclosure

ADVISORY – ACTIVE SOIL GAS INVESTIGATIONS

As a coordinated effort, this document is issued by the California Regional Water Quality Control Board – Los Angeles Region (LARWQCB) and Department of Toxic Substances Control (DTSC) as an Advisory subject to review and revision as necessary. Mention of trade names or commercial products does not constitute the Agency's endorsement or recommendation. The information in this Advisory should not be considered as regulations. In this Advisory, "Agency" should mean LARWQCB and/or DTSC.

1.0 INTRODUCTION

Active soil gas investigations are useful to obtain vapor phase data at sites potentially affected by volatile organic compounds (VOCs), including chlorinated and aromatic hydrocarbons. Active soil gas investigations may also be used to investigate sites potentially affected by methane and hydrogen sulfide, and to measure fixed and biogenic gasses (e.g., oxygen, carbon dioxide, or carbon monoxide). Among other things, the data can be used to identify the source and determine the spatial distribution of VOC contamination at a site, or to estimate indoor air concentrations for risk assessment purposes.

For site characterization, the Agency encourages both soil gas and soil matrix sampling. Typically, soil gas data are more representative of actual site conditions in coarse-grained soil formations while soil matrix data are more representative of actual site conditions in fine-grained soil formations. For evaluating the risk associated with vapor intrusion to indoor air, soil gas data are the preferred contaminant data set, where practicable. Flux chamber and passive sampling methods are not discussed in this Advisory. Any sites where such sampling methods are necessary will be addressed separately.

On February 25, 1997, LARWQCB re-issued the "Interim Guidance for Active Soil Gas Investigation" (ASGI) as guidance for investigating sites with potential VOC contamination. Unless otherwise noted in this Advisory, the active soil gas investigation should be performed in accordance with the most current ASGI

2.0 SUPPLEMENTAL RECOMMENDATIONS

The following sections supplement the ASGI in an effort to ensure that consistent methodologies are applied during soil gas investigations to produce reliable and defensible data of high quality. All sampling probe installation, sampling, and analytical procedures, whether or not discussed below, are subject to Agency review and approval.

2.1 Project Management
2.2 Soil Gas Sampling Probe Installation
2.3 Purge Volume Test
2.4 Leak Test
2.5 Purge/Sample Flow Rate
2.6 Soil Gas Sampling
2.7 Analysis of Soil Gas Samples

2.1 Project Management

2.1.1 Workplan: An appropriate workplan should be prepared and submitted to the Agency for review and approval at least 30 days prior to its implementation. Any variations or deviations from this Advisory should be specified in the workplan. The soil gas workplan can either be incorporated as part of a comprehensive site investigation workplan or as a stand-alone document, depending on site-specific circumstances.

2.1.2 Field Activities

A. The Agency should be notified 10 working days prior to implementation of field activities. All necessary permits and utility clearance(s) should be obtained prior to conducting any investigations described in this Advisory.

B. All engineering or geologic work (e.g., logging continuous soil cores, soil description) should be performed or supervised by a California Registered Professional in accordance with the Business and Professions Code, Chapters 7 and 12.5, and the California Code of Regulations, Title 16, Chapters 5 and 29.

In addition, for proposed school sites, all work performed should be under the direction and supervision of a project coordinator experienced in soil gas investigations [e.g., an Environmental Assessor as defined in Education Code Section 17210(b)].

C. Evaluation of raw data by Agency staff may occur either in the field or in the office.

1. Hard copies of the complete raw laboratory data, including handwritten data and field notes, should be provided to the Agency staff upon request.

2. Adjustments or modifications to the sampling program may be required by Agency staff to accommodate changes mandated by evaluation of the data set or unforeseen site conditions.

D. Investigation derived wastes (IDWs) should be managed as hazardous waste until proven otherwise or until specifically approved by the Agency as being non-hazardous waste. IDWs should be handled and disposed in accordance with federal, state and local requirements.

E. Field Variations

1. To expedite the completion of field activities and avoid potential project delays, contingencies should be proposed and included in the project workplan (e.g., soil matrix samples will also be collected if clayey soils [as defined in the Unified Soil Classification System (USCS)] are encountered during the proposed soil gas investigation).

2. The Agency field staff should be informed of any problems, unforeseen site conditions, or deviations from the approved workplan. When it becomes necessary to implement modifications to the approved workplan, the Agency should be notified and a verbal approval should be obtained before implementing changes.

F. Soil Matrix Sampling Requirements: Companion soil matrix sampling may be conducted concurrently with a soil gas investigation (in accordance with the ASGI, Section 5.0), except where extremely coarse-grained soils (as defined in USCS) are encountered or when specifically excluded by the Agency.

2.1.3 Soil Gas Investigation Reports: A soil gas investigation report including a discussion of field operations, deviations from the approved workplan, data inconsistencies, and other significant operational details should be prepared. The report may either be a stand-alone document in a format recommended by the Agency or be included within a site-specific assessment report. At a minimum, the report should contain the following:

A. Site plan map and probe location map at an appropriate scale as specified in the workplan (e.g., scale: one inch = 40 feet);

B. Final soil gas iso-concentration maps for contaminants of concern at the same scale as the site plan map;

C. Summary tables for analytical data, in micrograms per liter (µg/L), in accordance with the ASGI;

D. Legible copies of field and laboratory notes or logs;

E. All analytical results and Quality Assurance/Quality Control (QA/QC) information including tables and explanations of procedures, results, corrective actions and effect on the data, in the format specified by the Agency; and

F. Upon request, all raw data including chromatograms and calibration data should be submitted to the Agency.

2.2 Soil Gas Sampling Probe Installation

2.2.1 Lithology: Site soil or lithologic information should be used to select appropriate locations and depths for soil gas probes. If on-site lithologic information is not available prior to conducting the soil gas investigation, at least one (1) continuously cored boring to the proposed greatest depth of the soil gas investigation should be installed at the first sampling location, unless specifically waived or deferred by Agency. Depending on site conditions, additional continuously cored borings may be necessary.

A. Lithologic logs should be prepared for all borings (e.g., continuously cored borings, soil matrix sampling, geotechnical sampling, etc.). Note: This does not apply to direct-push soil gas probe installations.

B. Information gathered from the continuously cored borings may include soil physical parameters, geotechnical data and contaminant data.

C. If low-flow or no-flow conditions (e.g., fine-grained soil, clay, soil with vacuum readings that exceed approximately 10 inches of mercury or 136 inches of water) are encountered, soil matrix sampling using EPA Method 5035A should be conducted in these specific areas. Also see Section 4 of LARWQCB's "General Laboratory Testing Requirements for Petroleum Hydrocarbon Impacted Sites" on use of EPA Method 5035A.

D. If the bottom five (5) feet of a continuously cored boring is composed of clay or soil with a vacuum exceeding approximately 10 inches of mercury or 136 inches of water, the continuously cored boring should be extended an additional five (5) feet to identify permeable zones. If the extended boring is also composed entirely of clay, the boring may be terminated. Special consideration should always be given to advancing borings and ensuring that a contaminant pathway is not being created through a low permeability zone.

2.2.2 Sample Spacing: A scaled site plan depicting potential or known areas of concern (e.g., existing or former sumps, trenches, drains, sewer lines, clarifiers, septic systems, piping, underground storage tanks [USTs], chemical or waste management units) should be provided in the project workplan. Sample spacing should be in accordance with the most current ASGI and may be modified based on site-specific conditions with Agency approval. To optimize detecting and delineating VOCs, the grid spacing should be modified to include biased sampling locations.

2.2.3 Sample Depth: Sample depths should be chosen to minimize the effects of changes in barometric pressure, temperature, or breakthrough of ambient air from the surface; and to ensure that representative samples are collected. Consideration should be given to the types of chemicals of concern and the lithology encountered.

A. At each sample location, soil gas probes should be installed at a minimum of one sample depth, generally at five (5) feet below ground surface (bgs), in accordance with the most current ASGI

B. Samples should be collected near lithologic interfaces or based on field instrument readings (e.g., Flame Ionization Detector [FID], Photo Ionization Detector [PID]) from soil cuttings and/or cores to determine the location of maximum analyte concentrations at the top or bottom of the interface depending upon the analyte.

C. Multi-depth sampling is appropriate for any of the following locations:

1. Sites identified with subsurface structures (e.g., USTs, sumps, clarifiers, waste or chemical management units), subsurface sources (e.g., oil fields, artificial fill, buried animal waste), changes in lithology, and/or contaminated groundwater. Soil gas probes should be emplaced below the base of any subsurface structures, sources or backfilled materials in the vadose zone. Collection of deeper samples should be done in consultation with Agency staff;

2. Areas with significantly elevated VOC concentrations detected during shallow or previous vapor sampling;

3. Areas where elevated field instrument readings are encountered from soil matrix cuttings, cores or samples; or

4. In the annular space of groundwater monitoring wells during construction, where an assessment of the vertical extent of soil gas contamination is necessary.

D. If no lithologic change or contamination is observed, default sampling depths may be selected for multi-depth sampling. For example, soil gas samples may be collected at 5, 15, 25, 40 feet bgs, etc., until either the groundwater is encountered or VOCs are not detected, whichever comes first

1. Additional samples may be necessary based on site conditions.

2. For Preliminary Endangerment Assessments: When 40 feet bgs is reached, collection of deeper samples may be waived.

However, assessment and/or characterization of the deeper vadose zone may be required in the future to protect groundwater resources.

2.2.4 Sampling Tubes: Sampling tubes should be of a small diameter (1/8 to 1/4 inch) and made of material (e.g., nylon, polyethylene, copper or stainless steel) which will not react or interact with site contaminants. For example, metal tubes should not be used for collection of hydrogen sulfide samples.

A. Clean, dry tubing should be utilized at all times. If moisture, water, or an unknown material is present in the probe prior to insertion, the tubing should be decontaminated or replaced.

B. After use at each location:

1. Non-reusable (e.g., nylon or polyethylene) sampling tubes should be discarded; or

2. Reusable sampling tubes should be properly decontaminated as specified in Section 2.2.7.

C. A drawing of the proposed probe tip design and construction should be included in the project workplan.

2.2.5 Soil Gas Probe Emplacement Methods

A. Permanent or Semi-permanent Soil Gas Probe Methods: Permanent or semi-permanent soil gas probes may be installed, using a variety of drilling methods. Please note that the mud rotary drilling method is not acceptable for soil gas probe emplacement. Other drilling methods such as air rotary and rotosonic can adversely affect soil gas data during and after drilling and will require extensive equilibration times. Therefore, they are not recommended. Other soil gas probe designs and construction (e.g., soil gas wells or nested wells) may be appropriate and should be discussed with Agency staff prior to emplacement. When additional sampling is not anticipated per consultation with the Agency, such probes may be properly removed or decommissioned after completion of the soil gas investigation.

1. The probe tip should be emplaced midway within a minimum of one (1) foot of sand pack. The sand pack should be appropriately sized (e.g., no smaller than the adjacent formation) and installed to minimize disruption of airflow to the sampling tip. See Figure 1 for more information.

2. At least one (1) foot of dry granular bentonite should be emplaced on top of each sand pack to preclude the infiltration

of hydrated bentonite grout. The borehole should be grouted to the surface with hydrated bentonite. With respect to deep probe construction with multiple probe depths, the borehole should be grouted between probes. One (1) foot of dry granular bentonite should be emplaced between the filter pack and the grout at each probe location. See Figure 2 for more information.

3. The use of a downhole probe support may be required for deep probe construction (e.g., 40 feet bgs for direct push probes).
    a. Such probe support may be constructed from a one-inch diameter bentonite/cement grouted PVC pipe or other solid rod, or equivalent, allowing probes to be positioned at measured intervals.
    b. The support should be properly sealed or solid (internally or externally) to avoid possible cross-contamination or ambient air intrusion.
    c. The probes should be properly attached to the exterior of the support prior to placement downhole.
    d. Alternative probe support designs should be described in the project workplan. If probe support will not be used for deep probes, justification should be included in the project workplan.
4. Tubing should be properly marked at the surface to identify the probe location and depth.
5. As-built diagrams for probes or wells should be submitted with the soil gas investigation report detailing the well identification and corresponding probe depths. A typical probe construction diagram may be submitted for probes with common design and installation.
6. Unless soil gas probes are removed or decommissioned, probes should be properly secured, capped and completed to prevent infiltration of water or ambient air into the subsurface and to prevent accidental damage or vandalism. For surface completions, the following components may be installed:
    a. Gas-tight valve or fitting for capping the sampling tube;
    b. Utility vault or meter box with ventilation holes and lock;
    c. Surface seal; and
    d. Guard posts.

B. Temporary Soil Gas Probe Emplacement Method: In general, the drive rod is driven to a predetermined depth and then pulled back to expose the inlets of the soil gas probe. After sample collection, both the drive rod and tubing are removed.

1. During installation of the probe, hydrated bentonite should be used to seal around the drive rod at ground surface to prevent ambient air intrusion from occurring.

2. The inner soil gas pathway from probe tip to the surface should be continuously sealed (e.g., a sampling tube attached to a screw adapter fitted with an o-ring and connected to the probe tip) to prevent infiltration.

2.2.6 Equilibration Time: During probe emplacement, subsurface conditions are disturbed. To allow for subsurface conditions to equilibrate, the following equilibration times are recommended:

A. For probes installed with the direct push method where the drive rod remains in the ground, purge volume test, leak test, and soil gas sampling should not be conducted for at least 20 minutes following probe installation.

B. For probes installed with the direct push method where the drive rod does not remain in the ground, purge volume test, leak test, and soil gas sampling should not be conducted for at least 30 minutes following probe installation.

C. For probes installed with hollow stem drilling methods, purge volume test, leak test, and soil gas sampling should not be conducted for at least 48 hours (depending on site lithologic or drilling conditions) after the soil gas probe installation.

D. Probe installation time should be recorded in the field log book.

2.2.7 Decontamination: After each use, drive rods and other reusable components should be properly decontaminated to prevent cross contamination. These methods include:

A. 3-stage wash and rinse (e.g., wash equipment with a non-phosphate detergent, rinse with tap water, and finally rinse with distilled water); and/or

B. Steam cleaning process

2.3 Purge Volume Test

To ensure stagnant or ambient air is removed from the sampling system and to assure samples collected are representative of subsurface conditions, a purge volume versus contaminant concentration test should be conducted as the first soil gas sampling activity at the selected purge test point. The purge volume test is conducted by collecting and analyzing a sample for target compounds after the removal of appropriate purge volumes.

2.3.1 Purge Test Locations: The purge test location should be selected as near as possible to the anticipated or confirmed contaminant source, and in an area where soil gas concentrations are expected to be greatest based on lithology (e.g., coarse-grained sediments). The first purge test location should be selected through the workplan approval process or as a field decision in conjunction with Agency staff.

2.3.2 Purge Volume: The purge volume or "dead space volume" can be estimated based on a summation of the volume of the sample container (e.g., glass bulbs), internal volume of tubing used, and annular space around the probe tip. Summa™ canisters, syringe, and Tedlar™ bags are not included in the dead space volume calculation. The Agency recommends step purge tests of one (1), three (3), and seven (7) purge volumes be conducted as a means to determine the purge volume to be applied at all sampling points.

A. The appropriate purge volume should be selected based on the highest concentration for the compound(s) of concern detected during the step purge tests. The purge volume should be optimized for the compound(s) of greatest concern in accordance with Section 2.2 of the ASGI.

B. If VOCs are not detected in any of the step purge tests, a default of three (3) purge volumes should be extracted prior to sampling.

C. The step purge tests and purging should be conducted at the same rate soil gas is to be sampled (see Section 2.5).

D. The purge test data (e.g., calculated purge volume, rate and duration of each purge step) should be included in the report to support the purge volume selection.

2.3.3 Additional Purge Volume Test

A. Additional purge volume tests should be performed to ensure appropriate purge volumes are extracted if:

1. Widely variable or different site soils are encountered; or

2. The default purge volume is used and a VOC is newly detected.

B. If a new purge volume is selected after additional step purge tests are conducted, the soil gas investigation should be continued as follows:

1. In areas of the same or similar lithologic conditions:

    a. Re-sample 20 percent of the previously completed probes. This re-sampling requirement may be reduced or waived in consultation with Agency staff, depending on site conditions. If re-sampling indicates higher detections (e.g., more than 50 percent difference in samples detected at greater than or equal to 10 µg/L), all other previous probes should be re-sampled using the new purge volume.

    b. Continue the soil gas investigation with the newly selected purge volume in the remaining areas.

2. In areas of different lithologic conditions: Continue the soil gas investigation with the newly selected purge volume in the remaining areas.

2.4 Leak Test

Leakage during soil gas sampling may dilute samples with ambient air and produce results that underestimate actual site concentrations or contaminate the sample with external contaminants. Leak tests should be conducted to determine whether leakage is present (e g., the leak check compound is detected and confirmed in the test sample after its application).

2.4.1 Leak tests should be conducted at every soil gas probe.

2.4.2 Leak Check Compounds: Tracer compounds, such as pentane, isopropanol, isobutene, propane, and butane, may be used as leak check compounds, if a detection limit (DL) of 10 µg/L or less can be achieved. These compounds may be contained in common products such as shaving cream.

2.4.3 A leak check compound should be placed at any location where ambient air could enter the sampling system or where cross contamination may occur, immediately before sampling. Locations of potential ambient air intrusion include:

A. Sample system connections;

B. Surface bentonite seals (e.g., around rods and tubing); or

C. Top of the Temporary Soil Gas Probe (see Section 2.2.5.B).

2.4.4 The leak test should include an analysis of the leak check compound. If a leak check compound is detected in the sample, the following actions should be followed:

A. The cause of the leak should be evaluated, determined and corrected through confirmation sampling;

B. If the leak check compound is suspected or detected as a site-specific contaminant, a new leak check compound should be used;

C. If leakage is confirmed and the problem can not be corrected, the soil gas probe should be properly decommissioned;

D. A replacement probe should be installed at least five (5) feet from the original probe decommissioned due to confirmed leakage, or consult with Agency staff; and

E. The leak check compound concentration detected in the soil gas sample should be included and discussed in the report.

2.5 Purge/Sample Flow Rate

Sampling and purging flow rates should not enhance compound partitioning during soil gas sampling. Samples should not be collected if field conditions as specified in Section 2.6.4 exist.

2.5.1 The purging or sampling flow rate should be attainable in the lithology adjacent to the soil gas probe.

A. To evaluate lithologic conditions adjacent to the soil gas probe (e.g., where no-flow or low-flow conditions), a vacuum gauge or similar device should be used between the soil gas sample tubing and the soil gas extraction devices (e.g., vacuum pump, Summa™ canister).

B. Gas tight syringes may also be used to qualitatively determine if a high vacuum soil condition (e.g., suction is felt while the plunger is being withdrawn) is present.

2.5.2 The Agency recommends purging or sampling at rates between 100 to 200 milliliters per minute (ml/min) to limit stripping, prevent ambient air from diluting the soil gas samples, and to reduce the variability of purging rates. The low flow purge rate increases the likelihood that representative samples may be collected. The purge/sample rate may be modified based on conditions encountered in individual soil gas probes. These modified rates should be documented in the soil gas report.

2.6 Soil Gas Sampling

After the soil gas probe is adequately purged, samples should be collected by appropriate methodologies.

2.6.1 Sample Container: Samples should be collected in gas-tight, opaque/dark containers (e.g., syringes, glass bulbs wrapped in aluminum foil, Summa™ canisters), so that light-sensitive or halogenated VOCs (e.g., vinyl chloride) will not degrade.

A. If a syringe is used, it should be leak-checked before each use by closing the exit valve and attempting to force ambient air through the needle.

B. If syringe samples are analyzed within five (5) minutes of collection, aluminum foil wrapping may not be necessary.

C. EPA Method TO-14A, TO-15, or an equivalent air analysis method, requires samples be collected in Summa™ canisters.

D. If a Summa™ canister is used, a flow regulator should be placed between the probe and the Summa™ canister to ensure the Summa™ canister is filled at the flow rate as specified in Section 2.5.2.

E. Tedlar™ bags should not be used to collect VOC samples.

F. Specific requirements for methane and hydrogen sulfide sample containers are specified in Section 2.7.9.

2.6.2 Sample Collection

A. Vacuum Pump: When a vacuum pump is used, samples should be collected on the intake side of the vacuum pump to prevent potential contamination from the pump. Vacuum readings or qualitative evidence of a vacuum should be recorded on field data sheets for each sample.

B. Shallow Samples: Care needs to be observed when collecting shallow soil gas samples to avoid sample breakthrough from the surface. Extensive purging or use of large volume sample containers (e.g., Summa™ canisters) should be avoided for collection of near-surface samples [e.g., shallower than five (5) feet bgs].

2.6.3 Sample Container Cleanliness and Decontamination

A. Prior to its first use at a site, each sample container should be assured clean by the analytical laboratory as follows:

1. New containers should be determined to be free of contaminants (e.g., lubricants) by either the supplier or the analytical laboratory; and

2. Reused/recycled containers: Method blank(s), as specified in Section 2.7.1.A, should be used to verify sample container cleanliness.

B. After each use, reusable sample containers should be properly decontaminated.

1. Glass syringes or bulbs should be disassembled and baked at 240° C for a minimum of 15 minutes or at 120° C for a minimum of 30 minutes, or be decontaminated by an equivalent method.

2. Summa™ canisters should be properly decontaminated as specified by appropriate EPA analytical methods.

3. During sampling activities using reused/recycled sampling containers (e.g., glass syringes, glass bulbs), at a minimum one (1) decontaminated sample container per 20 samples or per every 12 hours, whichever is more often, should be used as a method blank (as specified in Section 2.7.1.A) to verify and evaluate the effectiveness of decontamination procedures.

C. Plastic syringes should be used only once and then properly discarded.

2.6.4 Field Conditions: Field conditions, such as rainfall, irrigation, fine-grained sediments, or drilling conditions may affect the ability to collect soil gas samples.

A. Wet Conditions: If no-flow or low-flow conditions are caused by wet soils, the soil gas sampling should cease. In addition, the Agency recommends that the soil gas sampling should not be conducted during or immediately after a significant rain event (e.g., 1/2 inch or greater) or onsite watering.

B. If low flow conditions are determined to be from a specific lithology, a new probe should be installed at a greater depth or a new lateral location should be selected after evaluation of the site lithologic logs (See Section 2.2.1) or in consultation with Agency staff.

C. If moisture or unknown material is observed in the glass bulb or syringe, soil gas sampling should cease until the cause of the problem is determined and corrected.

D. If refusal occurs during drilling, soil gas samples should be collected as follows or in consultation with Agency staff.

1. For sample depths less than five feet, collect a soil gas sample following the precautions outlined in Section 2.6.2.B.

2. For sample depths greater than five feet, collect a soil gas sample at the depth of refusal.

3. A replacement probe should be installed within five (5) feet laterally from the original probe decommissioned due to refusal. If refusal still occurs after three tries, the sampling location may be abandoned.

2.6.5 Chain of Custody Records: A chain of custody form should be completed to maintain the custodial integrity of a sample. Probe installation times and sample collection times should be included in the soil gas report.

2.7 Analysis of Soil Gas Samples

2.7.1 Quality Assurance/Quality Control (QA/QC): The soil gas analytical laboratory should comply with the project Quality Assurance Project Plan (QAPP) and follow the QA/QC requirements of the most current ASGI and the employed EPA Method. If there is any inconsistency, the most restrictive and specific requirements should prevail. The analytical data should be consistent with the Data Quality Objectives (DQOs) established for the project. The Agency staff may inspect the field and/or laboratory QA/QC procedures. Copies of the QA/QC plan and laboratory calibration data should be presented to the Agency field staff upon request

Field QC samples should be collected, stored, transported and analyzed in a manner consistent with site samples. The following QC samples should be collected to support the sampling activity:

A. Sample Blanks

1. Method Blanks: Method blanks should be used to verify the effectiveness of decontamination procedures as specified in Section 2.6.3.B.3 and to detect any possible interference from ambient air.

2. Trip Blanks for Off-site Shipments: Whenever VOC samples are shipped offsite for analysis, a minimum of one (1) trip blank

per day should be collected and analyzed for the target compounds. Trip blanks, consisting of laboratory grade ultra pure air, are prepared to evaluate if the shipping and handling procedures are introducing contaminants into the samples, and if cross contamination in the form of VOC migration has occurred between the collected VOC samples. Trip blank containers and media should be the same as site samples.

B. Duplicate Samples: At least one (1) duplicate sample per laboratory per day should be field duplicate(s). Duplicate samples should be collected from areas of concern.

   1. Duplicate samples should be collected in separate sample containers, at the same location and depth.

   2. Duplicate samples should be collected immediately after the original sample.

C. Laboratory Control Samples and Dilution Procedure Duplicates: Laboratory Control Samples (LCS) and Dilution Procedure Duplicates (DPD) should be done in accordance with the most recent ASGI (Sections 3.5.0 and 3.12.4, respectively).

D. Split Samples: The Agency staff may request that split samples be collected and analyzed by a separate laboratory.

2.7.2 Laboratory Certification: Although the California Department of Health Services, Environmental Laboratory Accreditation Program (ELAP) does not currently require certification for soil gas analytical laboratories, the Agency recommends laboratories utilizing EPA Methods 8260B, 8021B, and 8015B for analyses of soil gas samples obtain ELAP certifications for such EPA analytical methods accordingly. The Agency or DTSC's Hazardous Materials Laboratory (HML) staff may inspect the laboratory.

2.7.3 Detection Limits for Target Compounds: Analytical equipment calibration should be in accordance with the most current ASGI. Consideration and determination of appropriate DLs should be based on the DQOs of the investigation.

A. The DL for leak check compounds should be 10 µg/L or less (see Section 2.4.2). The DL for oxygen (O_2) and carbon dioxide (CO_2) should be one (1) percent or less. The DLs for methane and hydrogen sulfide are specified in Section 2.7.9.

B. If the investigation is being conducted to delineate the extent of contamination, a DL of 1 µg/L is appropriate for all targeted VOCs.

C. If the soil gas data are to be used to support risk assessment activities, a DL of 1 µg/L may be appropriate for the initial screening when evaluating all targeted VOCs. If the data are non-detect for all targeted VOCs, additional sampling with lower DLs is not required. If VOCs are detected, additional sampling, using a DL of 0.1 µg/L, may be required to confirm the non-detection of carcinogenic VOCs [see the Toxicity Criteria Database of the California Environmental Protection Agency, Office of Environmental Health Hazard (OEHHA), or the Integrated Risk Information System (IRIS) Database of the United States Environmental Protection Agency]. A DL of 0.1 µg/L may be proposed and used for all carcinogenic target VOCs from the beginning of the investigation.

D. Based on site-specific DQO needs, lower DLs may be required. Examples of sites requiring site-specifc DQO needs include, but are not limited to, chlorinated solvents sites, former industrial facilities and landfills. Several less common VOCs, not included on the ASGI-targeted compound list, may require lower detection limits [e.g., bis(chloromethyl)ether, DBCP (1,2-dibromo-3-chloropropane), or ethylene dibromide] when they are known or suspected to be present.

E. If the required DLs cannot be achieved by the proposed analytical method, additional sample analysis by a method achieving these DLs [e.g., EPA Method 8260B with selective ion method (SIM), TO-14A, TO-15] may be required. Use of these methods should comply with the QA/QC requirements as specified in Section 2.7.1.

F. For results with a high DL reported (e.g., due to matrix interference or dilution), the laboratory should provide a written explanation. Re-sampling and analyses may be required at the appropriate DL for a specific compound.

2.7.4 Sample Handling: Exposure to light, changes in temperature and pressure will accelerate sample degradation. To protect sample integrity:

A. Soil gas samples should not be chilled;

B. Soil gas samples should not be subjected to changes in ambient pressure. Shipping of sample containers by air should be avoided; and

C. If condensation is observed in the sample container, the sample should be discarded and a new sample should be collected.

2.7.5 Holding Time: All soil gas samples (e.g., samples of VOCs, methane, fixed gases, or biogenic gases), with the exception of hydrogen sulfide samples, should be analyzed within 30 minutes by an on-site mobile laboratory. Hydrogen sulfide samples should be analyzed as specified in Section 2.7.9.B.2. Under the following conditions, holding times may be extended and analyses performed off-site:

A. Soil gas samples collected in glass bulbs with surrogates added within 15 minutes of collection may be analyzed within 4 hours after collection;

B. Soil gas samples collected in Summa™ canisters may be analyzed within 72 hours after collection; and

C. Methane samples may be analyzed as specified in Section 2.7.9.A.2.

2.7.6 Analytical Methods

A. VOC Samples: All VOC samples should be analyzed using only a Gas Chromatograph/Mass Spectrometer (GC/MS) method (e.g., EPA Method 8260B, used for analysis of soil gas samples, EPA Method TO-14A or TO-15, or equivalent), except at well-characterized sites (e.g., VOCs are known to be present and confirmed based on previous GC/MS analyses). A non-GC/MS method (e.g., EPA Method 8021B, used for analysis of soil gas samples) may be used only for routine monitoring of VOC contamination at well-characterized sites.

If during routine monitoring, new VOC(s) were detected by a non-GC/MS method, then at least 10 percent of the samples with each newly identified VOC should be confirmed by a GC/MS method. Thereafter, routine monitoring can resume with the non-GC/MS method, including the new analyte(s).

B. Methane and Hydrogen Sulfide Samples: These gas samples should be analyzed using methods specified in Section 2.7.9.

2.7.7 Auto samplers may be used if:

A. One (1) sample is introduced at a time;

B. The sample vials are gas-tight and never opened after the sample is added;

C. Proper holding times are maintained (see Section 2.7.5); and

D. All samples are secured and under proper custody.

2 7 8 Target Compounds

A. VOCs

1. ASGI-Targeted Compounds: The ASGI (dated February 25, 1997) includes 23 primary and four (4) other target VOCs. All quantifiable results should be reported.

2. Others: The estimated results of all Tentatively Identified Compounds [TICs]) or non-AGSI-targeted compounds detected should be included in the report. If TICs or non-ASGI-targeted compounds are identified, contact the Agency to determine whether additional action is required (e.g., running additional standards to quantify TICs or non-ASGI compounds) and whether the use of these estimated data for risk evaluation is appropriate.

B. Leak Check Compounds: All quantifiable results should be reported as specified in Section 2.4.4.E.

C. Specific Compounds: Based on the site history and conditions, analyses for specific compounds may be required by the Agency staff. Examples include:

1. In areas where USTs or fuel pipelines are identified, soil gas samples should be analyzed for oxygenated compounds [e.g., methyl tertiary butyl ether (MTBE), ethyl tertiary butyl ether (ETBE), di-isopropyl ether (DIPE), tertiary amyl methyl ether (TAME), tertiary butyl alcohol (TBA), and ethanol];

2. At oilfield sites where semi-VOCs or Total Petroleum Hydrocarbons (TPHs) are detected in the soil gas samples, fixed and biogenic gas (O_2, CO_2, and CH_4) data should be obtained using a Thermal-Conductivity Detector (TCD) or a hand-held instrument;

3. At petroleum contaminated sites (including oilfields), dairies, wetlands, landfills or other sites where the presence of methane and/or hydrogen sulfide is suspected, soil gas samples should be analyzed for methane and/or hydrogen sulfide;

4. At sites where use of chlorinated solvents with 1,4-dioxane is suspected or known to exist, soil gas samples may be analyzed for 1,4-dioxane with a detection limit of 1 μg/L; or

5. See Section 2.7.9.A.4 below.

2.7.9 Methane and Hydrogen Sulfide Sampling Programs: If the presence of methane and/or hydrogen sulfide is suspected, they should also be included in the analytical plan. After evaluating the initial soil gas data, the Agency may recommend that testing for methane or hydrogen sulfide cease.

A. Methane Sampling Program: Methane samples may be analyzed by a GC using modified EPA Method 8015B, EPA Method TO-3, or ASTM 3416M (EPA 3C), or by an appropriate hand-held instrument (e.g., Land Tech Gas Analyzer GA-90, Gas Emissions Monitor GEM-500, GEM-2000).

1. Detection Limit: The DL for methane analysis should not exceed 500 parts per million by volume (ppmv).
2. Methane Sample Containers: In addition to the gas-tight sample containers previously specified in Section 2.6.1, Tedlar™ bags may be used for collection of methane samples with a holding time of no more than 24 hours.
3. Methane Screening Level: When methane is detected at 1,000 ppmv or more, additional sampling and/or further investigation is recommended to identify the source(s).
4. At sites where methane is investigated and detected at a level of 5,000 ppmv or more, fixed and biogenic gas (O_2, CO_2, and CH_4) data should be obtained using a Thermal-Conductivity Detector (TCD) or a hand-held instrument.
5. To determine that the area is pressurized by migration of gases, pressure readings of each sampling tube system should be recorded in the field logs and reported along with the methane concentration.
6. Special GC Requirements: The GC method requires calibration curves for analytes such as methane since it is not a normal target analyte for such an analytical method.
7. Special Hand-Held Instruments Requirements: Hand-held instruments should be calibrated in accordance with the manufacture's instructions. When a hand-held instrument is used to analyze methane samples, the Agency recommends that at least 10 percent of all positive methane samples (e.g., more than 5,000 ppmv), rounded to the nearest whole number, be confirmed by another hand-held instrument (different unit or brand) or by a GC method.

B. Hydrogen Sulfide Sampling Program: Hydrogen sulfide may be analyzed by a GC using the South Coast Air Quality Management District (SCAQMD) Method 307-91 or EPA Method 16, or by an appropriate hand-held instrument (e.g., LTX-310 calibrated for hydrogen sulfide or Jerome 631-X).

1. Detection Limit: The DL should be equal to or less than 0.5 ppmv or be sensitive enough to allow for a modeled ambient air concentration (at least one microgram per cubic meter) at the soil surface.

2. Holding Time: Hydrogen sulfide samples should be extracted directly into a hand-held analyzer within 30 minutes of collection to minimize the risk of losing the hydrogen sulfide due to reaction with active surfaces. If a hand-held instrument is not used, hydrogen sulfide samples should be analyzed as below:

    a. Within 30 minutes of collection, using the GC procedures; or

    b. Within 24 hours of collection, if a surrogate is added to the samples, or 100 percent duplicate samples are collected.

3. Sample Containers: The following sample containers are recommended:

    a. Minimum one (1) liter black Tedlar™ bag fitted with polypropylene valves or the equivalent;

    b. 100-ml gas-tight syringe fitted with an inert valve and wrapped in aluminum foil;

    c. Gas-tight glass bulb wrapped in aluminum foil; or

    d. Glass-lined or silicon coated Summa™ canister.

4. Precautions

    a. Since hydrogen sulfide is extremely unstable in the presence of oxygen and moisture, contact of hydrogen sulfide samples with them should be avoided.

    b. Due to the high reactivity of hydrogen sulfide gas, contact of hydrogen sulfide samples with metallic or other non-passive surfaces should be avoided during sample collection, storage and analysis.

    c. Care must be taken so that GC components do not react with the sample. Typically glass-lined injection ports and Teflon™ tube packed columns are used to avoid loss of hydrogen sulfide due to reaction with active surfaces.

3.0 SOIL PARAMETERS

If the soil gas data will be used in a health risk assessment, an estimation of the indoor air concentration should be performed using soil gas data with an Agency approved or modified predictable indoor air model. Default values of input parameters may be used in accordance with the approved indoor air modeling guidance and in consultation with Agency staff. If default values are not used, site-specific soil parameters should be obtained as discussed below.

To assess health risk, indoor air quality, the threat of groundwater contamination from VOCs, or to evaluate the effectiveness of a proposed remedial technology, the following soil matrix parameters should be obtained from a minimum of three (3) sample locations (at depths* corresponding to or associated with the detected VOCs) for each soil type in association with the soil gas investigation:

3.1 Soil description performed and presented in accordance with the Unified Soil Classification System (USCS);

3.2 Density;

3.3 Organic carbon content of the soil** (by the Walkee Black Method);

3.4 Soil moisture;

3.5 Effective permeability***;

3.6 Porosity; and

3.7 Grain size distribution analysis (curve) and evaluation of fine-grained soil content (by wet sieve analysis and any supplementary methods as necessary) to determine the percent clay, silt and sand. (The grain size distribution analysis will be used to classify the soil in accordance with the U. S. Soil Conservation Service [SCS] soil type, which is the same as the U. S. Department of Agriculture soil type.)

* Samples may be collected from proposed depths at the continuously cored boring.

** This input parameter is required for soil matrix VOC samples only. This parameter sample should not be collected from an impacted area.

*** As an alternative, the measurements of saturated hydraulic conductivity may be used to estimate vapor permeability.

4.0 REFERENCES

Additional information may be found in the following documents:

American Society for Testing and Materials (ASTM), "Standard Guide for Soil Gas Monitoring in the Vadose Zone, ASTM Standard D 5314-92," January 1993; Reapproved 2001; website http://www.astm.org

California Regional Water Quality Control Board, Los Angeles Region, "Interim Guidance for Active Soil Gas Investigation," February 25, 1997

California Regional Water Quality Control Board, Los Angeles Region, "General Laboratory Testing Requirements for Petroleum Hydrocarbon Impacted Sites," June 22, 2000

U.S. Environmental Protection Agency, "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA Publication SW-846, Third Edition," November 1986, as amended by Updates I (Jul. 1992), II (Sep. 1994), IIA (August 1993), IIB (Jan. 1995), III (Dec. 1996), IIIA (Apr. 1998), IVA (Jan. 1998) and IVB (Nov. 2000); website http://www.epa.gov/SW-846/main.html

U.S. Environmental Protection Agency, "U.S. EPA Contract Laboratory Program National Functional Guidelines for Organic Data Review, EPA 540/R-94/012," February 1994; website http://www.epa.gov/region09/qa/superfundclp.html

U.S. Environmental Protection Agency, "Soil Gas Sampling, SOP#: 2042, Revision #: 0.0," June 1, 1996; website http://www.ert.org/respns_resrcs/sops.asp

U.S. Environmental Protection Agency, "Summa Canister Cleaning Procedures, SOP #1703, Rev. #: 0.0," 09/01/94; website http://www.ert.org/respns_resrcs/sops.asp

California Environmental Protection Agency (Cal/EPA), Office of Environmental Health Hazard (OEHHA), Toxicity Criteria Database; website http://www.oehha.ca.gov/risk/ChemicalDB/index.asp

United States Environmental Protection Agency, Integrated Risk Information System (IRIS) Database; website http://www.epa.gov/iris/

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FOR MORE INFORMATION

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Figures – Soil Gas Probe Emplacement Methods

Figure 1 – Permanent/Semi-permanent Gas Probe Construction Diagram

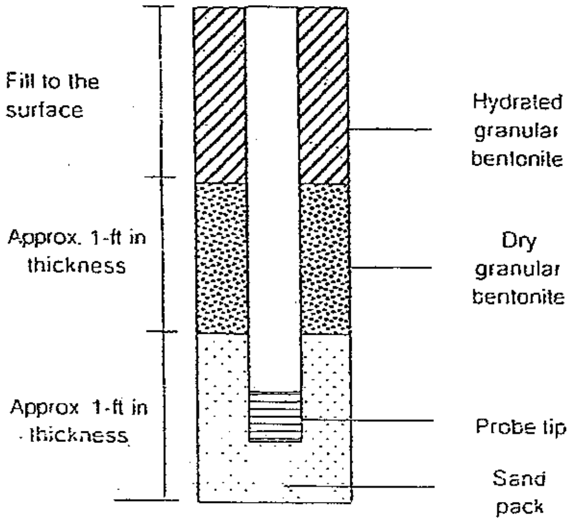
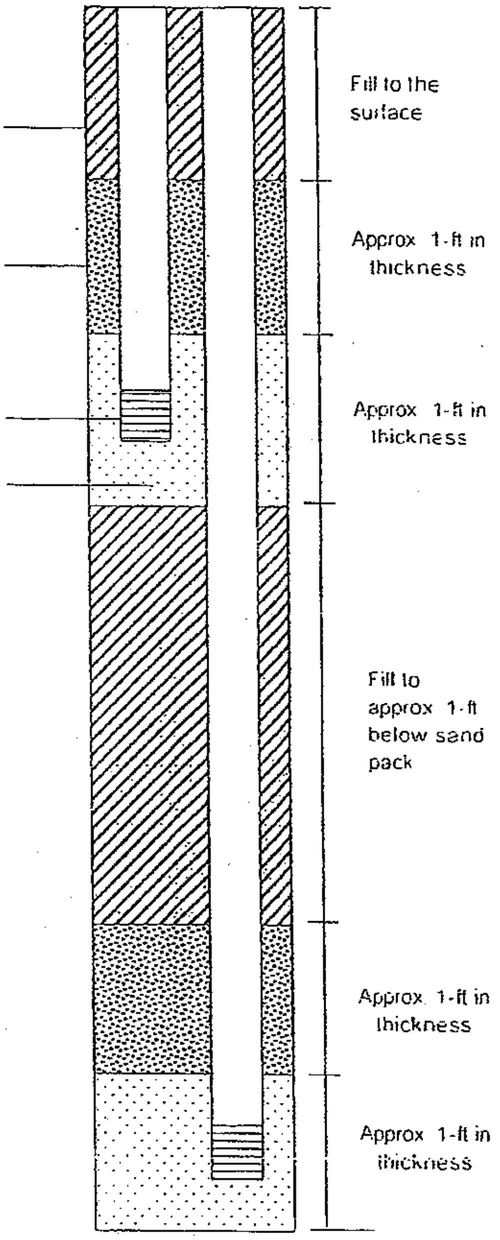
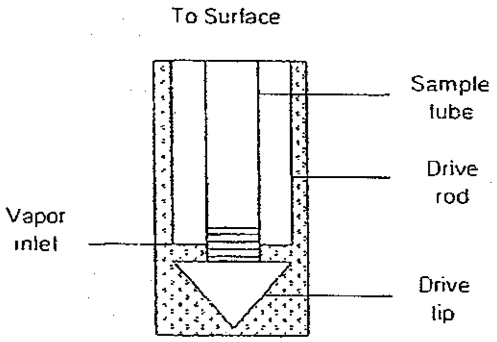


Figure 2 – Multi-depth Gas Probe Construction Diagram



Temporary Gas Probe Method



Attachment B
SOP

MOBILE GEOCHEMISTRY
H&P

Soil Vapor Standard Operating Procedures Fulfilling CA-EPA (DTSC) Soil Gas Advisory

Revision 4

January 2007

Prepared by:

H&P Mobile Geochemistry

Carlsbad, California

Soil Gas Sampling Procedures

Probe Construction and Insertion

Manually-Driven Probes

H&P's manually driven soil vapor probes are constructed of 0.625 inch outside diameter steel and equipped with a hardened steel tip. The probes can reach a depth of 5 feet below ground surface. An inert 1/8 inch nylaflow tube is threaded down the center of the probe and connected to a sampling port just above the tip. This internal sample tubing design eliminates any contact between the sample port and the gas sample.

The probe is driven into the ground by an electric rotary hammer. Once inserted to the desired depth, the probe is rotated approximately 3 turns to open the tip and exposes the vapor sampling ports. This design prevents clogging of the sampling ports and cross-contamination from soils during insertion.

Hydraulically-Driven Probes

H&P's hydraulically-driven soil vapor probes are constructed of either 1.25 or 1.5 inch outside diameter steel and equipped with a hardened drop-off steel tip. The probes are nominally 4 feet long and threaded together to reach multiple depths. The probe is driven into the subsurface with H&P's *STRATAPROBE*™ direct-push system. Once inserted to the desired depth, the probe is retracted slightly to expose the vapor sampling port. A small diameter inert tubing is then inserted through the center of the rod and threaded into a gas tight fitting just above the tip. After a sample is obtained the tubing is removed and the probe rod advanced to the next sampling depth or removed. This design prevents clogging of the sampling port and cross-contamination from soils during insertion.

Surface Seals

The probe rod is sealed at the surface with granular and hydrated bentonite for a minimum of 20 minutes before sampling.

Soil Gas Sampling

Soil vapor is withdrawn from the end of the inert nylaflow tubing that runs from the sampling tip to the surface using a 20 to 60 cubic centimeter (cc) syringe or gas tight canister (Summa) connected via an on-off valve (see diagram). The probe tip and sampling tubing is nominally purged of three to five internal dead volumes, or based upon a pre-determined purge volume established by a purge volume test described below. A sample of in-situ soil vapor is then withdrawn and immediately transferred to the mobile lab for analysis within minutes of collection. The use of small calibrated syringes allowed for careful monitoring of purge and sample volumes. This procedure ensures adequate sample flow is obtained without excessive pumping of air or introduction of surface air into the sample.

For off-site analysis, samples are collected in canisters or in tedlar bags when allowed. Samples collected in tedlar bags for VOC analysis are either analyzed on the same day or transferred to a canister.

Purge Volume Test

If required, a site specific purge volume test is conducted at the beginning of the soil gas survey to purge ambient air from the sampling system. Three different volumes are sampled (nominally 1, 3, 7 purge volumes) and analyzed immediately to determine the volume amount with the highest concentration. Therefore, the optimum purge volume is achieved and used during the entire site investigation.

Use of Tracer Compound to Ensure Probe Seal Integrity

A tracer compound, typically difluoroethane, iso-propanol, or butane, is used to test for leaks around the probe barrel at the ground surface and in the sampling system. The tracer is placed around the base of the probe barrel and at the top of the probe barrel during sample collection. If the tracer is detected per CA-EPA advisory specifications, another sample is collected.

Sample Flow Rate

Sample collection is timed so that the flow rate does not exceed 200 ml/per minute. This is accomplished by withdrawing the plunger on the 60 cc syringe at a constant rate for 20 seconds. The collector notes the collection time on a logsheet, and also records any resistance to sample flow that is felt on the syringe during collection.

Summa Canister

Summa canisters are connected to the end of the nylaflow tubing to the same three way valve used with the syringe. A choke is placed on the canister to ensure that the flow rate is no more than 200 ml/ per minute into the summa canister.

Field Records

The field technician maintains a logsheet summarizing:

- Sample identification
- Probe location
- Date and time of sample collection
- Sampling depth
- Identity of samplers
- Weather conditions
- Sampling methods and devices
- Soil gas purge volumes
- Volume of soil gas extracted
- Observation of soil or subsurface characteristics (any condition that affects sample integrity)
- Apparent moisture content (dry, moist or saturated etc.) of the sampling zone
- Chain of custody protocols and records used to track samples from sampling point to analysis.

Analytical Methodology

The following analytical protocols fulfills the both the CA-EPA advisory (2003) and LA-RWQCB soil gas analytical guidelines (1997).

Operating Conditions and Instrumentation

Volatile Organic Compounds (VOCs) by EPA 8260

Instrument: Hewlett-Packard 6890(6850)/5973 or 5890/5972 GCMS
Column: 25 meter HP-624, 0.20mm x 1.0u. capillary.
Carrier flow: Helium at 1.0 ml/min.
Detectors: Quadrupole MS, full scan mode
Concentrator: Tekmar 3000/Solatek 72

Volatile Organic Compounds (VOCs) by EPA TO-14 or TO-15

Instrument: Hewlett-Packard 6850/5973
Column: 60 meter HP-624, 0.32mm x 1.8u. capillary.
Carrier flow: Helium at 3.0 ml/min.
Detectors: Quadrupole MS, full scan mode
TO-14 Instrumentation: Entech 7100 Air Concentrator/Entech 7300 Autosampler

Fixed and Biogenic Gases (O2, CO2, & Methane)

Instrument: SRI 8610 or Carle AGC 311 Gas Chromatograph
Column: 6 foot CTR
Carrier flow: Helium at 15 ml/min.
Detectors: Thermoconductivity (TCD) for O2 & CO2.

Detectors: Flame ionization detector (FID) for methane.

Hydrogen Sulfide

Instrument: Jerome 631x
Detectors: Gold-film

Standard Preparation

Primary (stock) standards: Made from certified neat components or from traceable standards purchased from certified suppliers.

Secondary (working) Standards: Made by diluting primary standard. Typical concentrations are 1ug/ml, 10 ug/ml, and 50 ug/ml.

Laboratory Check Samples are prepared at the midpoint concentration from a standard purchased from a source different than the primary standards.

Lot numbers and preparations of all standards are recorded on a log sheet and kept in the mobile laboratory.

Gas Standards for TO-14A/15 analysis purchased from Spectra Gases, Branchburg, N.J. diluted from 1.0 ppmv to 10ppbv (for targets) and 1.0ppmv to 100ppbv (internal standards and surrogates

Initial Multi-Point Calibration Curve

An initial calibration curve of a minimum of 3 points is performed either:

- At the start of the project.
- When the GC column or operating conditions have changed
- When the daily mid-point calibration check cannot meet the requirements as specified below.
- For TO-15 a five point calibration is used.

Calibration curves for each target component are prepared by analyzing low, mid, and high calibration standards covering the expected concentration range. The lowest standard concentration will not exceed 5 times the reporting limit for each compound.

A linearity check of the calibration curve for each compound is performed by computing a correlation coefficient and an average response factor. If a correlation coefficient of 0.990 or a percent relative standard deviation (%RSD) of ± 15% is obtained, an average response factor is used over the entire calibration range. If the linearity criteria are not obtained, quantitation for that analyte is performed using a calibration curve.

After each initial multi-point calibration, the validity of the curve is further verified with a laboratory control standards (LCS) prepared at the mid-point of the calibration range. The LCS includes all target compounds and the response factor (RF) must fall within ± 20% of the factor from the initial calibration curve.

Continuing Calibration (Daily Mid-point Calibration Check)

Continuing calibration standards prepared from a traceable source are analyzed at the beginning of each day. Acceptable continuing calibration agreement is set at ± 20% to the average response factor from the calibration curve, except for freon, chloroethane, and vinyl chloride when a 25% agreement is required. When calibration checks fall outside this acceptable range for analytes detected on the site, corrective action, consisting of verification of the standard and/or a new calibration curve for the analytes out of specifications is performed by the on-site chemist.

The continuing calibration includes all compounds expected or detected at the site in addition to any specific compounds designated in the project workplan.

Detection Limits

Reporting limits for this program are defined as 5 times lower than the lowest concentration standard of the calibration curve, as follows:

Compound	Detector	Report Limit
VOCs by TO-14A/15	Mass Spec	1.0 to 5 ppbv
VOCs	Mass Spec	0.1 to 1 ug/l-vapor
Methane	FID	10 ppmv
Fixed Gases	TCD	0.1% by vol
H2S	Gold Film	0.10 ppmv

Injection of Soil Gas Samples

Vapor samples are withdrawn from the probe sampling syringe with a 5 cc syringe and injected with surrogates into a purge & trap instrument for VOC analysis. Separate aliquots are directly injected into gas chromatographs for fixed gases and methane analysis. The injection syringe is flushed 2 times with the sample prior to injection. Injection syringes are flushed several times with clean air or discarded between injections.

TO-14A/15 samples are taken into Summa or similar passivated canisters. Holding time for these canisters is 30 days.

Laboratory Data Logs

The field chemist maintains injection and sample analysis records including date and time of analysis, sampler's name, chemist's name, sample ID number, concentrations of compounds detected, calibration data, and any unusual conditions.

Quality Control Procedures

Compliance With Standards

Sampling and analytical procedures complied with the American Society for Testing and Materials' *Standard Guide for Soil Gas Monitoring in the Vadose Zone* (ASTM D5314-93), the LA-RWQCB Soil Gas Guidelines (Feb 1997 version), and the San Diego County SAM Soil Gas Guidelines (October, 2001).

Sampling Quality Control

Method Blanks

Prior to sampling each day, all components of the sampling system are checked for contamination by drawing ambient air from above ground through the sampling equipment, and injecting a sample into a gas chromatograph. The analysis results are compared to that of the ambient air and recorded in the data tables as blanks.

Sample Quality Control

Each sample is given a unique identification number specifying location and depth. Purge and sample volumes are monitored closely using small calibrated syringes to assure a proper flow of soil gas. This ensures a representative sample is obtained from the sample zone without excessive pumping, which could result in sampling of surface air.

Decontamination Procedures

To minimize the potential for cross-contamination between sites, all external soil vapor probe parts are wiped or washed cleaned of excess dirt and moisture with solvents or de-ionized water as appropriate. The probe's internal nylaflow tubing is purged with clean air between sampling locations or replaced as necessary. Sampling syringes are flushed with clean air after each use or replaced.

Corrective Action

Corrective action is taken when unexpected contaminant levels are detected. First duplicate samples are taken to verify the initial detection of petroleum hydrocarbons. If contamination is suspected, then the sample probes are disassembled, wiped cleaned of excess dirt and moisture, rinsed with deionized water, washed with Alconox and water, and rinsed again with deionized water. The sample tubing in the probe is replaced. Contaminated sampling syringes are discarded.

Analytical Quality Control

Method Blanks

Method blanks are performed at the start of each day by drawing clean air through the sampling equipment and analyzing. These blanks verify all components of the sampling and analytical system are free of contamination. Additional blanks are performed more often as appropriate depending upon the measured concentrations, at a minimum 1 every 20 samples. The results of all blank analyses are recorded in the data tables. If a blank shows a measurable amount of any target compound, the on-site chemist will investigate and determine the source, and resolve the contamination problem prior to analyzing any samples.

Duplicate Samples

Duplicate (repetitive) analysis of a sample is performed when inconsistent data are observed, but at least one every 20 samples. Because soil vapor duplicates can vary widely, nominal relative percent difference (RPD) acceptance criteria is ± a factor of 2.

Continuing Calibration (Daily Mid-point Calibration Check)

As described on page 5 of this document, continuing calibration standards prepared from a traceable source are analyzed at the beginning of each day.

The continuing calibration includes all compounds expected or detected at the site and any specific compounds designated in the project workplan.

Laboratory Check Samples (LCS)

Laboratory check samples, prepared at the lowpoint concentration from a standard purchased from a source different than the calibration standards, are analyzed at the end of each day if all samples are below detection. Acceptance criteria is ± 20% from the true value. If the LCS falls outside this acceptance range for analytes detected on site, corrective action, consisting of verification of the standard and/or a new calibration curve for the analytes out of specifications, is performed.

Attachment C

Proposed Timeline

Days from Agency Response			120 days		90 days		60 days		120 days		90 days		150 days
Task													
Prepare Work Plan	Completed 12/17	Waiting on Agency Concurrence	Site Investigation, evaluation, and reporting	Waiting on Agency Concurrence	Prepare revised CAP including remediation goals	Waiting on Agency Concurrence	Preparation of Feasibility Testing Work Plan	Waiting on Agency Concurrence	Feasibility testing, evaluation, and reporting	Waiting on Agency Concurrence	Preparation of Remdial Action Plan	Waiting on Agency Concurrence	Remedial System Design, installation and start-up
Prepare Site Conceptual Model	Completed 12/17												

Attachment D

Revised Mass Calculations

Residual Mass Calculations in Soil

76 Station 1156

4276 MacArthur Blvd., Oakland, CA

Constituent of Concern	Area of Concern (feet^2)	Depth of soil sample (feet bgs)	Volume of Concern (feet^3)	Average Concentration (within Impacted region) (mg/kg)	Density of Soil (grams /cm^3)	Residual Mass Remaining (pounds)
TPH-G	8,694	7-9	5,216	570	1.20	222
TPH-G	2,661	12-17	3,992	910	1.20	272

total mass of contaminants in soil (pounds)	494.22

Notes:
Soil concentrations based on previous site investigations.
Volume of concern based on area times soil depth at sample collection times porosity
Mass= (volume * (1728 in^3 / ft^3) * (16.38 cm^3 / in^3)) * (density) * (concentration)* (1 kg/10^6 mg) * (1pound/ 454 grams)
porosity of clay 0.30
Soil mass based on various depths from previous sample points
Benzene was at low levels at the 15 foot bgs level, MtBE was at low levels
soil data observed at 7-9 foot region
soil data observed at 12-17 foot region