
State Water Resources Control Board

TO: Gerald W. Bowes, Ph.D.
Manager, Cal/EPA Scientific Peer Review Program
OFFICE OF RESEARCH, PLANNING AND PERFORMANCE

FROM: Kevin Graves, P.E.
Manager, UST Program Section
DIVISION OF WATER QUALITY

DATE: December 8, 2011

SUBJECT: FINAL REQUEST FOR EXTERNAL PEER REVIEWERS OF THE SCIENTIFIC BASIS OF THE TECHNICAL JUSTIFICATION FOR THE PROPOSED LOW-THREAT UST CLOSURE POLICY

The purpose of this letter is to request external scientific peer reviewers of the technical justification for proposed *Low-Threat UST Closure Policy, 11-10-11* (Policy). The Policy is focused on unauthorized releases of petroleum fuels from Underground Storage Tanks (USTs). Peer reviewers are asked to review the scientific basis and scientific portion of the technical justification for proposed Policy and determine whether the technical justification and literature cited, are based on sound scientific knowledge, methods, and practices.

Included with this cover letter are eight attachments as follows:

1. Attachment 1: Description of Proposed Action
2. Attachment 2: Findings, Assumptions and Conclusions to be Reviewed
3. Attachment 3: List of Participants Involved in Developing the Proposed Low-Threat UST Closure Policy Directly or Indirectly
4. Attachment 4: Low-Threat UST Closure Policy, 11-10-11
5. Attachment 5: Technical Justification for Groundwater Media-Specific Criteria
6. Attachment 6: Technical Justification for Vapor Intrusion Media-Specific Criteria
7. Attachment 7: Technical Justification for Soil Screening Levels for Direct Contact and Outdoor Air Exposure Pathways
8. Attachment 8: References (To be provided on CD)

We suggest that you solicit reviewers with expertise in the following areas:

- Geology and Hydrogeology
- Petroleum Fate and Transport in Soil and Groundwater
- Natural Attenuation of Petroleum
- Vapor Intrusion
- Risk Assessment/Toxicology

Expected Date of State Water Resources Control Board Action:

The State Water Resources Control Board is expected to formally consider the proposed Policy during its March 2012 meeting. In order to meet this schedule, we request receipt of the peer reviewer's comments by January 31, 2012.

Contact Information:

Please contact me if you have questions.
Kevin Graves Kgraves@waterboards.ca.gov
(916) 341-5782

Sincerely,

A handwritten signature in black ink, appearing to read "Kevin L. Graves". The signature is fluid and cursive, with a long horizontal stroke at the end.

Kevin L. Graves, Chief
UST Program Section

Attachments (8)

cc: Victoria A. Whitney
Deputy Director
Division of Water Quality

Attachment 1

Description of Proposed Action

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

The State Water Resources Control Board (State Water Board) proposes to adopt a Low-Threat UST Closure Policy (Policy). The purpose of the Policy is the establishment of low-threat petroleum site closure criteria. The Policy is consistent with existing statutes, regulations, State Board precedential decisions and resolutions, and is intended to provide clear direction to responsible parties, their service providers, and regulatory agencies. The Policy seeks to increase UST cleanup process efficiency. A benefit of improved efficiency is the preservation of limited resources for mitigation of releases posing a greater threat to human and environmental health.

The Policy is a state policy for water quality control and applies to all sites governed by Health and Safety Code Section 25296.10. The term "regulatory agencies" in the Policy means the State Water Board, Regional Water Boards and local agencies authorized to implement Health and Safety Code Section 25296.10.

Attachment 2

Findings, Assumptions and Conclusions to be Reviewed

The statute mandate for external scientific peer review (Health and Safety Code Section 57004) states that the reviewer's responsibility is to determine whether the scientific portion of the proposed rule is based upon sound scientific knowledge, methods, and practices.

We request that you make this determination for each of the following assertions that constitute the scientific basis of the proposed regulatory action.

This attachment consists of ten assertions to be addressed. The assertions are arranged in three groups that correspond to similar sections in the Policy and supporting technical justification document. We are requesting that each assertion be addressed in its entirety, as expertise allows, in the order presented.

Assertions for Groundwater

Note: For further explanation and additional information concerning the assertions in the groundwater section below, refer to: Technical Justification for Groundwater Media-Specific Criteria (Attachment 5).

1. It has been well established that natural attenuation processes tend to stabilize the spreading of petroleum plumes in groundwater. Biodegradation reduces dissolved petroleum concentrations over time and ultimately can restore groundwater to below regulatory objectives.

Biodegradation/natural attenuation of petroleum hydrocarbon and oxygenate plumes has been documented by many researchers since the 1990s. This body of work demonstrates that biodegradation/natural attenuation of petroleum hydrocarbons and MTBE occurs under both aerobic and anaerobic conditions. The rate of degradation/attenuation depends on the constituent and the plume bio/geochemical conditions.

Various researchers have conducted multi-site studies of groundwater plume lengths at petroleum release sites across the United States. These studies considered sites where active remediation was performed and sites where no active remediation was performed. Many studies focused on benzene plumes while others focused on both benzene and oxygenate plumes, including MTBE.

This is further discussed in Attachment 5.

2. The Policy requires a separation distance from the edge of a stabilized petroleum plume to an existing well that is more protective than Department of Water Resources (DWR) well standards.

This use of separation distances is consistent with other State and local practices regarding impacts to groundwater caused by other anthropogenic releases. For example, State and local agencies establish required separation distances or "setbacks" between water supply wells and septic system leach fields (typically 100 feet), and sanitary sewers (typically 50 feet; [DWR 1991]).

This is further discussed in Attachment 5.

3. The required separation distances from the edge of a plume to an existing well combined with the requirement for plume stability will protect existing wells from impacts unless unique site specific conditions exist.

This Policy describes criteria on which to base a determination that risks to existing and anticipated future beneficial uses of groundwater have been mitigated or are de minimus. If groundwater with a designated beneficial use is affected by an unauthorized release, to satisfy the media-specific criteria for groundwater, the contaminant plume that exceeds water quality objectives must be stable or decreasing in areal extent, and meet all of the additional characteristics of one of the five classes of sites. A plume that is “stable or decreasing” is a contaminant mass that has expanded to its maximum extent: the distance from the release where attenuation exceeds migration.

Stabilized petroleum plumes are not expected to impact the nearest existing water supply well and/or surface water body located within the separation distances described in the four low-threat classes. Refer to the Policy document (Attachment 4) to find the four low-threat classes.

This is further discussed in Attachment 5.

Assertions for Vapor Intrusion

Note: For further explanation and additional information concerning the assertions in the vapor intrusion section below, refer to:

- I. **Appendices 1 through 4 from the Policy document (Attachment 4); and**
- II. **Technical Justification for Vapor Intrusion Media-Specific Criteria (Attachment 6).**

4. The framework for the petroleum vapor intrusion evaluation, which considers the effect of vadose-zone bioattenuation processes, is appropriate for use at UST release sites.

Petroleum hydrocarbons rapidly biodegrade in the presence of Oxygen (O_2) (i.e., when conditions in the unsaturated zone are aerobic). The significance of biodegradation will depend largely on availability of O_2 and the demand for O_2 caused by the biodegradation reaction. One of the critical factors affecting O_2 demand is source strength/type (e.g., light non-aqueous-phase liquid (LNAPL) or dissolved phase). Recent modeling and field studies show that bioattenuation of petroleum hydrocarbons at retail sites can be significant (Abreu et al., 2009; Davis, 2009; Lahvis, 2011). Petroleum hydrocarbon volatile organic compounds (VOCs) (such as, benzene, toluene, ethylbenzene and xylenes [BTEX]) concentrations have been shown to attenuate by 4 to 6 orders of magnitude within a short vertical distance (e.g., < 2 m) in the unsaturated zone. The bioattenuation zone is defined as the part of the unsaturated zone where there is sufficient oxygen to support biodegradation of the hydrocarbons.

The characteristic occurrence of rapid hydrocarbon attenuation in the unsaturated zone is amenable to a site-screening methodology for vapor intrusion based on exclusion distances. Exclusion distances are defined as VOCs source-receptor (building) separation distances beyond which vapor intrusion risks are assumed negligible. Exclusion distances are broadly

defined for two source scenarios: (i) low-concentration sources, such as those expected from dissolved-phase groundwater plumes and (ii) high-concentration sources that may be present when light non-aqueous-phase liquid (LNAPL) is present. Different exclusion distances are utilized for these source scenarios, because the thickness of the bioattenuation zone required to degrade hydrocarbons to below levels of concern will be different for low- and high concentration sources.

This is further discussed in Attachment 6.

5. A 30-foot source-receptor separation distance used for LNAPL (high-concentration) source sites is conservative [Appendix 1 and 2 of the Policy]

The 30-ft. exclusion distance is conservative based on both modeling results and field data analysis. Model results show greater than 9 orders of magnitude (i.e., relatively complete) attenuation of benzene between soil gas and indoor air (i.e., an attenuation factor between soil-gas and indoor air ($\alpha > 1E-09$) within 7 m (~ 20 ft.) of a high concentration LNAPL source assuming reasonable approximations of the biodegradation rate (Abreu et al., 2009). Field (soil-gas) data show benzene and TPH are attenuated to levels below analytical reporting limits within 8 ft. of a LNAPL or residual source (R. Davis (2010) – also published in Hartman (2010)).

Risk-based screening levels calculated by the California EPA Office of Environmental Health Hazard Assessment (OEHHA) California Human Health Screening Level (CHHSL) can be used to put some of the modeling results and field study results in perspective. The CHHSL for benzene in soil gas for a residential building on engineered fill (i.e. new construction) is $85 \mu\text{g}/\text{m}^3$. An analysis of field data by Lahvis (2011) shows a greater than 95% probability that benzene concentrations in soil gas will attenuate below $100 \mu\text{g}/\text{m}^3$ (alternatively, there is less than a 5 % probability of observing benzene concentrations exceeding $100 \mu\text{g}/\text{m}^3$) at distances more than 13 ft. from a LNAPL (residual or free-phase) source.

The proposed 30-ft. off-set distance is even more conservative for sources displaced laterally as indicated in Abreu and Johnson (2005). As discussed in the technical background section 3.2.2, 13 ft. to 20 ft. is sufficient to attenuate hydrocarbons migrating from LNAPL sources in soil and groundwater to below levels of concern. Therefore, a 30 ft. lateral exclusion distance is very conservative.

This is further discussed in Attachment 6.

6. The dissolved phase concentrations and proposed exclusion distances specified in scenarios below are conservative (low-concentration sources) [Appendix 3 of the Policy]

- i. **A 5-ft. bioattenuation zone is used for sites with benzene groundwater concentrations $<100 \mu\text{g}/\text{l}$, no soil impacts, and low ($<4\%$) soil gas oxygen concentrations (or no soil gas oxygen measurements), or**
- ii. **A 10-ft. bioattenuation zone is used for sites with benzene groundwater concentrations $<1000 \mu\text{g}/\text{l}$, no soil impacts, and low ($<4\%$) soil gas oxygen concentrations (or no soil gas oxygen measurements), or**
- iii. **A 5-ft. bioattenuation zone is used for sites with benzene groundwater concentrations $<1000 \mu\text{g}/\text{l}$, no soil impacts, and soil gas oxygen concentrations $\geq 4\%$.**

Field soil-gas data show vapor concentrations attenuating below analytical reporting limits within 5 ft. of benzene sources in groundwater (benzene concentrations in groundwater up to 6,000 µg/l) (Davis, 2009). Review of field soil-gas data for gasoline sites from Davis (2009) and Wright (2011) show benzene concentrations in soil gas attenuate below 80 µg/m³ and 20 µg/m³ within 10 ft. of the water table for dissolved-phase benzene source concentrations up to 1,000 µg/l and 100 µg/l, respectively. Once again, for reference, the CHHSL for benzene in soil gas for a residential building on engineered fill is 85 µg/m³.

Examining the distribution of field soil gas results, there is less than a 5% probability of benzene vapor concentrations exceeding 50 µg/m³ more than 5 ft. from the source at gasoline sites with benzene concentrations in groundwater <1,000 µg/l. There is less than a 5% probability of benzene vapor concentrations near building foundations exceeding 10 µg/m³ at gasoline sites with benzene concentrations in groundwater <100 µg/l regardless of the source-receptor separation distance (Lahvis - written communication). The field data indicate that the water table would have to essentially be in contact with a building foundation for there to be a potential concern for vapor intrusion at low concentration sites.

Modeling studies also predict that biodegradation will be sufficient to attenuate the concentrations to below conservative screening levels. Results from Abreu et al. (2009) shows >9 orders of magnitude attenuation (for reasonable approximations of the biodegradation rate $\lambda = 0.79 \text{ hr}^{-1}$) within a source/building separation distance of $L=3 \text{ m}$ (10 ft.) in a sand unsaturated zone. Abreu et al. (2009) also indicates that even greater hydrocarbon attenuation (which would lead to smaller exclusion distances) are predicted for dissolved-phase sources in less permeable (e.g., silty clay) unsaturated zone systems.

Note that the concentrations/distances available from the literature review do not match with the values used in the Policy, because details of the different studies vary. However, the dissolved phase concentrations and proposed exclusion distance specified in scenario (iii) are conservative compared to the conclusions reached in the published literature.

This is further discussed in Attachment 6.

7. Application of an additional attenuation factor of 1000x to risk-based soil-gas criteria (i.e. vapor sources) located 5 ft. from a building foundation is conservative [Appendix 4 of the Policy]

Abreu et al. (2009) model results show that vadose-zone biodegradation reduces predicted indoor air benzene concentrations by approximately 10,000x with a 2 m separation distance between the source and building foundation for soil-gas up to 10,000,000 µg/m³. Field soil-gas (benzene) concentrations from Davis (2009) and Wright (2011) collected from vertically nested vapor probes support the model predictions (Lahvis - written communication). More specifically, the field data for gasoline sites show benzene attenuation in the unsaturated zone generally exceeds 1000x within a 5 ft. vertical distance of benzene (source) soil-gas concentrations ranging between 10,000 and 100,000 µg/m³ (Lahvis - written communication). Similar attenuation is observed for benzene soil gas (source) concentrations ranging between 100,000 and 1,000,000 µg/m³. The soil-gas data are from the databases described by Davis (2009) and Wright (2011) for retail-only locations. This finding supports the model theory of Abreu et al. (2009) and indicates that the proposed soil-gas bioattenuation factor of 1000x is conservative.

The proposed 1000x additional attenuation for benzene concentrations in soil gas up to 85,000 and 280,000 $\mu\text{g}/\text{m}^3$ located 5 ft. or greater from a building foundation is thus deemed conservative for residential and commercial settings, respectively.

This is further discussed in Attachment 6.

Assertions for Direct Contact

Note: For further explanation and additional information concerning the assertions in the direct contact section below, refer to: Technical Justification for Soil Screening Levels for Direct Contact and Outdoor Air Exposure Pathways (Attachment 7).

8. The equations used to develop the soil screening levels are appropriate.

Soil Screening Levels discussed in the Policy have been developed for benzene, ethylbenzene, naphthalene, and polyaromatic hydrocarbon (PAH) to define sites that are low-threat with respect to direct contact with soil and inhalation of soil emissions. The exposure pathways considered in the site conceptual model are: ingestion of soil, dermal contact with soil and inhalation of dust and volatile emissions from soil. Note these exposure pathways are assumed to occur simultaneously, i.e. the screening levels are protective of the cumulative exposure from all four exposure pathways.

Standard USEPA risk assessment equations were used to derive the screening levels. The equations used to develop the screening criteria are based on USEPA Regional Screening Level (RSLs) equations with one modification – the volatilization factor. The volatilization factor used in the RSLs was replaced with a volatilization factor obtained from the American Society of Testing Material's (ASTM's) Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites (ASTM 1995). The ASTM volatilization factor used to calculate concentrations in outdoor air considers mass balance. The volatilization algorithm commonly used in USEPA screening level equations can overestimate the amount of contaminant volatilizing into outdoor air for volatile chemicals (OEHHA, 2005). In the ASTM volatilization algorithm, if the calculated volatilization rate depletes the source before the end of the exposure duration, then the volatilization rate is adjusted so that the total source mass is assumed to volatilize by the end of the exposure duration. By using this simple mass-balance check, it is ensured that the total amount volatilized does not exceed the total amount of contaminant in soil.

This is further discussed in Attachment 7.

9. The Input parameters used to develop the soil screening levels are appropriate.

Soil Screening levels were calculated for three exposure scenarios, and then the most conservative screening level was chosen for the screening level. The exposure scenarios considered were:

- residential,
- commercial/industrial, and
- workers in a utility trench or similar construction project.

The input parameter values are different for each receptor. Exposure parameters values were assumed to equal the defaults values used in California Department of Toxic Substances (DTSC) Office of Human and Ecological Risk (HERO) "Human Health Risk Assessment (HHRA)

Note Number 1" (DTSC 2011). The Soil Screening Levels presented in this document are conservative because the assumptions used to calculate the values are based on conservative assumptions and exposure scenarios.

This is further discussed in Attachment 7.

10. The use of benzo(a)pyrene (BaP) toxicity to represent all of the polyaromatic hydrocarbons (PAHs) is conservative.

Benzo(a)pyrene is the most toxic of the USEPA seven carcinogenic PAHs it was reasonable to represent the toxicity of the entire group of carcinogenic PAHs with benzo(a)pyrene's toxicity value. The soil screening level for "PAH" is appropriate to be compared with site concentrations for the total concentration of the seven carcinogenic PAHs. The carcinogenic PAHs are: benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-cd)pyrene. The toxicity value used for the entire group of carcinogenic hydrocarbons is California's Office of Environmental Health Hazard Assessment (OEHHA) cancer potency value for benzo(a)pyrene (OEHHA 2010). This is a conservative assumption because the few PAHs that are more carcinogenic than benzo(a)pyrene are not found in petroleum mixtures.

This is further discussed in Attachment 7.

The Big Picture

Reviewers are not limited to addressing only the specific issues presented above, and are asked to contemplate the following questions.

- (a) In reading the three technical justification documents, and literature cited, are there any additional scientific issues that are part of the scientific basis not described above? If so, please comment with respect to the statutory language given above.
- (b) Taken as a whole, is the scientific portion of the proposed Policy based upon sound scientific knowledge, methods, and practices?

Reviewers should also note that some proposed actions may rely significantly on professional judgment where available scientific data are not as extensive as desired to support the statute requirement for absolute scientific rigor. In these situations the proposed course of action is favored over no action.

Attachment 3**List of Participants Involved in Developing the Proposed
Low-Threat UST Closure Policy Directly or Indirectly**

Name	Organization
Stakeholder Group Members	
Dave Arrieta	Western States Petroleum Association
Jay McKeeman	California Independent Oil Marketers Association
Ravi Arulanantham	GeoSyntec
Roy Herndon	Orange County Water District
David Noren	North Coast Regional Water Quality Control Board, Board Member
Kurt Berchtold	Santa Ana Regional Water Quality Control Board, Executive Officer
Barry Marcus	Sacramento County Local Oversight Program
Stephanie Shakofsky	Center for Creative Land Recycling
Markus Niebanck	Sierra Club
 State Water Resources Control Board (SWRCB) and Regional Water Quality Control Board (RWQCB) Staff	
Kevin Graves	SWRCB Staff
Vicky Whitney	SWRCB Staff
Ben Wright	SWRCB Staff
Lori Brock	SWRCB Staff
Stephen Hill	RWQCB (San Francisco Bay) Staff
 Other Contributors	
Lynn Spence	Spence Environmental Engineering
Blayne Hartman	Hartman Environmental Geoscience
Dawn Zemo	Zemo and Assoc.
Adrienne Barnes	Sullivan Group
Curt Stanley	Shell Global Solutions
Paul Johnson	Arizona State University
Matt Lahvis	Shell Global Solutions
George DeVaul	Shell Global Solutions
Robert Cheung	GeoSyntec
Bill Bosan	California Department of Toxic Substance Control

Attachment 4

Low-Threat UST Closure Policy 11-10-11

Preamble

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

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

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

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

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

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

The purpose of this policy is the establishment of low-threat petroleum site closure criteria. The policy is consistent with existing statutes, regulations, State Board precedential decisions and resolutions, and is intended to provide clear direction to responsible parties, their service

providers, and regulatory agencies. The policy seeks to increase UST cleanup process efficiency. A benefit of improved efficiency is the preservation of limited resources for mitigation of releases posing a greater threat to human and environmental health.

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

This policy is a state policy for water quality control and applies to all sites governed by Health and Safety Code section 25296.10. The term "regulatory agencies" in this policy means the State Water Board, regional water boards and local agencies authorized to implement Health and Safety Code section 25296.10.

Definitions: Unless expressly provided in this policy, the terms in this policy shall have the same definitions provided in Chapter 6.7 of Division 20 of the Health and Safety Code and Chapter 16 of Division 3 of Title 23 of the California Code of Regulations.

Criteria for Low-Threat Case Closure

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

It is important to emphasize that the criteria described in this policy do not attempt to describe the conditions at all low-threat sites in the State. Regulatory agencies should issue a closure letter for a case that does not meet these criteria if the site is determined to be low-threat based upon a site specific analysis.

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

General Criteria

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

- a. The unauthorized release is located within the service area of a public water system;
- b. The unauthorized release consists only of petroleum;

- c. The unauthorized ("primary") release from the UST system has been stopped;
- d. Free product has been removed to the maximum extent practicable;
- e. A conceptual site model has been developed;
- f. Secondary source removal has been addressed;
- g. Soil or groundwater has been tested for MTBE and results reported in accordance with Health and Safety Code section 25296.15; and
- h. Nuisance as defined by Water Code section 13050 does not exist at the site.

a. The unauthorized release is located within the service area of a public water system

This policy is protective of existing water supply wells. New water supply wells are unlikely to be installed in the shallow groundwater near former UST release sites. However, it is difficult to predict, on a statewide basis, where new wells will be installed, particularly in rural areas that are undergoing new development. This policy is limited to areas with available public drinking water supplies to reduce the likelihood that new wells in developing areas will be inadvertently impacted by residual petroleum in groundwater. Case closure outside of areas with a public water supply should be evaluated based upon this policy and a site specific evaluation of developing water supplies in the area.

b. The unauthorized release consists only of petroleum

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

c. The unauthorized release has been stopped

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

d. Free product has been removed to the maximum extent practicable

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

- (a) Free product shall be removed in a manner that minimizes the spread of the unauthorized release into previously uncontaminated zones by using recovery and disposal techniques appropriate to the hydrogeologic conditions at the site, and that properly treats, discharges or disposes of recovery byproducts in compliance with applicable laws;
- (b) Abatement of free product migration shall be used as a minimum objective for the design of any free product removal system; and
- (c) Flammable products shall be stored for disposal in a safe and competent manner to prevent fires or explosions.

e. A conceptual site model has been developed

The Conceptual Site Model (CSM) is a fundamental element of a comprehensive site investigation. The CSM establishes the source and attributes of the unauthorized release, describes all affected media (including soil, groundwater, and soil vapor as appropriate), describes local geology, hydrogeology and other physical site characteristics that affect

contaminant environmental transport and fate, and identifies all confirmed and potential contaminant receptors (including water supply wells, surface water bodies, structures and their inhabitants, etc.). The CSM is relied upon by practitioners as a guide for investigative design and data collection. Petroleum release sites in California occur in a wide variety of hydrogeologic settings. As a result, contaminant fate and transport and mechanisms by which receptors may be impacted by contaminants vary greatly from location to location. Therefore the CSM is dynamic and unique to each individual release site. All relevant site characteristics identified by the CSM should be assessed such that the nature, extent and mobility of the release have been established to determine conformance with applicable criteria in this policy.

f. Secondary source removal has been addressed

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

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

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

h. Nuisance as defined by Water Code section 13050 does not exist at the site

Water Code section 13050 defines "nuisance" as anything which meets all of the following requirements:

- (1) Is injurious to health, or is indecent or offensive to the senses, or an obstruction to the free use of property, so as to interfere with the comfortable enjoyment of life or property.
- (2) Affects at the same time an entire community or neighborhood, or any considerable number of persons, although the extent of the annoyance or damage inflicted upon individuals may be unequal.
- (3) Occurs during, or as a result of, the treatment or disposal of wastes.

Media-Specific Criteria

Releases from USTs can impact human health and the environment through contact with any or all of the following contaminated media: groundwater, surface water, soil, and soil vapor. Although this contact can occur through ingestion, dermal contact, or inhalation of the various media, the most common drivers of health risk are ingestion of groundwater from drinking water wells, inhalation of vapors accumulated in buildings, contact with near surface contaminated

soil, and inhalation of vapors in the outdoor environment. To simplify implementation, these media and pathways have been evaluated and the most common exposure scenarios have been combined into three media-specific criteria:

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

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

1. Groundwater

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

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

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

It is a fundamental tenet of this low-threat closure policy that if the closure criteria described in this policy are satisfied at a release site, water quality objectives will be attained through natural attenuation within a reasonable time, prior to the need for use of any affected groundwater.

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

- (1) a. The contaminant plume that exceeds water quality objectives is less than 100 feet in length.
 - b. There is no free product.
 - c. The nearest existing water supply well and/or surface water body is greater than 250 feet from the defined plume boundary.
- (2) a. The contaminant plume that exceeds water quality objectives is less than 250 feet in length.
 - b. There is no free product.
 - c. The nearest existing water supply well and /or surface water body is greater than 1000 feet from the defined plume boundary.
 - d. The dissolved concentration of benzene is less than 3000 µg/l and the dissolved concentration of MTBE is less than 1000 µg/l.
- (3) a. The contaminant plume that exceeds water quality objectives is less than 250 feet in length.
 - b. Free product has been removed to the maximum extent practicable, may still be present below the site, but does not extend off-site.
 - c. The plume has been stable or decreasing for a minimum of five years.
 - d. The nearest existing water supply well and/or surface water body is greater than 1000 feet from the defined plume boundary.
 - e. The property owner is willing to accept a deed restriction if the regulatory agency requires a deed restriction as a condition of closure.
- (4) a. The contaminant plume that exceeds water quality objectives is less than 1000 feet in length.
 - b. There is no free product.
 - c. The nearest existing water supply well and/or surface water body is greater than 1000 feet from the defined plume boundary.
 - d. The dissolved concentration of benzene is less than 1000 µg/l and the dissolved concentration of MTBE is less than 1000 µg/l.
- (5) a. An analysis of site specific conditions determines that the site under current and reasonably anticipated near-term future scenarios poses a low threat to human health and safety and to the environment and water quality objectives will be achieved within a reasonable time frame.

Sites with Releases That Have Not Affected Groundwater

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

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

2. Petroleum Vapor Intrusion to Indoor Air

Exposure to petroleum vapors migrating from soil or groundwater to indoor air may pose unacceptable human health risks. This policy describes conditions, including bioattenuation zones, which if met will assure that exposure to petroleum vapors in indoor air will not pose unacceptable health risks. In many petroleum release cases, potential human exposures to

vapors are mitigated by bioattenuation processes as vapors migrate toward the ground surface. For the purposes of this section, the term “bioattenuation zone” means an area of soil with conditions that support biodegradation of petroleum hydrocarbon vapors.

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

- a. Site-specific conditions at the release site satisfy all of the characteristics and screening criteria of scenarios 1 through 3 as applicable, *or* all of the characteristics and screening criteria of scenario 4 as applicable; *or*
- b. A site-specific risk assessment for the vapor intrusion pathway is conducted and demonstrates that human health is protected to the satisfaction of the regulatory agency.

Exception: Exposures to petroleum vapors associated with historical fuel system releases are comparatively insignificant relative to exposures from small surface spills and fugitive vapor releases that typically occur at active fueling facilities. Therefore, satisfaction of the media-specific criteria for petroleum vapor intrusion to indoor air is not required at active commercial petroleum fueling facilities, except in cases where release characteristics can be reasonably believed to pose an unacceptable health risk.

3. Direct Contact and Outdoor Air Exposure

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

- a. Maximum concentrations of petroleum constituents in soil are less than or equal to those listed in Table 1 for the specified depth below ground surface;
- b. Maximum concentrations of petroleum constituents in soil are less than levels that a site specific risk assessment demonstrates will have no significant risk of adversely affecting human health; *or*
- c. As a result of controlling exposure through the use of mitigation measures or through the use of institutional or engineering controls, the regulatory agency determines that the concentrations of petroleum constituents in soil will have no significant risk of adversely affecting human health.

Table 1
Concentrations Of Petroleum Constituents In Soil That Will Have No Significant Risk Of Adversely Affecting Human Health

Chemical	Residential		Commercial/ Industrial		Utility Worker
	0 to 5 feet bgs mg/kg	Volatilization to outdoor air (5 to 10 feet bgs) mg/kg	0 to 5 feet bgs mg/kg	Volatilization to outdoor air (5 to 10 feet bgs) mg/kg	0 to 10 feet bgs mg/kg
Benzene	1.9	2.8	28	810	180
Ethylbenzene	21	32	250	9,400	1,800
Naphthalene	9.7	9.7	3,100	3,100	2,200
PAH*	0.063	190	0.68	160,000	4.6

*Notes: Based on the seven carcinogenic PAHs as benzo(a)pyrene toxicity equivalent [BaPe]. Sampling and analysis for PAH is only necessary where soil was affected by either waste oil and/or Bunker C fuel.

Low-Threat Case Closure

Cases that meet the general and media-specific criteria established in this policy satisfy the case-closure requirements of Health and Safety Code section 25296.10, including the requirement in State Water Board Resolution 92-49 that requires that cleanup goals and objectives be met within a reasonable time frame. If the site has been determined by the regulatory agency to meet the criteria in this policy, the regulatory agency shall notify responsible parties that they are eligible for case closure and that the following items, if applicable, shall be completed prior to the issuance of a uniform closure letter specified in Health and Safety Code section 25296.10. After completion of these items, the regulatory agency shall issue a uniform closure letter within 30 days.

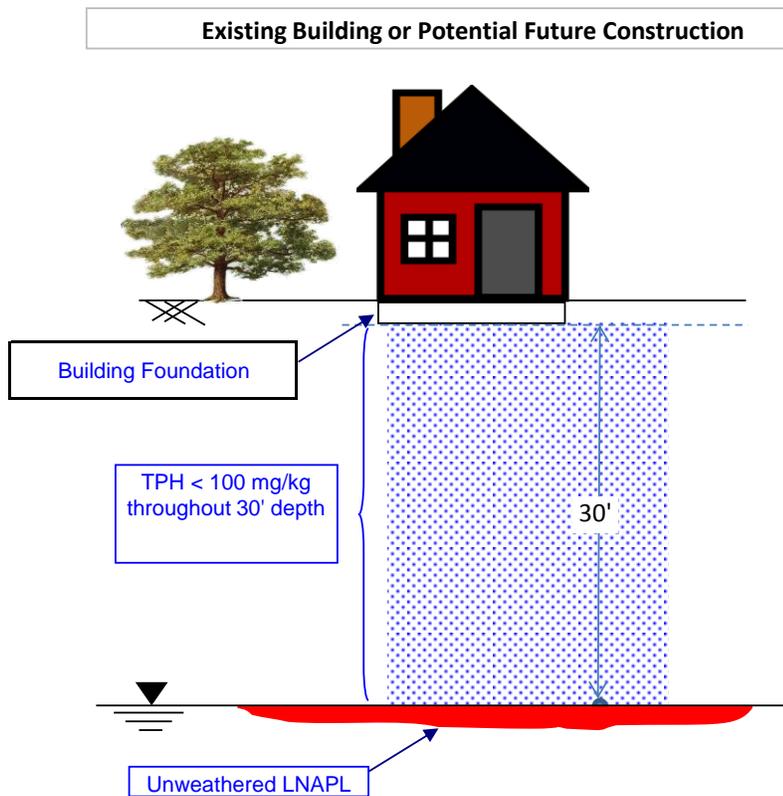
- a. Notification Requirements – Municipal and county water districts, water replenishment districts, special act districts with groundwater management authority, agencies with authority to issue building permits at land affected by the petroleum release, owners of the property, and the owners and occupants of all adjacent parcels and all parcels that are impacted by the unauthorized release shall be notified of the proposed case closure and provided a 30 day period to comment. The regulatory agency shall consider any comments received when determining if the case should be closed or if site specific conditions warrant otherwise.
- b. Monitoring Well Destruction – All wells and borings installed for the purpose of investigating, remediating, or monitoring the unauthorized release shall be properly destroyed prior to case closure unless a property owner certifies that they will keep and maintain the wells or borings in accordance with applicable local or state requirements.
- c. Waste Removal – All waste piles, drums, debris and other investigation or remediation derived materials shall be removed from the site and properly managed in accordance with regulatory agency requirements.

Closing Comments

This concludes the Low-Threat UST Closure Policy. This policy is based on existing statutes, regulations and State Water Board resolutions. This policy clarifies aspects of prior guidance and establishes criteria to be used by technical practitioners and all regulatory agencies in California.

Appendix 1
Scenario 1: Unweathered* LNAPL in Groundwater

Required Characteristics of the Bioattenuation Zone



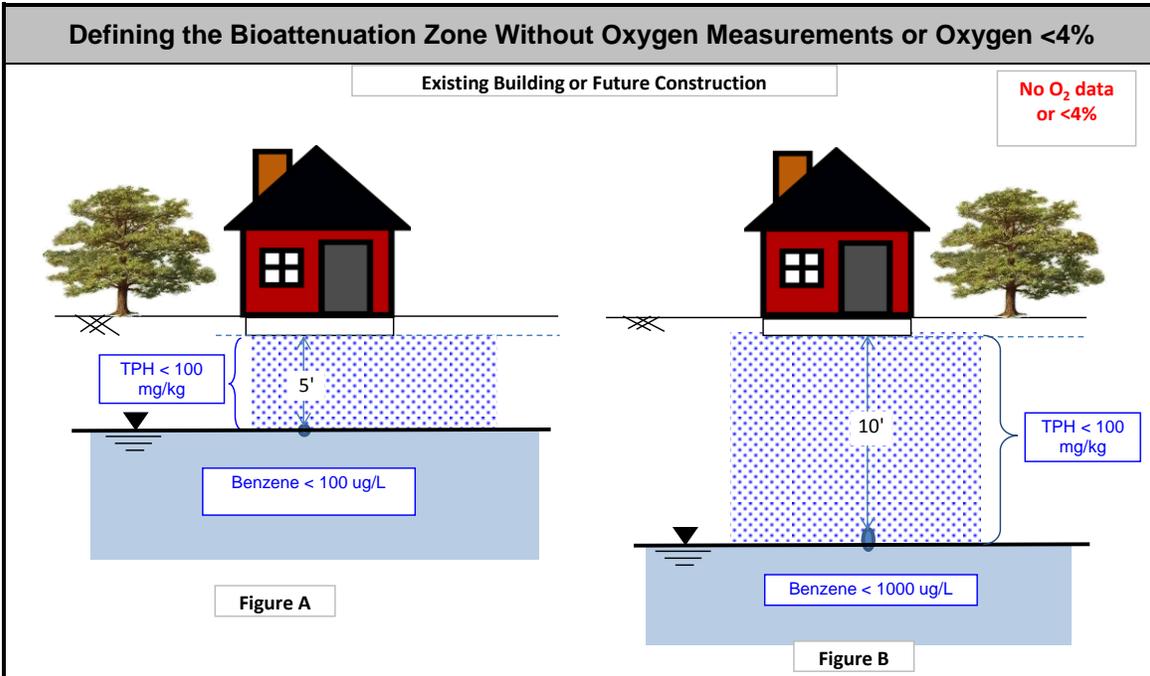
Required Characteristics of the Bioattenuation Zone:

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

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

Appendix 3

Scenario 3 - Dissolved Phase Benzene Concentrations Only in Groundwater
(Low concentration groundwater scenarios with or without O₂ measurements)



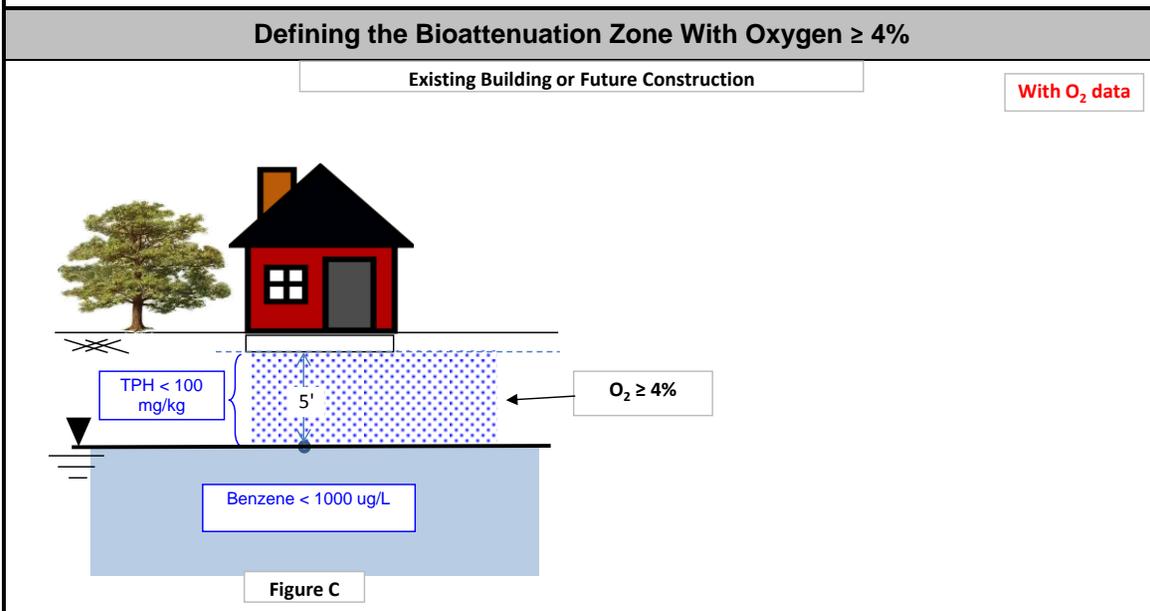
Required Characteristics of Bioattenuation Zone For Sites Without Oxygen Measurements

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

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

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

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

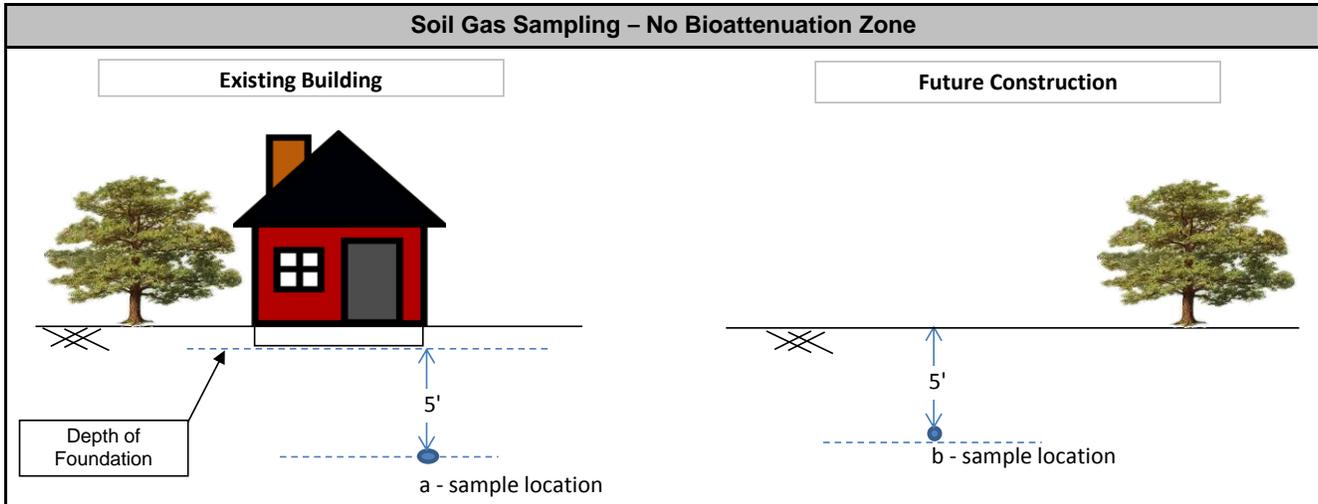


Required Characteristics of Bioattenuation Zone For Sites With Oxygen ≥ 4%

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

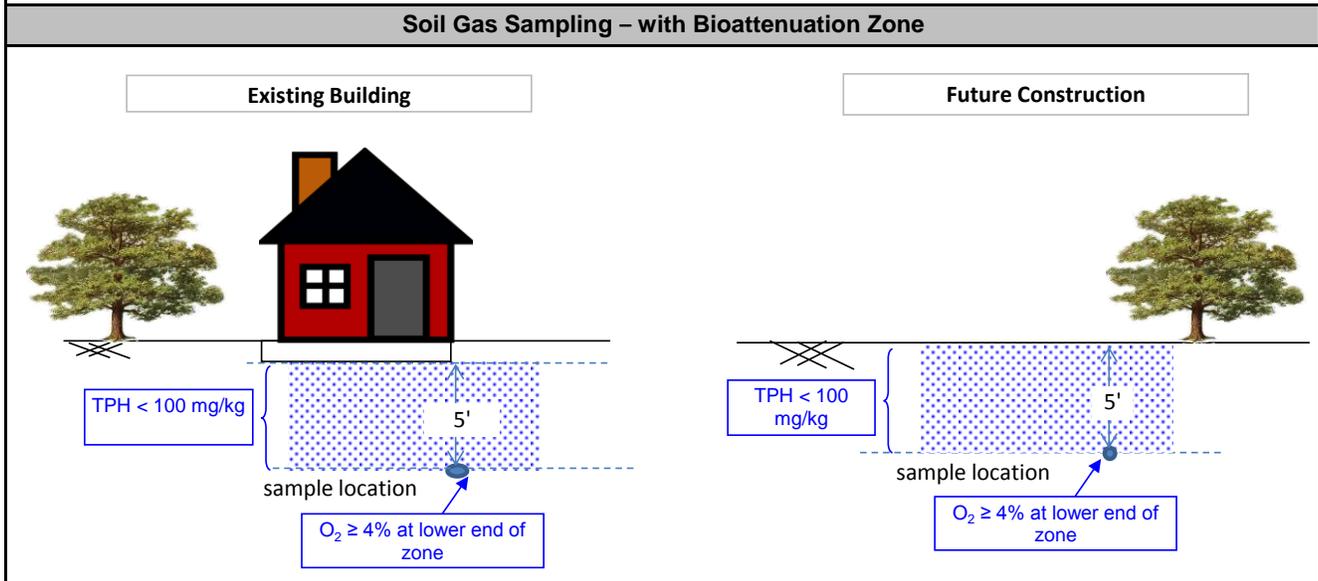
- 1. Shall be a continuous zone that provides a separation of least 5 feet vertically between the dissolved phase Benzene and the foundation of existing or potential buildings; and
- 2. Contain Total TPH (TPH-g and TPH-d combined) less than 100 mg/kg throughout the entire depth of the bioattenuation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

**Appendix 4
Scenario 4 - Direct Measurement of Soil Gas Concentrations**



The criteria in Column B in the table below apply unless the requirements for a bioattenuation zone are satisfied. When applying the criteria in Column B, the soil gas sample must be obtained from the following locations:

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



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

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

Soil Gas Criteria (ug/m³)				
	A - With Bioattenuation Zone*		B - No Bioattenuation Zone	
	Residential	Commercial	Residential	Commercial
Constituent	Soil Gas Concentration (ug/m³)		Soil Gas Concentration (ug/m³)	
Benzene	< 85,000	< 280,000	< 85	< 280
Ethylbenzene	<1,100,000	<3,600,000	<1,100	<3,600
Naphthalene	< 93,000	< 310,000	< 93	< 310

Notes:

A 1000-fold bioattenuation of petroleum vapors is assumed for the bioattenuation zone.
For the no bioattenuation zone, the screening criteria are the same as the California Human Health Screening Levels (CHHSLs) with engineered fill below Sub-slab.