

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 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.