Review of the Scientific Basis of the Technical Justification for the Proposed Low-Threat Underground Storage Tank Policy—State Water Resources Control Board

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Prior to addressing the Findings, Assumptions, and Conclusions detailed in the material forwarded to me in Attachment 2, I note that the intent of the proposed policy is to "to increase UST cleanup policy efficiency" in part to preserve "limited resources for the mitigation of releases posing a greater threat to human and environmental health." In that context, I find the Policy itself, as articulated in Attachment 4, to be well presented and easily understood. In particular, I found the general criteria presented on pages 12-14 to be quite helpful. I note only that, although it is mentioned in the introductory sections, there is no indication where the details of the Conceptual Site Model are to be found. This turned out to be in Section 3 of Attachment 7. Also, there are several abbreviations used in this Attachment which are not defined therein, but in other attachments e.g. bgs in Table 1 and TPH-g and TPH-d in the captions of Scenarios 1-4.

Assertions for Groundwater

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.

The majority of the cited references address the extent and time course of plume expansion and/or contraction. These processes are well summarized in an overview by API(1998) for benzene plumes, updated and expanded to include MTBE and TPHg based on California data by Shih et al.(2004), and expanded further to include MTBE and TBA by Kamath et al. Buscheck et al. provide the most compelling linkage to the above assertion in noting that these data provide the primary evidence that a dissolved contaminant plume stabilizes locally relatively quickly once the source is removed followed by a variable decay towards background depending on local conditions. Buscheck et al. also argue that the secondary evidence for the processes of stabilization and reduction in concentration in individual monitoring wells includes indicator parameters of bioremediation and quantitative estimates of attenuation rates based on chemical analysis of dissolved species over time. Various of the references provide estimates of attenuation rates which allow estimates of reduction in concentrations to various regulatory endpoints. Overall this assertion is well justified but, as implied by Buscheck et al., direct and detailed in situ studies of the relative importance of biodegradation versus dispersion, diffusion, dilution, or volatilization are not presented and, perhaps, not available. However, the data are consistent with biodegradation being of primary importance.

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.

As clarified in the material sent in response to my enquiry regarding relevant DWR well standards, DWR (1991) gives guidelines for the horizontal distance between various potential contaminant sources and wells. The maximum distance given on page 12 therein is 150 feet for cesspools or seepage pits. Hence, the Assertion is correct.

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.

As noted under the Assertion 1 comment above, there is considerable data on the extent of plumes from LUST releases and their movement and concentration over time. These data are generally supportive of the set-backs required in classes 1-4 of the Policy. However, I believe it would be more accurate to include the words "with high probability" in Assertion 3. That is:

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 ***with high probability*** unless unique site specific conditions exist.

A second editorial note concerns the apparent inconsistency or redundancy of elements of the description of groundwater contamination Classes 1, 2, and 4 on page 16 of the Policy with respect to free product. Class 1 simply states, :b. There is no free product, whereas Class 2 also states b. There is no free product, but also that : d.The dissolved concentration of benzene is less than 3000 μg/l and the dissolved concentration of MTBE is less than 1000 μg/l. In Attachment 5 these concentration limits are said to be evidence of the absence of free product. For consistency, presumably the concentration limits should also be in the Class 1 requirement. In the same context, in Class 4 there is to be no free product and there are concentration limits, but with a different value for the benzene limit of 1000 μg/l. I found no mention of the rationale for the value of 1000 μg/l. A final point is that it is not stated, but implied, that the concentration limits apply to all groundwater samples collected at the site in final survey prior to site closure.

<u>Assertions for Vapor Intrusion</u>

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.

Among the cited references, the paper by Borden and Bedient briefly summarizes the history of studies of microbial degradation of hydrocarbons focusing mainly on aerobic processes and the availability of oxygen in the unsaturated zone. The field investigation reported by Lahvis et al (1999) clearly demonstrates the appropriateness of the application of these ideas as well as a good deal of subsequent modeling work to studies of UST release sites. Clearly, the importance of vadose-zone bioattentuation processes is regarded as central to the current framework for addressing UST releases from both a regulatory and risk assessment perspective as evidenced by the professional literature and presentations cited 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].

This Assertion is based most directly on the data assembled and reviewed by Davis (2009, 2010) and the simulation studies by Abreu et al. (2005, 2009). Most of these data and the simulations are for benzene, but a good case is made that benzene is a conservative chemical to use in assessing the risk from other petroleum hydrocarbons in this context. While the 2009 Abreu paper is an application of the model developed by these authors earlier and published in 2005 in Environmental Science and Technology, the Davis material is a conference presentation, some of which was published earlier (Davis 2009) in the LUSTline Bulletin, and some in a conference paper by Wright (2011). It is stated that the origins of the Davis 2009 database was initiated earlier as part of a working group including USEPA representatives as well as state regulatory representatives and that this database is now being used by both federal and state authorities to develop new vapor intrusion guidelines. Hence, despite the fact that I cannot determine how much of this body of material might be considered formally peer-reviewed, the synthesis and outcome of the analysis by these authors and others (API 2009, Hartman 2010, Lahvis 2011) is consistent and supportive of the Assertion with a safety factor on the order of 2 or 3.

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 μg/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 μg/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 μg/l, no soil impacts, and soil gas oxygen concentrations ≥4%.

As discussed on the comment on Assertion 5 above, the same body of material supports the foregoing zone depths and concentration criteria as being conservative. That is, the Assertion rests principally on the extensive modeling work of Abreu et al (2009), supported by analyses of the field data sets of Davis (2009) and Wright (2011) and summarized in the written communication of Lahvis and in Davis (2010). For example, Abreu's Figure 10, page 25, Attachment 6, predicts attenuation factors on the order of 10^{-7} for a two meter separation of sandy soil. The 4% oxygen concentration is consistent with the analysis of the Davis database by Lahvis (2011) who observed that, although there is a poor correlation between benzene soil gas concentrations of benzene and oxygen, generally oxygen content in the unsaturated zone exceeds 4% which indicates a zone of aerobic biodegradation. Again, this is supported for low concentration dissolved sources by the simulations studies of Abreu (2009). Hence, for sources less than 1000μg/l, it is reasonable to require a 10 ft. bioattentuation zone where there is no oxygen data or if the concentration is below 4%, but a 5 ft. zone for oxygen concentrations above 4%. These criteria are conservative in both cases.

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]

Again, this assertion is based on the same body of evidence as Assertions 4-6 above. The specific evidence for the additional1000X attenuation factor is well summarized in the discussion on page 7 of Attachment 2 and, as above, the assertion is conservative.

Assertions for Direct Contact and Outdoor Air Exposure Pathways

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

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

The derivation of the soil screening levels is, as extensively explained in Attachment 7, based on standard USEPA-CalEPA carcinogen risk assessment methodology, both qualitatively and quantitatively. Hence, the methods applied have an extensive history and documentation in the regulatory literature. The application of these methods to mixtures is awkward as is implied in section 2.2 of Attachment 7 in which it is explained that total petroleum hydrocarbons (TPH) are not considered as a unique entity. Rather, several specific chemical components of the mixture are selected for assessment. As a consequence, possible interactions in environmental chemistry and/or their toxicology are not considered. Nonetheless, the methods used are state of the regulatory art and. as is often implied in Attachment 7, very likely to yield very conservative screening levels for cancer risk in the present application. Hence, whatever criticisms that might be lodged at this assessment relate to the general approach, not the details of this particular application. As a second example, any set of equations that contain 50 or more parameters, each subject to some degree of uncertainty and/or variability will produce end estimates of risk with very large variance which is generally not addressed. These two examples are, of course, the rationale for the conservatism used at every step in the process. Some might argue that effort would be better spent in assessing, at least in some preliminary fashion, the likelihood of non-carcinogenic endpoints that could be of greater concern.

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

Insofar as the risk assessment is solely focused on carcinogenic endpoints, this assumption is sensible and conservative. For an endpoint like asthma or other immunologically-mediated outcomes this may not be the case.

An editorial note: only in the footnote to Table 8 of Attachment 7 is it mentioned that “the PAH screening level is only applicable where soil was affected by waste oil and/or Bunker C fuel.” This should be mentioned in section 2.2.