# Draft Final
## Vapor Intrusion Screening Evaluation
## Montrose-Del Amo Dual Site Groundwater Operable Unit 3
## Montrose and Del Amo Superfund Sites
## Torrance, California

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# Acronyms and Abbreviations

| | |
|---|---|
| µg/L | microgram per liter |
| AF | attenuation factor |
| C/I | commercial/industrial |
| COC | chemical of concern |
| DNAPL | dense non-aqueous phase liquid |
| DTSC | California Department of Toxic Substances Control |
| ELCR | excess lifetime cancer risk |
| EPA | U.S. Environmental Protection Agency |
| HI | hazard index |
| HQ | hazard quotient |
| IUR | inhalation unit risk |
| LNAPL | light non-aqueous phase liquid |
| J&E | Johnson and Ettinger |
| OEHHA | California Office of Environmental Health Hazard Assessment |
| OU | operable unit |
| PCE | tetrachloroethene |
| RBSL | risk-based screening level |
| RfC | reference concentration |
| TCE | trichloroethene |
| Tetra Tech | Tetra Tech, Inc. |
| TM | technical memorandum |
| VI | vapor intrusion |
| VISL | vapor intrusion screening level |
| VOC | volatile organic compound |

# 1.0 Introduction

This technical memorandum (TM) presents the methodology and results of two separate screening evaluations of the vapor intrusion (VI) pathway for three specific areas of potential concern in the Dual Site Groundwater Operable Unit (OU), hereinafter refer to as OU-3, of the Montrose and Del Amo Superfund Sites. OU-3 is located in the southwestern portion of Los Angeles County, between the cities of Torrance and Carson, California (Figure 1). Additional sources of trichloroethene (TCE) present beyond the defined OU-3 plume boundaries are being addressed outside of this OU. This phase of the evaluation (Phase 2) is focused on the potential vapor intrusion pathway down gradient of all plumes, regardless of sources.

In 2013, EPA had determined that the VI pathway should be reassessed for the commercial and residential areas above the contaminated groundwater downgradient (south) of the former Montrose and Del Amo facilities. The VI pathway was previously evaluated at some of the OUs associated with the Montrose and Del Amo Superfund Sites. Areas of contamination in the commercial/industrial areas near contaminant sources north of the facilities had been evaluated previously and mitigation actions were taken. A health-protective screening evaluation of the downgradient portion of OU-3 was conducted in September 2013 based on current data, and indicated low potential for exposure over most of the area (Tetra Tech, Inc. [Tetra Tech], 2013). That study identified some uncertainties in three specific locations and recommended an even more rigorous re-evaluation of those areas. The three locations had higher concentrations of volatile organic compounds (VOCs) present in the shallowest water bearing unit. Because the named water bearing units (e.g., upper Bellflower) do not extend consistently across the site, the shallowest groundwater at any given location may be flowing through different units (e.g., middle Bellflower). For convenience in this report, we will call the shallowest water bearing unit, the water table aquifer. The significance of the water table is that it is the contact between the vadose zone (unsaturated), and the phreatic zone (saturated). It is the horizon through which VOCs pass in vapor phase into the vadose zone. This water table aquifer is the layer of groundwater closest to the ground surface, ranging from depths from approximately 28 feet below ground surface to 65 feet deep in the OU-3 area.

A thorough description of the site, historical operations, previous investigations, and conceptual site model were reported in *Current Status of Vapor Intrusion Assessment, Montrose and Del Amo Superfund Sites, Torrance, California* (CH2M Hill, 2012) and *Groundwater Data Evaluation to Support Vapor Intrusion Assessment Montrose and Del Amo Superfund Sites Torrance, California* (Tetra Tech, 2013). Therefore this information is not presented herein.

## 1.1 Background

Historically, numerous VI assessments have been conducted for the Montrose and Del Amo Superfund Sites, as summarized in the *Current Status of Vapor Intrusion Assessment, Montrose and Del Amo Superfund Sites, Torrance, California* (CH2M Hill, 2012). The VI pathway at the Montrose and Del Amo sites was thoroughly characterized, including extensive field sampling efforts and community outreach (U.S. Environmental Protection Agency [EPA], 1995; 1996). At the time of the studies, EPA concluded there was no evidence of unacceptable risk in residential areas from the Superfund Sites.

In January 2013, EPA began a reassessment of the VI pathway at the Montrose and Del Amo Superfund Sites based on multiple justifications: advances in science, changes in site conditions, and recent re-evaluation of EPA policy on VI. The following phased approach, similar to step six of *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (EPA, 2002), was developed by EPA's Environmental Response Team for recharacterization and reassessment of the VI pathway:

- Phase 1: Gather current information from multiple groundwater monitoring sources and various assessment and modeling reports.
- Phase 2: Perform VI modeling and evaluate the results to provide an assessment of data gaps, uncertainty, and weaknesses in the ability to quantify the risks from this pathway. To do this, EPA proposed a two-step process:
  - Estimate empirical groundwater-to-indoor-air attenuation factors (AF) to calculate site-specific VI screening levels (VISL) using the EPA's VISL calculator (VISL-Calculator.xlsm), and then screen site groundwater data against the site-specific VISLs.
  - Estimate groundwater-to-indoor-air AFs using an enhanced version of EPA's Johnson and Ettinger (J&E) model spreadsheet for groundwater (GW-ADV-Feb04.xlsm) with site-specific inputs (depth to groundwater, soil strata, and chemical data) to calculate potential risk/hazard and site-specific risk-based screening levels (RBSL), and then screen off-site groundwater data against the site-specific RBSLs.
- Phase 3: Develop a detailed plan to collect specific information necessary to further evaluate the VI pathway.
- Phase 4: Implement the plan and report the results with interpretation.

Phase 1 has been completed and is documented in *Groundwater Data Evaluation to Support Vapor Intrusion Assessment Montrose and Del Amo Superfund Sites, Torrance, California* (Tetra Tech, 2013). Similar to Phase 1, step six of the *OSWER Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils (Subsurface Vapor Intrusion Guidance)* (EPA, 2002) also calls for examining existing data to determine whether the issue has been adequately and objectively resolved. Depending on that reassessment, the effort proceeds to defining which data are needed, how they will be gathered in a scientifically defensible manner, and how the investigation results will be used to reevaluate risk from the VI pathway. This report demonstrated that current data are useful for rapidly focusing further specific evaluations on locations with the greatest potential for VI, and identifying the site-specific factors contributing to the generalized, health-protective screening results when using generalized health-protective factors. The report recommended several areas for further evaluation, including occupied residential and commercial buildings that overlie the commingled plumes of VOCs in OU-3, specifically:

- Area 1: Residential area southeast of the Montrose Site (with elevated concentrations of chlorobenzene and TCE in the water table)
- Area 2: Commercial/industrial (C/I) area with elevated TCE concentrations in the water table south of the Montrose and Jones sites
- Area 3: Residential area south of the Del Amo site Waste Pits (with historical detections of TCE in the water table and expressed community interest in revaluation of previous investigations)

These areas along with the commingled groundwater plumes of primary chemicals of concern (COCs) (benzene, chlorobenzene, tetrachloroethene [PCE], and TCE) are shown on Figure 1. These areas were identified based on a comparison of COC concentrations in the water table groundwater beneath these locations with EPA's health-protective groundwater-to-indoor-air screening levels (EPA, 2012a).

This TM presents the methodology and results in support of Phase 2 of VI pathway reassessment, and a proposed conceptual approach to Phase 3.

## 1.2 Objectives

The objectives of the Phase 2 screening evaluations described in this TM are as follows:

- Compile paired soil gas and groundwater data, where available, and groundwater data in the vicinity of Areas 1, 2, and 3
- Utilize the compiled data to estimate site-specific AFs to develop VISLs for screening the primary COC concentrations in groundwater beneath and off the site
- Conduct modeling using the EPA's J&E model spreadsheet for groundwater to determine area-specific RBSLs to screen the groundwater concentrations for potential VI
- Present a comparison of the area-specific maximum groundwater concentrations to the RBSLs, and determine individual-analyte and cumulative risk/hazard
- Evaluate a potential residential exposure scenario for Areas 1, 2, and 3 (Figure 2) and a C/I exposure scenario for Areas 1 and 2
- Evaluate the results to assess data gaps, uncertainty, and potential weaknesses to quantify potential risks from the VI pathway
- Provide an approach and justification for confirmation or validation sampling

## 1.3 Technical Memorandum Organization

This TM is organized as follows:

- **Section 1.0, "Introduction"—**Presents the project purpose, objectives, a brief background, technical approach, and document organization.
- **Section 2.0, "Vapor Intrusion Pathway Screening Evaluation Based On Empirical Attenuation Factors"—**Describes the methodology and results of a site-specific screening evaluation performed using empirical AFs and VISLs developed for groundwater.
- **Section 3.0, "Vapor Intrusion Pathway Screening Evaluation Based On Modeled Attenuation Factors"—**Describes the methodology and results of a screening evaluation performed using modeled AFs and RBSLs developed for groundwater.
- **Section 4.0, "Recommendations"—** Presents recommendations based on the results of the site-specific VI pathway screening evaluations summarized in Sections 2.0 and 3.0.

- **Section 5.0, "Phase 3-Plan Development"—**Provides an outline for developing a detailed plan to collect specific information necessary to further evaluate the VI pathway.
- **Section 6.0, "References"—**Provides a list of all the cited documents within the text, figures, and tables.

Figures and tables are presented after Section 5.0. The following appendices are included after the figures and tables:

- **Appendix A, "Enhanced Johnson and Ettinger Model Spreadsheet Description"—**Describes the EPA's J&E model spreadsheet and enhancements made to calculate analyte-specific and cumulative risk/hazard and site-specific RBSLs for groundwater.
- **Appendix B, "Area 1, Enhanced Johnson and Ettinger Model Spreadsheet Input and Output Sheets"—**Includes the modeling input and output sheets for Area 1.
- **Appendix C, "Area 2, Enhanced Johnson and Ettinger Model Spreadsheet Input and Output Sheets"**—Includes the modeling input and output sheets for Area 2.
- **Appendix D, "Area 3, Enhanced Johnson and Ettinger Model Spreadsheet Input and Output Sheets"**—Includes the modeling input and output sheets for Area 3.
- **Appendix E, "Area 3, BioVapor and Enhanced Model Spreadsheet Input and Output Sheets"**—Includes the BioVapor and enhanced J&E modeling input and output sheets for Area 3.

# 2.0 Vapor Intrusion Pathway Screening Evaluation Based On Empirical Attenuation Factors

This section summarizes the methodology and results of the site-specific VI screening evaluation based on empirical AFs for the Montrose and Del Amo Superfund Sites that was completed and authored by CH2M Hill (2013).

## 2.1 Methodology

Site-specific AFs from the groundwater plume to shallow soil gas were estimated based on the previous soil gas and groundwater sampling results at selected locations at the Montrose and Del Amo Superfund Sites. Groundwater and soil gas sampling results collected at select well pairs were used to estimate these site-specific VI AFs. A well pair is composed of a groundwater monitoring well and a shallow soil gas sampling point (that is, a soil gas point at 5 to 7 feet below ground surface) located in the immediate proximity to each other. Only groundwater wells screened in the water table aquifer were considered in this evaluation, because that is where vapors volatilize into the vadose zone. Data from wells screened in deeper aquifers are not typically used for evaluating VI, because these aquifers are separated from the vadose zone and surface receptors by the water table aquifer and aquitard materials.

Because groundwater concentrations vary significantly over short distances and with time in the areas where soil gas data are available, selecting contemporaneous groundwater and soil gas results collected in close proximity to each other was a major consideration. Groundwater and soil gas data were evaluated in order to determine the appropriate soil gas and well pairs for attenuation factor estimates. This evaluation included the following steps:

1. Compile historical groundwater and soil gas sampling results at the Montrose and Del Amo Superfund Sites.
2. Identify preliminary soil gas/well pairs of a shallow soil gas monitoring point and a water table groundwater well located within 50 feet of each other.
3. Identify contemporaneous groundwater and soil gas sampling results for selected well pairs (results collected within a six-month period).
4. Assess whether selected soil gas locations are impacted by the vadose zone soil contamination. Generally, without the presence of vadose zone contamination, VOCs in soil gas resulting from groundwater contamination decrease in concentration (that is, attenuate) with vertical height above the water table.

If soil gas samples from multiple depths were available at the selected soil gas monitoring locations, the soil gas results were evaluated for attenuation of soil gas concentrations. The lack

of attenuating gradient may indicate the presence of vadose zone contamination in nearby soil. Therefore, the soil gas/well pairs that had increasing vapor concentrations with height above the water table were not selected for the estimates of AFs. However, it is important to note that the availability of soil gas data was limited to the areas located in proximity to contaminant sources (i.e., areas with vadose zone and light non-aqueous phase liquid [LNAPL] or dense non-aqueous phase liquid [DNAPL] contamination such as the Montrose property and LNAPL source areas at the Del Amo site). Therefore, soil gas values measured at and near these LNAPL and DNAPL source areas could be impacted by the vadose zone contamination in addition to dissolved concentrations in groundwater (see Section 2.2.4).

The selected soil gas/well pairs are listed in Table 1. Please note that the soil gas/well pair used in the previous assessment of groundwater monitoring well SWL0049 (AECOM, 2013) was not selected for this evaluation due to the fact that soil gas and groundwater samples were collected several years apart.

As shown in Table 1, two new well pairs, MW-01/SG-33 and MW-04/SG-03, were identified for the Montrose Superfund Site.

- MW-01/SG-33: Groundwater well MW-01 and soil gas sampling point SG-33 were sampled in January 2004 and October 2003, respectively, and are located within approximately 60 feet of each other (see Figures 1 and 2).
- MW-04 and SG-03: Groundwater well MW-4 and soil gas sampling point SG-03 were sampled in January 2004 and October 2003, respectively, and are located within 50 feet of each other (see Figures 1 and 2).

In addition, well MW-21 and three nearby soil gas sampling locations were identified at the Del Amo site. Groundwater samples were collected at well MW-01 in 1990 through 1994, and soil gas data were collected at the three nearby shallow soil gas sampling locations (SGL0013, SGL0622, and SGL0626) in 1992 and 1995. Well MW-21 and soil gas sampling points are located from 10 to 50 feet from each other (see Figures 1 and 3).

The groundwater and soil gas sampling results at selected well pairs were used to estimate site-specific VI AFs. (Please note that these estimates were based on the conservative assumption that all the COCs detected in shallow soil gas monitoring locations were the result of VI from groundwater and not from vadose zone soil sources.) However, the vadose zone soil contamination likely contributed to the soil gas concentrations measured at the source areas where paired soil gas and groundwater well data were available. Therefore, the site-specific attenuation factors estimated based on the data from these locations likely underestimate the amount of attenuation expected in the residential and commercial areas (1, 2, and 3), where site-related sources are not present in the vadose zone.

The site-specific AF from groundwater to shallow soil gas was estimated using the Henry's Constant at 25 degrees Celsius (EPA, 2013a). Equations used for attenuation factor calculations are shown as follows:

Attenuation factor from groundwater to shallow soil gas:

$$AF_{GW\text{-}SG} = \frac{SG_{shallow}}{SG_{source}}$$

Where:

$AF_{GW\text{-}SG}$ = Attenuation factor from groundwater to shallow soil gas

$SG_{shallow}$ = Contaminant concentration in shallow soil gas

$SG_{source}$ = Contaminant concentration at vapor source. $SG_{source}$ is calculated by assuming the soil gas concentration at the groundwater interface is in equilibrium with the groundwater concentration based on Henry's Law: $SG_{source}$ = Contamination concentration in groundwater × Henry's law constant

Attenuation factor from groundwater-to-indoor-air:

$$AF_{GW\text{-}IA} = AF_{GW\text{-}SG} \times AF_{SG\text{-}IA}$$

Where:

$AF_{GW\text{-}IA}$ = Attenuation factor from groundwater-to-indoor-air

$AF_{GW\text{-}SG}$ = Attenuation factor from groundwater to shallow soil gas

$AF_{SG\text{-}IA}$ = Attenuation factor from shallow soil gas to indoor air; an attenuation factor of 0.05 was assumed (California Department of Toxic Substances Control [DTSC], 2011)

The site-specific AFs from groundwater-to-indoor-air estimated using these equations were entered in the EPA VISL calculator (EPA, 2012a) to calculate the target groundwater concentrations (VISL for groundwater) for each COC. The target risk for carcinogens equal to 1E-6 and target hazard quotient (HQ) for non-carcinogens equal to 1 were used for these calculations. The calculated site-specific VISLs for groundwater were also compared with the default VISLs for groundwater in the calculator where the default AFs from groundwater-to-indoor-air is 0.001 for all chemicals.

## 2.2 Results

The following subsections present the results of the site-specific VI screening evaluation conducted by CH2M Hill.

### 2.2.1 Estimates of Attenuation Factors at the Montrose Site

The selected soil gas/well pairs at the Montrose site were used to estimate AFs for chlorobenzene and TCE (see Table 2).

#### 2.2.1.1 Chlorobenzene

As shown in Table 2, the site-specific AFs from the groundwater plume to shallow soil gas for chlorobenzene at soil gas/well pairs MW-04/SG-03 and MW-01/SG-33 are 6.1E-3 and 5.9E-4, respectively, averaging 3.4E-3. Assuming a 0.05 AF between shallow soil gas and indoor air (DTSC, 2011), the resulting AF from groundwater-to-indoor-air at well pairs MW-04/SG-03 and MW-01/SG-33 are 3.1E-4 and 2.9E-5, respectively, averaging 1.7E-4.

#### 2.2.1.2 Trichloroethene

The site-specific AF from the groundwater plume to shallow soil gas for TCE was estimated using only the data at soil gas/well pair MW-01/SG-33. The TCE concentration in the soil gas sample collected at SG-03 was below its method detection limit during 2003, so this pair was not used in the calculation. The estimated TCE attenuation factors from the groundwater plume to shallow soil gas is 5.8E-4, and from groundwater-to-indoor-air is 2.9E-5 assuming a 0.05 AF between shallow soil gas and indoor air (DTSC, 2011).

### 2.2.2 Estimates of Attenuation Factors at the Del Amo Site

The selected soil gas/well pairs at the Del Amo site were used to estimate AFs for benzene (see Table 3). Specifically, the benzene concentration measured in well MW-21 and soil gas results collected at SGL0622 and SGL0626 in 1994 were used to estimate AFs for benzene. As shown in Table 3, the benzene AFs from groundwater to shallow soil gas range from 7.6E-6 to 5.6E-5, averaging 3.2E-5. Assuming a 0.05 attenuation factor between shallow soil gas and indoor air (DTSC, 2011), the resulting benzene AFs from groundwater-to-indoor-air range from 3.8E-7 to 2.8E-6, averaging 1.6E-6.

### 2.2.3 Estimates of Vapor Intrusion Screening Levels

Table 4 presents the calculated average values for groundwater-to-indoor-air site-specific AFs discussed above, as well as VISLs for groundwater (EPA, 2013a) estimated based on these site-specific AFs. Table 4 also presents estimated concentrations of concern in the water table, VISLs for comparison purposes. Based on these results, the three areas listed in Section 1.0 that were selected for further evaluation have concentrations of TCE and/or chlorobenzene above the calculated site-specific VISLs. Specifically, concentrations of chlorobenzene in well SWL0049 (Area 1) are above the calculated VISL for chlorobenzene of 2,400 micorgrams per liter (µg/L); and concentrations of TCE in Areas 2 and 3 are above the calculated site-specific VISL for TCE of 1.8 µg/L. The VISL for benzene, however, does not appear to be exceeded in any of these areas of potential concern. This is consistent with well-established observations of

biodegradation of petroleum hydrocarbons (EPA, 2013b), and supports the prior assessment that there is limited potential for VI related to the dissolved benzene in the identified areas of potential concern.

## 2.3 Uncertainties and Limitations

This evaluation was performed using limited groundwater and soil gas results collected at a limited number of soil gas/well pairs at the Montrose and Del Amo Superfund Sites. Although an effort was made to select data as contemporaneous and collocated as possible, the data points were not completely collocated and/or were not exactly contemporaneous, which introduces some uncertainty in the estimates of the site-specific AFs.

In addition, as discussed above, the available soil gas/well pairs are located in or near the areas where vadose zone soil contamination and/or LNAPL and DNAPL are present in the subsurface. Thus, the measured soil gas concentrations are likely caused by a combination of both soil and groundwater vapor sources. This introduces a potential high bias in the AF estimates, resulting in lower estimates of VISLs. Consequently, potential VI impacts are likely overestimated based on these AFs in the subject residential and commercial areas (1, 2, and 3), where the site-related contamination is not expected to be present in the vadose zone.

Spatial variability in the characteristics of vadose zone soil also may introduce some uncertainty in assessing and applying AFs estimated based on soil gas/well pairs that are not located within the areas of potential concern that are being evaluated. However, a review of well logs for the monitoring wells used for the estimates of AFs and wells located within the areas of potential concern demonstrated that similar fine-grained sediments and moist soils are present at these locations. Therefore, the uncertainty associated with the potentially different vadose zone properties does not appear to be significant.

# 3.0 Vapor Intrusion Pathway Screening Evaluation Based On Modeled Attenuation Factors

This section summarizes the methodology and results of a site-specific VI screening evaluation based on modeled AFs for OU-3 of the Montrose and Del Amo Superfund Sites.

## 3.1 Methodology

As a more rigorous step and complementary to the empirical AF approach described in Section 2.0, AFs for groundwater-to-indoor-air were modeled using area-specific data input into an enhanced version of EPA's J&E model spreadsheet, and, as needed, into American Petroleum Institute's BioVapor model. The resulting AFs were then used to estimate individual and cumulative potential risk and hazard and to calculate RBSLs for comparison to concentrations of VOCs detected in groundwater at the three areas of potential concern identified in Section 1.1. A brief description of the models used and site-specific inputs are described in the following subsections.

### 3.1.1 Enhanced Version of EPA's Johnson and Ettinger Model Spreadsheet

Modeling VI of VOCs from groundwater into buildings can be accomplished using screening models (DTSC, 2011 and EPA, 2004a; 2004b) or advanced models (EPA, 2004 a,b). For this effort, an enhanced version of the EPA's advanced J&E model spreadsheet (Version 3.1; EPA, 2004b) was used that accommodates up to three soil layers (EPA, 2004b), allows evaluation of multiple detected analytes (up to 60) in one model run, and calculates chemical-specific AFs, individual- and cumulative-risk/hazard, and individual-chemical RBSLs. A detailed description of the enhanced model spreadsheet is provided in Appendix A. The site-specific inputs selected for this modeling effort are described in Section 3.1.3.

Because model inputs vary for the different areas of potential concern for physical conditions (such as soil type, layer thickness and depth to water table) and exposure scenarios (i.e., residential or C/I), potential risk/hazard and RBSLs were calculated separately for each area and exposure scenario(s). Based on current land uses, Areas 1 and 2 were evaluated for both residential and C/I exposure scenarios and Area 3 was only evaluated for a residential exposure scenario. Results of the various model runs are described in Section 3.2.

### 3.1.2 BioVapor

For exposure scenarios in which petroleum hydrocarbons are a potential risk/hazard for VI, an additional tool was used to model chemical-specific AFs that include aerobic biodegradation of petroleum hydrocarbons in soil gas (BioVapor model). This allows for a more realistic assessment of potential risk/hazard via the VI exposure pathway (EPA, 2013b). The BioVapor model (DeVaull, 2007; API, 2010) uses an analytical solution similar to the J&E model, but it

accounts for oxygen-limited, aerobic biodegradation, whereas the J&E model does not. In the absence of aerobic biodegradation, the model is essentially equivalent to the J&E model. Although other analytical models have accounted for biodegradation with first order decay, the BioVapor model improves on this method by accounting for limited oxygen availability (API, 2010) and more correctly corresponds to observed petroleum hydrocarbon concentrations. Therefore, concentrations of all volatile petroleum hydrocarbons detected in the groundwater source sample were input into the model, whether it was a risk driver or not, so that competitive degradation of the individual hydrocarbons or hydrocarbon groups were accounted for when calculating the chemical-specific AFs. Often, the AFs are as much as three orders of magnitude less than AFs determined using the J&E model without consideration for biodegradation, which directly affects the resulting estimated risk/hazard and RBSLs. The site-specific inputs selected for this modeling effort are described in Section 3.1.3.

The BioVapor model is locked and password-protected, so the toxicity factors could not be confirmed or updated. Therefore, for this modeling effort, the calculated AFs from BioVapor, that include aerobic biodegradation, were inserted into the appropriate "Infinite Source Indoor Attenuation Coefficient" cells on the INTERCALCS sheet of the enhanced J&E model spreadsheet in order to calculate area-specific risk/hazard and RBSLs using current toxicity factors in the updated VLOOKUP sheet of the enhanced J&E model spreadsheet. Results of the BioVapor modeling and associated risk/hazard estimations are described in Section 3.2.

### 3.1.3 Input Parameters

Input parameters for both the enhanced J&E model spreadsheet and BioVapor model are generally the same including the groundwater contaminant concentrations, chemical properties, vadose zone soil properties, building properties, and exposure and risk factors. Area-specific parameters were used when available, otherwise health-protective default parameters recommended by the EPA, the California Office of Environmental Health Hazard Assessment (OEHHA), or the DTSC were used.

Input parameters used in the enhanced J&E model spreadsheet that were site-specific, differing from the health-protective default values recommended by EPA, OEHHA, or DTSC, were:

- Depth below grade to the water table at each area of potential concern was estimated based on an evaluation of 2012 water level data from wells in close proximity to the areas of potential concern.
- Vadose zone stratum soil types and thicknesses at each area of potential concern were estimated based on logs of soil borings completed in close proximity to the areas of potential concern. Table 5 summarizes the selected borings and assignments of the vadose zone stratum soil types for each area of potential concern.

Appendix A provides specifics of the chemical, soil, and building parameters used in the enhanced J&E model spreadsheet for each exposure scenario; and Appendices B, C, and D include a tabulated summary of the input parameters and their basis for use in modeling each area of potential concern and exposure scenario.

The input parameters for BioVapor were site-specific where applicable; otherwise the default parameters recommended by the BioVapor User's Manual were applied. The site-specific parameters included the following:

- Depth to source (from bottom of foundation) was based on the estimated depth to the water table in 2012 at each area of potential concern.
- Groundwater to deep soil gas attenuation factor value of 1 was used in BioVapor so that the calculated 'soil gas source concentration' matched the "source vapor concentration" calculated by the enhanced J&E model spreadsheet. A soil gas attenuation factor value of 1 is health-protective because it represents no attenuation across the capillary fringe.

Appendix E includes the input sheets for the BioVapor modeling effort.

Rather than simply screening the three primary VOCs detected in groundwater (i.e., benzene, chlorobenzene, and TCE), maximum concentrations for all VOCs detected in close proximity to each area of potential concern were input into the models. This is conservative (i.e., health-protective) for evaluation of potential exposure via cumulative risk/hazard. The groundwater contaminant data selected for modeling each area of potential concern was from the off-site well with the highest concentrations of VOCs detected in 2012 and within close proximity to each designated area. The candidate and selected wells for each area included the following:

- Area 1—Well SWL0049 was the only off-site well in close proximity to this area that was sampled in 2012 and had detected VOCs (Figure 1). Eighteen VOCs were reported in the groundwater sample collected from this well in February 2012 (URS, 2012). The detected VOCs and reported concentrations used in modeling are listed in Tables 6 and 7.
- Area 2—Well XMW-6 was the only off-site well in close proximity to this area that was sampled in 2012 (Figure 1). All other nearby wells have not been sampled since 2006 or earlier and therefore were not considered representative of current conditions. Twenty-five VOCs were reported in the groundwater sample collected from this well in January 2012 (AECOM, 2012). The detected VOCs and reported concentrations used in modeling are listed in Tables 8 and 9.

- Area 3—Wells SWL0008 and SWL0051 were the only off-site wells in close proximity to this area that were sampled in 2012 and had detected VOCs. The data from well SWL0008 was selected because it had more VOCs and greater concentrations of VOCs detected. Thirteen VOCs were reported in the groundwater sample collected from this well in February 2012 (URS, 2012). The detected VOCs and reported concentrations used in modeling are listed in Tables 10 and 11.

### 3.1.4 Toxicity Factors

Inhalation unit risks (IUR) and reference concentrations (RfC) used in the enhanced J&E model spreadsheet for calculating risk/hazard and the RBSLs were obtained from the following sources:

- OEHHA's toxicity criteria database, which contains approved IURs. The IURs in this database have undergone review and are recognized toxicity values for evaluations in California (http://www.oehha.ca.gov/risk/ChemicalDB/index.asp).
- EPA's Integrated Risk Information System—The IURs and RfCs in Integrated Risk Information System have undergone peer review and are recognized as agency-wide consensus information (http://www.epa.gov/iris).
- Other EPA values, as presented in EPA's Regional Screening Levels table (EPA, 2013c), including values from the following:
  - EPA's provisional peer-reviewed toxicity values. The provisional peer-reviewed toxicity values have undergone EPA review and are recognized as consensus information.
  - EPA's health effects assessment summary tables.
  - EPA's National Center for Environmental Assessment papers (chemical-specific references).
- For noncancer effects, non-EPA values from:
  - OEHHA chronic inhalation reference exposure levels (http://www.oehha.ca.gov/risk/ChemicalDB/index.asp).
  - Agency for Toxic Substances and Disease Registry minimal risk levels (2013).

If the IUR from an EPA source was more stringent than the IUR from OEHHA, then the more health-protective (higher) IUR was used. This hierarchy for toxicity criteria is generally consistent with the recommended hierarchy (EPA, 2003), except that the more health-protective of California Environmental Protection Agency and EPA IURs and RfCs were used.

## 3.2 Results

Results of the site-specific modeling of the VI pathway for each area of potential concern are described in terms of estimated risk and hazard in the following subsections. As per the *National Oil and Hazardous Substances Pollution Contingency Plan* (EPA, 1990), risk drivers are identified as those chemicals of potential concern that have an estimated cancer risk that is equal to or exceeds the point of departure (1E-6) for the cancer risk management range (1E-6 to 1E-4) and an estimated noncancer HQ greater than 1 (EPA, 1991). In addition to estimating potential risk and hazard, the modeling effort also generated area-specific RBSLs for groundwater based on a target risk of 1E-6 and HQ of 1. An evaluation of the modeled RBSLs with available groundwater data is also provided.

### 3.2.1 Area 1—Residential Area Southeast of the Montrose Site

Based on current land use, Area 1 was evaluated for a residential exposure scenario and C/I exposure scenarios. The modeled VI pathway risk and hazard estimates for a residential exposure scenario at Area 1 are summarized in Table 6. The estimated cumulative risk for the VI pathway in the vicinity of well SWL0049 was 2E-5 and the estimated hazard index (HI) was 1.3. The primary risk drivers and their estimated excess lifetime cancer risk (ELCR) and HQ are as follows:

| Risk Driver | Risk (ELCR) | Hazard (HQ) |
|---|---|---|
| 1,2-Dichloroethane | 9E-6 | 0.1 |
| Benzene | 5E-6 | 0.01 |
| PCE | 4E-6 | 0.05 |
| TCE | 3E-6 | 0.8 |
| Cumulative | 2E-5 | 1.3 |

Modeling benzene biodegradation would not significantly reduce the overall risk/hazard being driven by the chlorinated VOCs and thereby any decision made based on this site-specific screening evaluation. Therefore, BioVapor was not run for Area 1. The estimated HQ for chlorobenzene was 0.4 and does not exceed its modeled RBSL of 8,148 µg/L (Table 6), which indicates chlorobenzene does not appear to pose an increased or unacceptable non-carcinogenic VI health risk to residents in vicinity of well SWL0049.

The modeled, VI pathway risk and hazard estimates for a C/I exposure scenario at Area 1 are summarized in Table 7. The estimated cumulative risk for the VI pathway in the vicinity of well SWL0049 was 2E-6 and the estimated HI was 0.2, based on the same VOCs contributing to risk/hazard for the residential scenario.

The estimates of potential risk and hazard were based on concentrations of VOCs in groundwater at one well and therefore are only representative of the area in close proximity to this well, SWL0049. The potential cumulative risk of 2E-5 for a residential exposure scenario in combination with the lack of spatial and temporal groundwater data suggests that the VI pathway in Area 1 should be further characterized and assessed. This finding is corroborated based on a comparison of the modeled residential RBSLs (Table 6) and groundwater data available in the vicinity of Area 1 (Figure 7 of URS, 2012). RBSLs for the primary risk drivers of a residential exposure scenario, as listed above, are likely exceeded between the southern boundary of the Del Amo site and beyond well SWL0049 for an uncertain distance to the southeast and southwest, but likely no further than West Milton Street or South Raymond Avenue.

### 3.2.2 Area 2—Commercial/Industrial Area South of the Montrose and Jones Sites

Based on current land use, Area 2 was evaluated for a C/I exposure scenario and, additionally, a residential exposure scenario because of the residential neighborhood west of Denker Avenue. The modeled, VI pathway risk and hazard estimates for a C/I exposure scenario at Area 2 are summarized in Table 8. The estimated cumulative risk for the VI pathway in the vicinity of well XMW-06 was 3E-4 (exceeding the risk management range) and the estimated HI was 4.9. The primary risk drivers and their estimated ELCRs and HQs are as follows:

| Risk Driver | Risk (ELCR) | Hazard (HQ) |
|---|---|---|
| 1, 2, 3-Trichloropropane | 2E-6 | 0.003 |
| Carbon Tetrachloride | 2E-5 | 0.03 |
| Chloroform | 4E-5 | 0.05 |
| PCE | 3E-4 | 3.5 |
| TCE | 4E-6 | 1.2 |
| Cumulative | 3E-4 | 4.9 |

The modeled VI pathway risk and hazard estimates for a residential exposure scenario at Area 2 are summarized in Table 9. The estimated cumulative risk for the VI pathway in the vicinity of well XMW-06 was 3E-3 (exceeding the risk management range) and the estimated HI was 41. It is important to note that there is no current or planned residential use in the immediate vicinity of the monitoring well.

The estimates of potential risk and hazard were based on concentrations of VOCs in groundwater at one well and therefore are only representative of the area in close proximity to this well, XMW-06. However, based on a comparison of the modeled C/I RBSLs (Table 8) and available groundwater data in the vicinity of Area 2 (Figure 7 of URS, 2012), it appears that the C/I RBSLs for several VOCs (i.e., chloroform, PCE, and TCE) are likely exceeded between the

southern boundary of the Montrose site and beyond well XMW-16 for an uncertain distance to the southeast, south, and southwest, but likely no further than the current understanding of the dissolved TCE plume in the water table zone (Figure 9 of URS, 2012). Similarly, based on a comparison of the modeled residential RBSLs (Table 9), with the limited groundwater data in the vicinity of well XMW16, the extent of elevated VOCs found in the well is uncertain. The potential cumulative risk of 3E-4 for a C/I exposure scenario in combination with the lack of spatial and temporal groundwater data suggests that the VI pathway in Area 2 warrants further characterization and assessment.

Similar to Area 1, it was decided that modeling benzene biodegradation would not significantly reduce the overall risk/hazard being driven by the chlorinated VOCs and thereby any decision made based on this site-specific screening evaluation. Therefore, BioVapor was not run for Area 2.

### 3.2.3 Area 3—Residences South of the Del Amo Waste Pits

Based on current land use, Area 3 was only evaluated for a residential exposure scenario. The modeled, VI pathway risk and hazard estimates for Area 3, assuming no biological degradation, are summarized in Table 10. The estimated cumulative risk for the VI pathway in the vicinity of well SWL0008, without biological degradation, was 9E-6 and the estimated HI was 0.3, with only benzene as the risk driver.

| Risk Driver | Risk (ELCR) | Hazard (HQ) |
|---|---|---|
| Benzene | 9E-6 | 0.3 |
| Benzene (with BioVapor) | 3E-7 | 0.1 |

Because benzene, a petroleum hydrocarbon, was the only risk driver and it is known that petroleum hydrocarbons aerobically biodegrade in the presence of oxygen (EPA, 2013b), the BioVapor model (API, 2010) was run so that biological degradation could be accounted for in order to provide a more realistic estimate of potential risk and hazard. The BioVapor modeling input and output sheets as well as the associated enhanced J&E modeling input and output sheets are included in Appendix E. The modeled, VI pathway risk and hazard estimates for Area 3, assuming biological degradation of petroleum hydrocarbons, are summarized in Table 11. Assuming biological degradation of all the detected petroleum hydrocarbons including benzene, the resulting estimated cumulative risk for the VI pathway was 3E-7 and the estimated HI was 0.1, below the risk/hazard threshold for unacceptable exposure (EPA, 1990).

A comparison of the modeled RBSLs (Tables 10 and 11) and available groundwater data in the vicinity of Area 3 (Figure 7 of URS, 2012) indicates that none of the non-petroleum VOCs detected in the 2012 groundwater samples from wells SWL008 or SWL0051 exceed or approach

the residential RBSLs. For example, the reported TCE concentrations of 5.3 µg/L at well SWL0008 and 9.1 µg/L at well SWL0051 do not exceed or approach their modeled RBSL of 27 µg/L (Table 10), which indicates TCE does not appear to pose an increased or unacceptable VI health risk to residents in vicinity of wells SWL0008 or SWL0051.

Based on the area-specific modeling effort using RBSLs, Area 3 does not appear to require further characterization or assessment of the VI pathway. However, comparison of the groundwater TCE concentration to the generic VISL indicates that an area of Area 3 may require additional evaluation (see also, Section 4.0).

## 3.3 Data Gaps, Uncertainties, and Limitations

The following subsections describes data gaps, uncertainties, and limitations identified while screening the VI pathway based on modeled AFs and limited groundwater data.

### 3.3.1 Data Gaps

The following data gaps were identified while completing the screening evaluation and should be addressed by additional data gathering:

- The limited set of available groundwater data both spatially and temporally, creates a need for further delineation of constituent concentrations in groundwater and more VI modeling to confirm the screening evaluation or sampling at the location of the receptor to confirm or rule out the VI pathway.
- Confirm whether there are or are not preferential pathways in the subsurface that can affect the VI pathway. This can be a substantial challenge to be contended with. Sampling closer to the receptor can help control aberrant results, coupled with multi-depth soil gas sampling to confirm or rule out vadose zone contribution to the VI pathway. Available lithological and depth to groundwater data utilized in this phase of the evaluation is included in Table 5.
- Confirm whether the vadose zone includes sufficient levels of oxygen to support natural degradation of petroleum hydrocarbons where they may be risk drivers for decision making. In situ measurements can resolve this data need.
- As concentrations can change with groundwater movement in time, sampling of indoor air at the location of the receptor can provide real-time characterization of VI and lessen the need to be dependent on groundwater concentrations to evaluate the VI pathway.
- Data sets for off-site subsurface soil gas or sub-slab vapor concentrations are not currently available to confirm or rule out VI for residential or C/I buildings. Even so, evaluation of such data for VI would still require an AF to estimate the indoor air

concentration and impact to human health. AFs are intended to be health-protective, but they also introduce uncertainties by being conservative (EPA, 2012b). Further, sampling of subsurface soil gas or sub-slab vapor concentrations suffer from both temporal and spatial variation (Folkes, et al., 2009) based on observations with time or weather conditions. A more direct approach is to measure indoor air with consideration for potential indoor air sources and potential false positives based on ambient air where needed.

- Building specifications, especially for the ventilation air exchange rate, ceiling height, and idiosyncratic contents of the buildings, can affect indoor air exposure concentrations. Even outdoor barometric pressure, wind speed and direction, and temperature can affect indoor air constituent concentrations. These are good reasons to collect and evaluate winter and summer VI data. Indoor air concentrations at the location of the receptor help to characterize protection of the receptor or what might be required to achieve such protection.

### 3.3.2 Uncertainties

A VI pathway screening evaluation is designed to be conducted in a health-protective fashion to favor Type I (false positive) error over Type II (false negative) error in the results. Parameters for modeling involve environmental media including contaminant concentrations, sources, pathways, receptors, exposure scenarios, and building specifications. A problem arises that with so many parameters chosen in a conservative fashion, the product of the evaluation can severely over-estimate VI risk/hazard impact because of compounding conservatisms (Burmaster and Harris, 1993). Severe over-estimation often provides a result that may be so conservative as to not be useful for decision making. Such modeling usually requires real-world confirmation—what is now commonly called multiple lines of evidence.

As described in the EPA's document *Uncertainty and the Johnson-Ettinger Model for Vapor Intrusion Calculations, Office of Research and Development* (EPA, 2005), many of the input parameters of the J&E model have significant degrees of uncertainty (i.e., building properties), particularly when the model is used in a generic sense where parameters are not measured on a site-specific basis nor calibrated to measured indoor air concentrations. A necessary step in model application is calibration of results to field data. In situations where the model is not calibrated to measured indoor air data, and subsequently demonstrated to have predictive capability, the input parameters cannot be assured to represent the properties of the flow system.

Similarly, variation in lithology of the subsurface in the various areas and neighborhoods may produce inconsistencies in VI impacts, even with indoor air sampling among nearby buildings. Such inconsistencies have been found for residential homes over TCE groundwater plumes in Endicott, New York and Redfield, Colorado (Folkes, et al., 2009). Sampling closer to the

receptor with complementary two-depth soil gas sampling when indoor thresholds are exceeded can control this uncertainty by establishing building-specific, empirical AFs for comparison among buildings (EPA, 2013c).

### 3.3.3 Limitations

Potential limitations in addressing data gaps and uncertainties are tied to the advantages and disadvantages of the sampling approaches. The limitation in a modeling approach is that an impact concentration is being estimated for a remote location based on a model, equation, algorithm, or AF applied to a source concentration. Indirect pathways like VI require it. Inaccuracies or uncertainties in the inputs inherently lead to inaccuracies in the outputs. The need is for real-world confirmation, as in direct measurement. As an example, if indoor air, soil gas, and sub-slab testing are compared to modeling of groundwater concentrations, the attributes for and against can be itemized as follows:

| Sampling Approach | Advantages | Disadvantages |
|---|---|---|
| Modeling of Groundwater Concentrations | • Health-protective assessment is accessible based on existing data.<br>• The model run provides a record that can be modified as parameters change going forward.<br>• Model parameters can be calibrated as site characterization increases. | • Use of maximum concentrations may not represent applicable exposure conditions; additional groundwater data gathering would be required to determine representative concentrations<br>• Should be conducted with winter/summer groundwater concentrations to compare results for site characterization. |
| Soil Gas Sampling | • Data collection with quality assurance support can be implemented on-site in real time.<br>• Re-sampling can be conducted if needed.<br>• Grab-sampling can be conducted with a glass syringe for on-site analysis or grab- or time-weighted sampling with Summa canister can be conducted for off-site, fixed lab analysis. | • Data collection required in numerous yards of neighborhood homes and buildings.<br>• AF required to evaluate results.<br>• Individual and multiple-property results must be compared for consistency among building-specific, empirical attenuation factors and potential preferential pathways. |
| Sub-Slab Sampling | • Data provide accumulation concentrations beneath homes and buildings; may identify hot spots or preferential pathways.<br>• Re-sampling can be conducted if needed.<br>• Can be conducted with glass syringe or Summa canister.<br>• Vapor probes may be left in place for temporal sampling. | • AF required to evaluate results.<br>• Permission from residents and businesses to drill through floor required.<br>• Results indicating VI impact would necessitate indoor air sampling to confirm or rule out impact. |
| Indoor Air Sampling | • Grab-sample analysis results can be obtained at time of sampling and analysis. | • Indoor air sources may create false positives. |

| | | |
|---|---|---|
| | • Re-sampling can be conducted if needed.<br>• Sampling results provide concentrations at the locations of the receptors.<br>• Contact with residents is more immediate.<br>• Sampling includes all of the vapor contributions from subsurface, vadose zone, and ambient air.<br>• An AF is not required to evaluate the data.<br>• If grab-sample results exceed exposure thresholds, time-weighted samples can be collected in real time followed by off-site lab analysis.<br>• If grab-sample and/or time-weighted-sample results exceed exposure thresholds, on-property soil gas sampling can be conducted to corroborate results and determine building-specific, empirical AFs.<br>• Exceedance of exposure thresholds prompts steps to mitigate exposure more quickly than with other sampling sequences.<br>• Buildings to be sampled should be itemized for those in Areas 1, 2, and 3 overlying groundwater constituents with concentrations that exceed the concentrations determined using the VISL and/or RBSL approaches plus 100 feet for the chlorinated VOC attenuation distance (EPA, 2002; ASTM International, E2600-10). | • Ambient air toxics may indicate false positives.<br>• Winter/summer re-sampling is necessary to confirm or rule out indoor results.<br>• Iterations of sampling and analysis increase site characterization costs. |
| Any sampling program representing neighborhoods or groups of business buildings will require an inventory for tracking of on-property activities, as well as access permissions from the property owners. All of this would be expected to be conducted through a community outreach program, conducted from the beginning of the off-site VI monitoring effort and continuing through characterization and control of potential VI pathways from off-site groundwater. | | |

Determination of representative concentrations was identified as a data gap for modeling from currently available groundwater monitoring data. By sampling at the receptor for inhalation air concentration the need for representative concentrations in groundwater is precluded.

There is an element of uncertainty in how/whether the indoor air results provide consistency among groups of homes and buildings. This has been found in large sampling efforts conducted for homes situated over TCE plumes in groundwater (Folkes, et al., 2009), and will be given consideration in this case as well.

Sampling of sub-slab or subsurface soil gas could provide representative samples, but the basic need would still remain to select a slab attenuation factor that would convert the soil gas

concentration to the exposure point concentration for human inhalation exposure. Even with support from the EPA vapor intrusion database (EPA, 2012b), uncertainty is inherent in the accuracy of the AFs compiled therein. Therefore, sampling of indoor air with the option to resample and reanalyze is the more direct approach (Interstate Technology & Regulatory Council, 2007).

The approaches for VI confirmation sampling described herein constitute a framework within which Areas 1, 2, and 3 can be tested and confirmed or ruled out for VI concern. The results will provide a more certain basis for determining whether there is a need for mitigation action to prevent VI exposure and, if so, identifying the best approach for health protection. If confirmed, the framework provides steps where mitigation action may be taken. If ruled out, the framework provides a consistent database for comparisons among groups of homes and buildings to characterize the nature of VI in the off-site neighborhood while groundwater remediation is occurring.

# 4.0 Recommendations

These recommendations are based on EPA and other guidance and technical study. They are offered for use by the stakeholders in consultation with EPA.

Based on historical VI evaluations (CH2M Hill, 2012 and Tetra Tech, 2013) and the two screening evaluations presented in this TM, it appears that there are several lines of evidence indicating that the VI pathway warrants additional characterization and further assessment at all three areas of potential concern. Both screening evaluations in this TM indicate that off-site groundwater concentrations may have a potential for a complete VI pathway to off-site buildings. These evaluations are deliberately conservative (i.e., health protective) to bound the identified uncertainties and data gaps. Even so, EPA (2002), Appendix G (Considerations for the Use of the Johnson and Ettinger Vapor Intrusion Model), cautions against assuming that results of J&E modeling are necessarily health protective. Consequently, they are insufficient to definitively evaluate the off-site VI pathway.

Therefore, to provide confidence in protection of human health, it is recommended that confirmation indoor air sampling begin at homes and businesses within 100 feet, the chlorinated VOC attenuation distance (EPA, 2002; ASTM International, 2010), of the wells with concentrations that exceed the most stringent screening levels derived by the empirical and modeled AF approaches in this TM, as shown on Figure 4.

# 5.0 Phase 3—Plan Development

The EPA's Environmental Response Team has planned for up to four phases of work for VI investigations at OU-3. Phase 3 consists of developing a detailed plan to collect specific information necessary to further evaluate the VI pathway. This section presents a sampling and analysis plan outline to provide a basis for indoor air sampling. A detailed sampling and analysis plan is to be completed following stakeholder's approval of this conceptual plan, and will be submitted to EPA and stakeholders for review and approval.

These next steps, to be expanded or contracted based on discussion with stakeholders, generally consist of the following:

- Conceptual site model
- Project quality objectives
- Sampling approach, design, and rational
  - Sampling approach
    - Community outreach
    - Inventory of buildings
    - Ambient air background sampling
    - Sampling of indoor air
    - Re-sampling
    - Step out sampling
  - Design and rational
- Lab analysis
- Project action limits
- Project quality assurance and quality control
- Data gaps, uncertainties, and limitations

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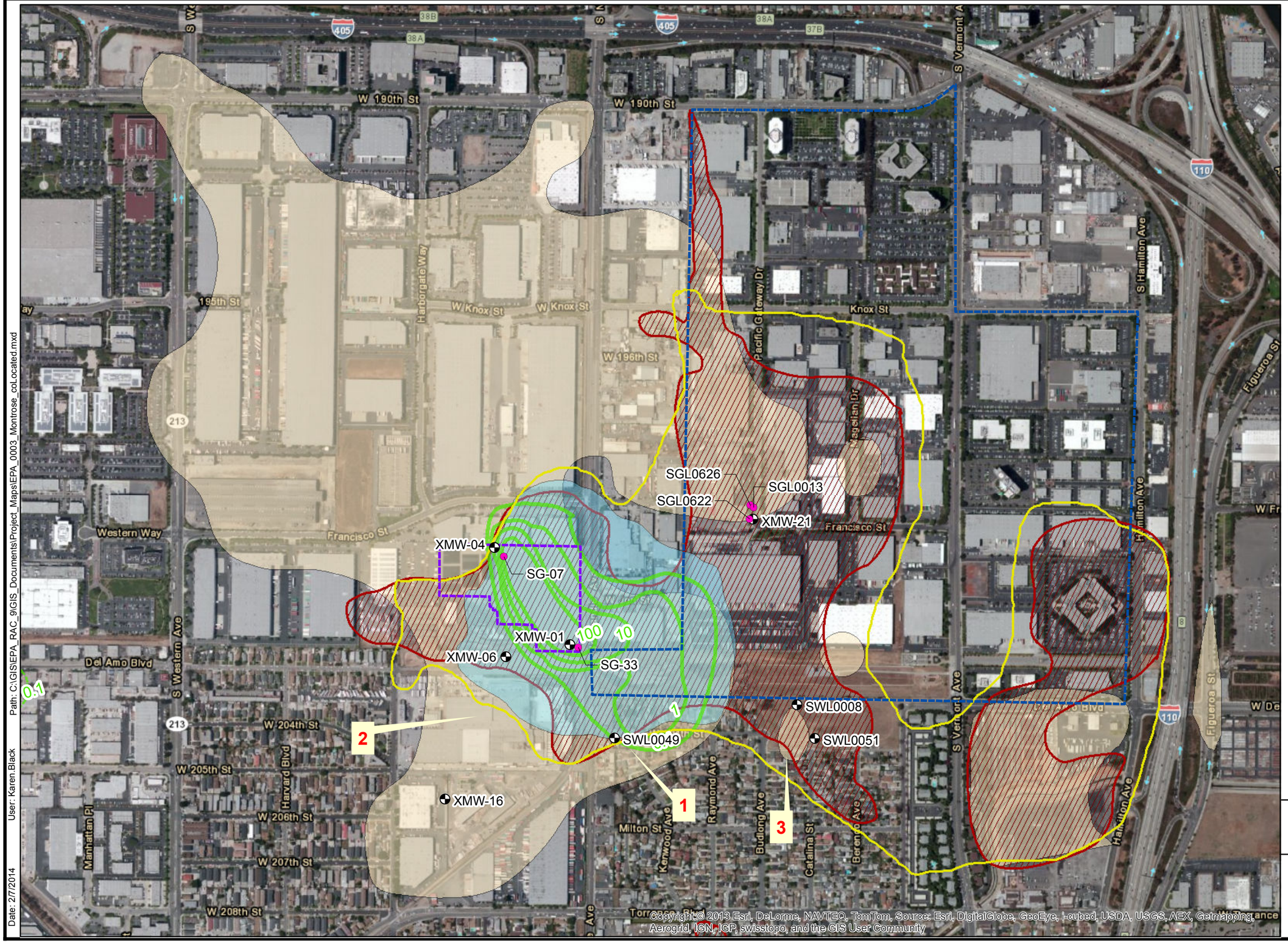
# Figures



**Legend**

- Well Location Used for VI Screening Evaluation
- Soil Gas Sampling Location Used for AF Calculations
- Montrose Property
- Del Amo Site
- Containment Zone, as presented in the groundwater ROD (EPA, 1999)
- Contour line of equal concentration of MCB in mg/L dashed where approximate, dashed where inferred
- Schematic Chlorobenzene Plume >0.07 mg/L
- Schematic Benzene Plume > 0.001 mg/L
- Schematic TCE Plume > 0.001 mg/L
- 3 Approximate area recommended for further VI evaluation

Notes:
0.001 mg/L (milligram per liter) = 1 µg/L (microgram per liter)
TCE= Trichloroethylene
VI = vapor intrusion

Sources: AECOM 2012; CH2MHILL 2007, 2012; URS 2012; TetraTech, 2013

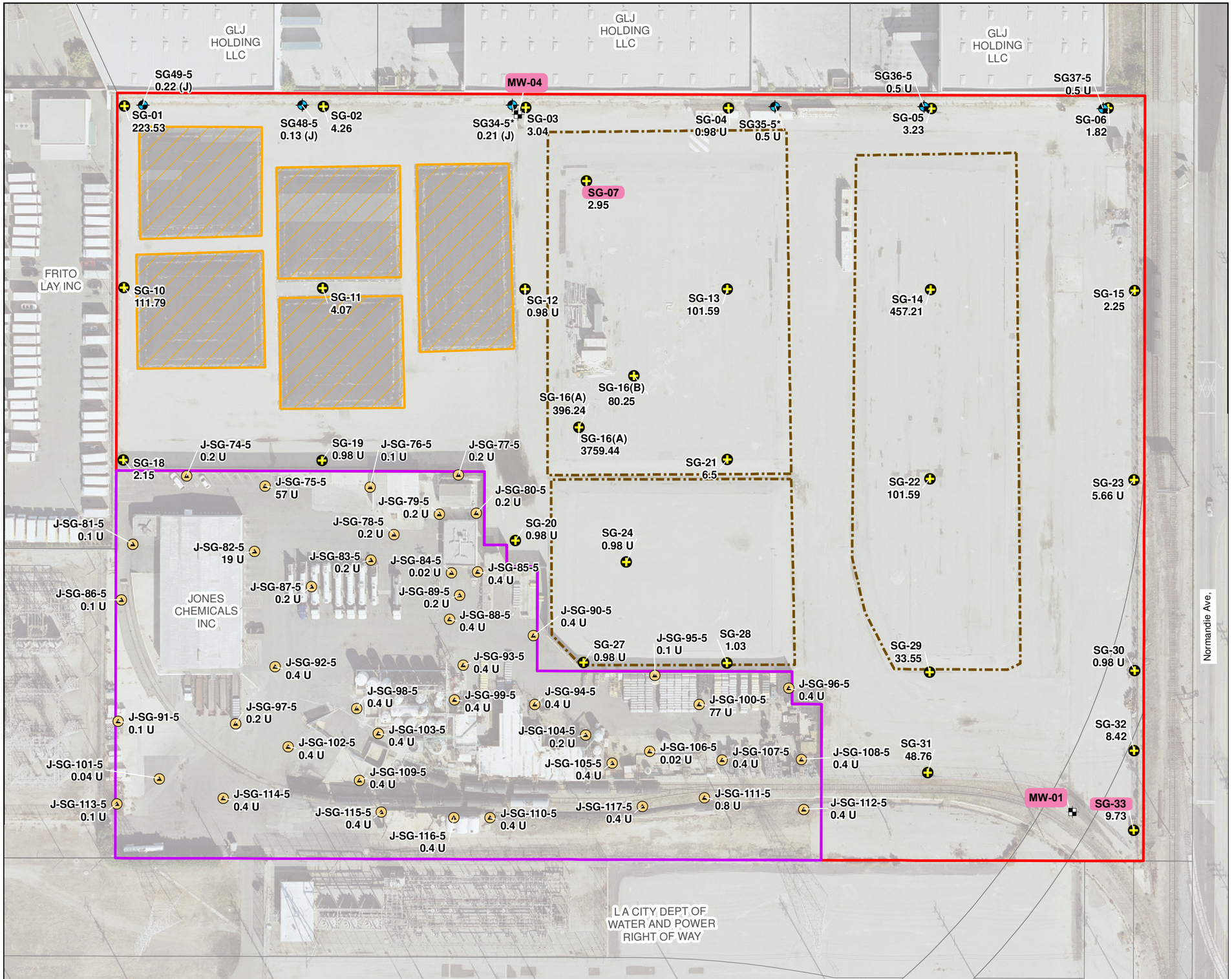
0 375 750 1,500
Feet

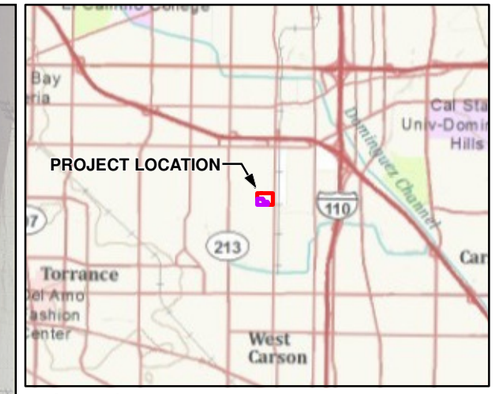
CBI

FIGURE 1
AREAS RECOMMENDED FOR FURTHER VI EVALUATION

MONTROSE AND DEL AMO SUPERFUND SITES
TORRANCE, CALIFORNIA

Date: 2/7/2014 User: Karen.Black Path: C:\GIS\EPA_RAC_9\GIS_Documents\Project_Maps\EPA_0003_Montrose_coLocated.mxd




**Legend**

- Groundwater Monitoring Wells (locations are approximate)
- Soil Gas Borings on Jones Chemical Property
- Soil Gas Borings on Montrose Property
- Soil Gas Borings on Montrose Property (July 2010)
- Former Montrose Chemical Plant Property
- JCI Jones Chemical Inc.
- County Parcels
- Soil Cells
- Raised Pads
- Groundwater and soil gas well pairs

**Note:**
1. Montrose data from October 2003 and July 2010. Jones Chemical data from May 2010.
2. Chlorobenzene concentration at 5 feet below ground surface in ug/L

**Base Image:** EPA High Resolution Orthoimage, Flown February 3, 2007 0.25-Foot Pixel Resolution

N

0 100 200
Feet

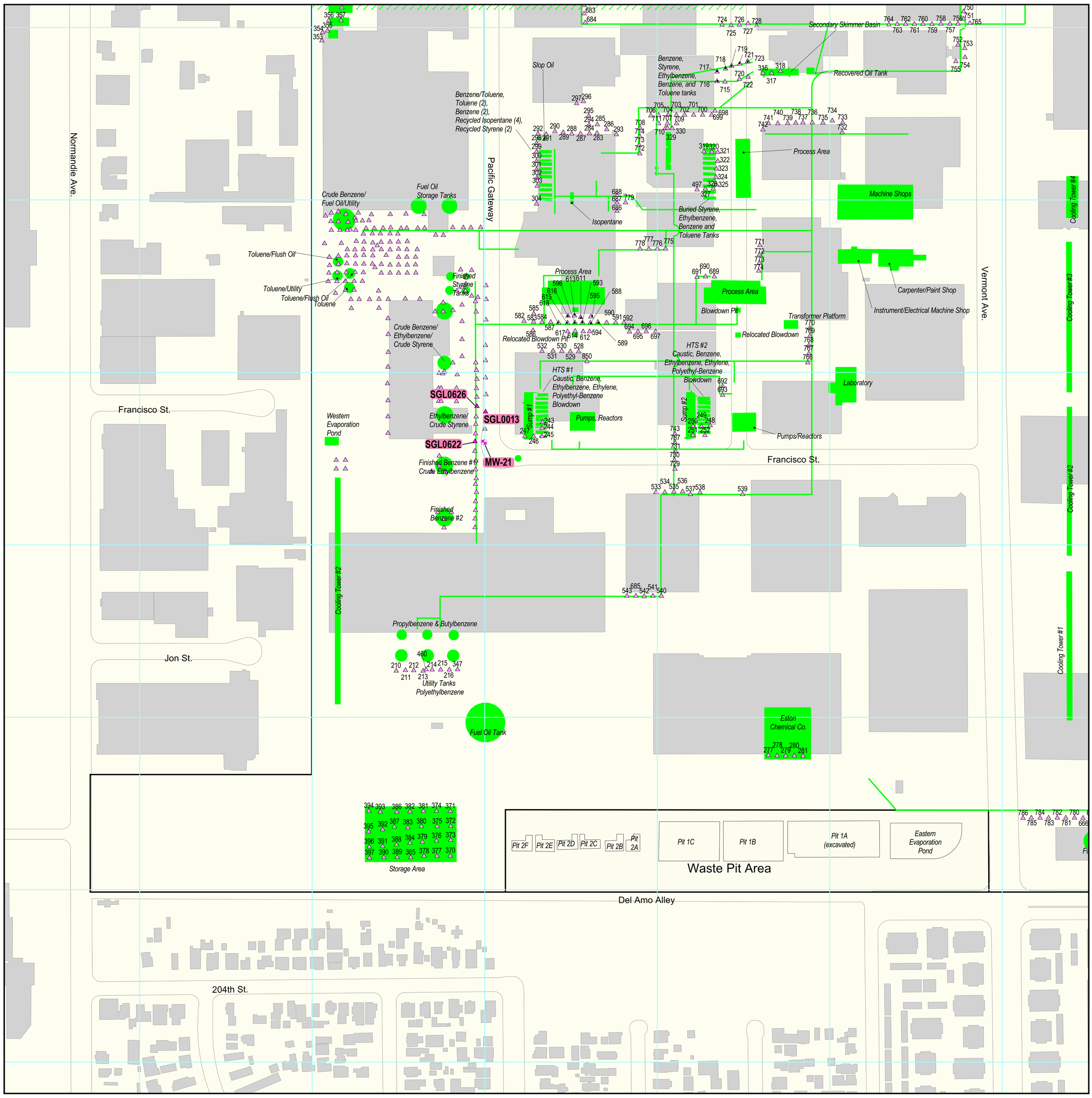
1 inch = 100 feet

FIGURE 2

**Co-located Soil Gas and Groundwater Sampling Locations at the Montrose Superfund Site**

ES111913053234BOI

BAO ZINFANDEL F:\GIS\PROJ\USENVIRONMENTALPROTE\COMMONFILES\GIS\MONTROSE_OU1\MAPFILES\2011\CHLOROBENZENE_5FT.MXD CARCHER 7/20/2011 3:00:31 PM




**Legend**

- RI/FS shallow soil gas sampling location
- Soil gas sampling locations used for AF calculations
- Monitoring Well (approximate location)
- Groundwater and soil gas pairs
- Former rubber plant facilities and features evaluated as part of the RI
- Current building

Note: RI and non-RI soil gas samples collected between 1991 and 1997

Note: all RI/FS soil gas sampling location identifiers consist of an "SGL" prefix followed by a four-digit number. Only the last three digits of that number are shown on this map. For example, SGL0215 is identified on the map as "215".

Note: Soil gas location source: Del Amo RI Report Soil and NAPL Operable Unit

FIGURE 3

**Co-located Soil Gas and Groundwater Sampling Locations at Del Amo Site**

ES111913053234BOI

Legend

- Well Location Used for VI Screening Evaluation
- Former Montrose Property
- Former Del Amo Property
- Proposed Vicinity of Further VI Evaluation (100 feet from well) 3

Note: VI = vapor intrusion

N

0 200 400
Feet

CBI

FIGURE 4
PROPOSED VICINITY OF FURTHER INVESTIGATION

MONTROSE AND DEL AMO SUPERFUND SITES
TORRANCE, CALIFORNIA

Date: 3/5/2014 User: billjensen Path: J:\EPA_RAC_9\GIS_Documents\Project_Maps\EPA_0004_Montrose_futureVI.mxd

# Tables

TABLE 1
**Selected Well Pairs for the Montrose and Del Amo Superfund Sites**
*Montrose and Del Amo Superfund Sites, Torrance, California*

| Site Name | Groundwater Monitoring Well | Soil Vapor Monitoring Location | Target Analytes |
|---|---|---|---|
| Montrose | MW-04 | SG-03 | TCE and Chlorobenzene |
| | MW-01 | SG-33 | TCE and Chlorobenzene |
| Del Amo | MW-21 | SGL0013 | Benzene |
| | | SGL0622 | Benzene |
| | | SGL0626 | Benzene |

**TABLE 2**

Site-Specific Vapor Intrusion Attenuation Factor Calculation at the Montrose Superfund Site

*Estimate of Vapor Intrusion Attenuation Factors at Montrose and Del Amo Superfund Sites, Torrance, California*

| **Chlorobenzene** | **Henry's law Unitless** | **0.127** | | | | | |
|---|---|---|---|---|---|---|---|
| Locations | Matrix | Sampling Depth (ft bgs) | Sampling Date | Chlorobenzene Concentration (µg/L) | Vapor Concentration at the Source (µg/L) | Groundwater - Shallow Soil Gas Attenuation Factor | Groundwater - Indoor Air Attenuation Factor |
| MW-04 | Groundwater | -- | Jan-04 | 3900 | 495.3 | 6.1E-03 | 3.1E-04 |
| SG-03 | Soil Gas | 5 | Oct-03 | 3.04 | | | |
| | | | | | | | |
| MW-01 | Groundwater | -- | Jan-04 | 130000 | 16510 | 5.9E-04 | 2.9E-05 |
| SG-33 | Soil Gas | 5 | Oct-03 | 9.73 | | | |
| **Average for Chlorobenzene** | | | | | | **3.4E-03** | **1.7E-04** |

| **TCE** | **Henry's law Unitless** | **0.403** | | | | | |
|---|---|---|---|---|---|---|---|
| Locations | Matrix | Sampling Depth (ft bgs) | Sampling Date | TCE Concentration (µg/L) | Vapor Concentration at the source (µg/L) | Groundwater - Shallow Soil Gas Attenuation factor | Groundwater - Indoor Air Attenuation factor |
| MW-04 | Groundwater | -- | Jan-04 | 56 | 22.5 | Not Calculated | |
| SG-03 | Soil Gas | 5 | Oct-03 | 0.98 U | | | |
| | | | | | | | |
| MW-01 | Groundwater | -- | Jan-04 | 210 | 84.5 | 1.2E-02 | 5.8E-04 |
| SG-33 | Soil Gas | 5 | Oct-03 | 0.98 | | | |
| **Average for TCE** | | | | | | **1.2E-02** | **5.8E-04** |

Notes:

bgs = below ground surface

ft = feet

TCE = Trichloroethene

µg/L = microgram per liter

Assuming a 0.05 attenuation factor between shallow soil gas and indoor air.

**TABLE 3**

Site-Specific Vapor Intrusion Attenuation Factor Calculation at the Del Amo Superfund Site

*Estimate of Vapor Intrusion Attenuation Factors at Montrose and Del Amo Superfund Sites, Torrance, California*

| **Benzene** | **Henry's law Unitless** | **0.227** | | | | |
|---|---|---|---|---|---|---|
| Locations | Sampling Depth (ft bgs) | Sampling Date | Benzene Concentration (µg/L) | Vapor Concentration at the Source (µg/L) | Groundwater - Shallow Soil Gas Attenuation Factor | Groundwater - Indoor Air Attenuation Factor |
| MW-21 | -- | Jun-94 | 12739 | 2890 | -- | -- |
| SGL0622 | 7 | Mar-94 | 0.16 | | 5.6E-05 | 2.8E-06 |
| SGL0626 | 7 | Mar-94 | 0.02 | | 7.6E-06 | 3.8E-07 |
| **Average for Benzene** | | | | | 3.2E-05 | 1.6E-06 |

Notes:

bgs = below ground surface

ft = feet

µg/L = microgram per liter

Assuming a 0.05 attenuation factor between shallow soil gas and indoor air.

TABLE 4
**Summary of Attenuation Factors and Screening Levels**
*Montrose and Del Amo Superfund Sites, Torrance, California*

| Analyte | Average Site-Specific Groundwater to Indoor Air Attenuation Factor (unitless) | Groundwater to Indoor Air VISL using Site-Specific Attenuation Factor (µg/L) | Groundwater to Indoor Air VISL using Default Attenuation Factor of 0.001 (µg/L) |
|---|---|---|---|
| Benzene | $1.6 \times 10^{-6}$ | 860 | 1.4 |
| Chlorobenzene | $1.7 \times 10^{-4}$ | 2400 | 410 |
| Trichloroethene | $5.8 \times 10^{-4}$ | 1.8 | 1.1 |

Table 5

Lithologic Layer Assignment for Vadose Zone - Areas 1, 2, and 3

Dual Site Groundwater Operable Unit, Montrose and Del Amo Superfund Sites, Torrance, California

Summarized from the boring logs for the nearest wells to each area

| | DTW (2012) (ft bgs) | Soil Type | Thickness (ft) | SCS Code Selected |
|---|---|---|---|---|
| Area 1 | | | | |
| SWL0049 | 42.95 | Loamy sand | 23.35 | LS |
| | | Sand | 14.9 | S |
| | | Loam | 2.4 | L |
| | | Silt | 2.3 | |
| Area 2 | | | | |
| MW-6 | 55.2 | Silt | 30 | SI |
| | | Loamy sand | 25.2 | LS |
| Area 3 | | | | |
| SWL0008 | 41.11 | Sand | 1.0 | S |
| | | Silt | 2.5 | |
| | | Loam | 23 | L |
| | | Sandy loam | 14.61 | SL |

Notes:

Lithologic layers were summarized from surface grade down to the water table measured in 2012.

Table 5

Lithologic Layer Assignment for Vadose Zone - Areas 1, 2, and 3

Dual Site Groundwater Operable Unit, Montrose and Del Amo Superfund Sites, Torrance, California

Details:

| | DTW (2012) (ft bgs) | Depth Interval (ft) | Thickness (ft) | Soil Type | Soil Code (USCS) | Description |
|---|---|---|---|---|---|---|
| Area 1 | | | | | | |
| SWL0049 | 42.95 | 0-5 | 5 | Sand | Fill | Silty gravel |
| | | 5-17.5 | 12.5 | Loamy sand | SM | Silty very fine sand with trace fine gravel |
| | | 17.5-18.75 | 1.25 | Sand | SP | Fine sand with trace silt |
| | | 18.75-18.85 | 0.1 | Silt | ML | Silt with trace clay |
| | | 18.85-24.9 | 6.05 | Sand | SP | Fine sand with trace silt |
| | | 24.9-27.5 | 2.6 | Sand | SM | Silty sand with trace clay |
| | | 27.5-36.95 | 9.45 | Loamy sand | SP | Very fine sand |
| | | 36.95-37.35 | 0.4 | Silt | ML | Silt with some very fine sand |
| | | 37.35-37.6 | 0.25 | Loamy sand | SM | Silty sand |
| | | 37.6-39.4 | 1.8 | Silt | ML | Silt |
| | | 39.4-41.8 | 2.4 | Loam | SM | Very fine silty sand |
| | | 41.8-42.95 | 1.15 | Loamy sand | SP | Very fine sand |
| Area 2 | | | | | | |
| MW-6 | 55.2 | 0-30 | 30 | Silt | ML | Silt |
| | | 30-55.2 | 25.2 | Loamy sand | SP | Sand, miost, (very) dense, fine-grained |
| Area 3 | | | | | | |
| SWL0008 | 41.11 | 0-1 | 1 | Sand | -- | Crushed rock surface cover |
| | | 1-24 | 23 | Loam | SM | Silty fine to very fine sand |
| | | 24-36 | 12 | Sandy loam | SP | Fine to medium sand, medium dense, moist |
| | | 36-38.5 | 2.5 | Silt | ML | Silt, with some clay, trace very fine sand |
| | | 38.5-41.11 | 2.61 | Sandy Loam | SM | Silty fine sand, dense, moist |

Notes:

Details only summarized down to water level measured in 2012.
OU denotes Operable Unit
AOC denotes Area of Concern
DTW denotes depth to water beneath ground surface
ft denotes feet
bgs denotes below ground surface
SCS denotes U.S. Soil Conservation Service

LS denotes Loamy Sand
S denotes Sand
L denotes Loam
SI denotes Silt
SL denotes Sandy Loam
USCS denotes Unified Soil Classification System
USCS soil codes are defined within the table entries

The SCS (U.S. Soil Conservation Soil system) of the National Resource Conservation System (NRCS) and the U.S. Department of Agriculture (USDOA) is prominently cited throughout the guidance and U.S. EPA spreadsheets of the Johnson-Ettinger model (EPA, 2004). The USCS is widely used by engineers and geologists.

Table 6
Area 1, Residential Exposure Scenario for Vapor Intrusion Screening
Dual Site Groundwater Operable Unit, Montrose and Del Amo Superfund Sites, Torrance, California

| Detected VOCs | CAS Number | Detected Conc. (µg/L) | RBSL(ca) (µg/L) | Risk (ELCR) | RBSL(nc) (µg/L) | Hazard Quotient (HQ) | Well ID | Sample Collection Date | Source of Sample Data |
|---|---|---|---|---|---|---|---|---|---|
| 1,1-Dichloroethylene | 75354 | 1.3 | NA | NA | 1,438 | 0.0009 | SWL0049 | 11/5/2012 | URS, 2012 |
| 1,2,4-Trichlorobenzene | 120821 | 3.6 | NA | NA | 1,374 | 0.003 | SWL0049 | 11/5/2012 | URS, 2012 |
| 1,2-Dichlorobenzene | 95501 | 3.9 | NA | NA | 61,667 | 0.00006 | SWL0049 | 11/5/2012 | URS, 2012 |
| 1,2-Dichloroethane | 107062 | 280 | 32 | 9E-6 | 2,494 | 0.1 | SWL0049 | 11/5/2012 | URS, 2012 |
| 1,4-Dichlorobenzene | 106467 | 11 | 54 | 2E-7 | 79,000 * | 0.0001 | SWL0049 | 11/5/2012 | URS, 2012 |
| Benzene | 71432 | 39 | 7.5 | 5E-6 | 2,812 | 0.01 | SWL0049 | 11/5/2012 | URS, 2012 |
| Chlorobenzene | 108907 | 2,900 | NA | NA | 8,148 | 0.4 | SWL0049 | 11/5/2012 | URS, 2012 |
| Cyclohexane | 110827 | 130 | NA | NA | 39,812 | 0.003 | SWL0049 | 11/5/2012 | URS, 2012 |
| Ethylbenzene | 100414 | 6.5 | 75 | 9E-8 | 80,151 | 0.00008 | SWL0049 | 11/5/2012 | URS, 2012 |
| Cumene | 98828 | 7.2 | NA | NA | 268 | 0.03 | SWL0049 | 11/5/2012 | URS, 2012 |
| Methylethylketone (2-butanone) | 78933 | 10 | NA | NA | 13,612,799 | 0.0000007 | SWL0049 | 11/5/2012 | URS, 2012 |
| Tetrachloroethylene | 127184 | 61 | 14 | 4E-6 | 1,282 | 0.05 | SWL0049 | 11/5/2012 | URS, 2012 |
| Toluene | 108883 | 3.5 | NA | NA | 24,375 | 0.0001 | SWL0049 | 11/5/2012 | URS, 2012 |
| Trichloroethylene | 79016 | 91 | 33 | 3E-6 | 116 | 0.8 | SWL0049 | 11/5/2012 | URS, 2012 |
| cis-1,2-Dichloroethylene | 156592 | 3.5 | NA | NA | 4,983 | 0.0007 | SWL0049 | 11/5/2012 | URS, 2012 |
| m-Xylene | 108383 | 2.8 | NA | NA | 9,142 | 0.0003 | SWL0049 | 11/5/2012 | URS, 2012 |
| n-Butylbenzene | 104518 | 4.6 | NA | NA | 2,000 * | 0.002 | SWL0049 | 11/5/2012 | URS, 2012 |
| sec-Butylbenzene | 135988 | 5.6 | NA | NA | 3,940 * | 0.001 | SWL0049 | 11/5/2012 | URS, 2012 |
| Cumulative Risk | | | | 2E-5 | | | | | |
| Hazard Index | | | | | | 1.3 | | | |

Notes:

* based on the pure component water solubility limit

µg/L denotes micrograms per liter

ca denotes carcinogenic

CAS denotes Chemical Abstract Service

conc. denotes concentration

ELCR denotes excess lifetime cancer risk

NA denotes none available

nc denotes non-carcinogenic

RBSL denotes risk-based screening level

Table 7
Area 1, Commercial/Industrial Exposure Scenario for Vapor Intrusion Screening
Dual Site Groundwater Operable Unit, Montrose and Del Amo Superfund Sites, Torrance, California

| Detected VOCs | CAS Number | Detected Conc. (µg/L) | RBSL(ca) (µg/L) | Risk (ELCR) | RBSL(nc) (µg/L) | Hazard Quotient (HQ) | Well ID | Sample Collection Date | Source of Sample Data |
|---|---|---|---|---|---|---|---|---|---|
| 1,1-Dichloroethylene | 75354 | 1.3 | NA | NA | 12,077 | 0.0001 | SWL0049 | 11/5/2012 | URS, 2012 |
| 1,2,4-Trichlorobenzene | 120821 | 3.6 | NA | NA | 11,538 | 0.0003 | SWL0049 | 11/5/2012 | URS, 2012 |
| 1,2-Dichlorobenzene | 95501 | 3.9 | NA | NA | 156,000 * | 0.00003 | SWL0049 | 11/5/2012 | URS, 2012 |
| 1,2-Dichloroethane | 107062 | 280 | 322 | 9E-7 | 20,947 | 0.01 | SWL0049 | 11/5/2012 | URS, 2012 |
| 1,4-Dichlorobenzene | 106467 | 11 | 542 | 2E-8 | 79,000 * | 0.0001 | SWL0049 | 11/5/2012 | URS, 2012 |
| Benzene | 71432 | 39 | 76 | 5E-7 | 23,621 | 0.002 | SWL0049 | 11/5/2012 | URS, 2012 |
| Chlorobenzene | 108907 | 2,900 | NA | NA | 68,441 | 0.04 | SWL0049 | 11/5/2012 | URS, 2012 |
| Cyclohexane | 110827 | 130 | NA | NA | 55,000 * | 0.002 | SWL0049 | 11/5/2012 | URS, 2012 |
| Ethylbenzene | 100414 | 6.5 | 754 | 9E-9 | 169,000 * | 0.00004 | SWL0049 | 11/5/2012 | URS, 2012 |
| Cumene | 98828 | 7.2 | NA | NA | 2,254 | 0.003 | SWL0049 | 11/5/2012 | URS, 2012 |
| Methylethylketone (2-butanone) | 78933 | 10 | NA | NA | 114,347,510 | 0.00000009 | SWL0049 | 11/5/2012 | URS, 2012 |
| Tetrachloroethylene | 127184 | 61 | 146 | 4E-7 | 10,772 | 0.006 | SWL0049 | 11/5/2012 | URS, 2012 |
| Toluene | 108883 | 3.5 | NA | NA | 204,752 | 0.00002 | SWL0049 | 11/5/2012 | URS, 2012 |
| Trichloroethylene | 79016 | 91 | 334 | 3E-7 | 978 | 0.09 | SWL0049 | 11/5/2012 | URS, 2012 |
| cis-1,2-Dichloroethylene | 156592 | 3.5 | NA | NA | 41,858 | 0.00008 | SWL0049 | 11/5/2012 | URS, 2012 |
| m-Xylene | 108383 | 2.8 | NA | NA | 76,791 | 0.00004 | SWL0049 | 11/5/2012 | URS, 2012 |
| n-Butylbenzene | 104518 | 4.6 | NA | NA | 2,000 * | 0.002 | SWL0049 | 11/5/2012 | URS, 2012 |
| sec-Butylbenzene | 135988 | 5.6 | NA | NA | 3,940 * | 0.001 | SWL0049 | 11/5/2012 | URS, 2012 |
| Cumulative Risk | | | | 2E-6 | | | | | |
| Hazard Index | | | | | | 0.2 | | | |

Notes:

* based on the pure component water solubility limit

µg/L denotes micrograms per liter

ca denotes carcinogenic

CAS denotes Chemical Abstract Service

conc. denotes concentration

ELCR denotes excess lifetime cancer risk

NA denotes none available

nc denotes non-carcinogenic

RBSL denotes risk-based screening level

Table 8
Area 2, Commercial/Industrial Exposure Scenario for Vapor Intrusion Screening
Dual Site Groundwater Operable Unit, Montrose and Del Amo Superfund Sites, Torrance, California

| Detected VOCs | CAS Number | Detected Conc. (µg/L) | RBSL(ca) (µg/L) | Risk (ELCR) | RBSL(nc) (µg/L) | Hazard Quotient (HQ) | Well ID | Sample Collection Date | Source of Sample Data |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,1,2-Tetrachloroethane | 630206 | 6.2 | 394 | 2E-8 | 109,375 | 0.00006 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 76131 | 11 | NA | NA | 144,303 | 0.00008 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,1,2-Trichloroethane | 79005 | 15 | 420 | 4E-8 | 481 | 0.03 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,1-Dichloroethane | 75343 | 39 | 744 | 5E-8 | 297,787 | 0.0001 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,1-Dichloroethylene | 75354 | 110 | NA | NA | 5,363 | 0.02 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,2,3-Trichloropropane | 96184 | 4.3 | 1.8 | 2E-6 | 1,676 | 0.003 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,2,4-Trichlorobenzene | 120821 | 3.7 | NA | NA | 7,741 | 0.0005 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,2-Dichlorobenzene | 95501 | 7.9 | NA | NA | 156,000 * | 0.00005 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,2-Dichloroethane | 107062 | 38 | 185 | 2E-7 | 12,004 | 0.003 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,2-Dichloropropane | 78875 | 1.1 | 227 | 5E-9 | 3,242 | 0.0003 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,3-Dichlorobenzene | 541731 | 0.78 | NA | NA | 87,862 | 0.000009 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,4-Dichlorobenzene | 106467 | 11 | 274 | 4E-8 | 79,000 * | 0.0001 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Benzene | 71432 | 17 | 36 | 5E-7 | 11,048 | 0.002 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Bromodichloromethane | 75274 | 0.9 | 253 | 4E-9 | 233,699 | 0.000004 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Carbon tetrachloride | 56235 | 81 | 5.1 | 2E-5 | 3,043 | 0.03 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Chlorobenzene | 108907 | 26 | NA | NA | 33,124 | 0.0008 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Chloroform | 67663 | 2,400 | 57 | 4E-5 | 46,246 | 0.05 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| cis-1,2-Dichloroethylene | 156592 | 57 | NA | NA | 20,561 | 0.003 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Diisopropyl ether | 108203 | 4.3 | NA | NA | 729,217 | 0.000006 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| m-Xylene | 108383 | 0.53 | NA | NA | 35,201 | 0.00002 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Methylene chloride | 75092 | 3.9 | 2,238 | 2E-9 | 319,652 | 0.00001 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| o-Xylene | 95476 | 1.7 | NA | NA | 40,274 | 0.00004 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| tertiary-Butylalcohol | 75650 | 260 | NA | NA | 8,556,408 | 0.00003 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Tetrachloroethylene | 127184 | 17,000 | 65 | 3E-4 | 4,790 | 3.5 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| trans-1,2-Dichloroethylene | 156605 | 2.6 | NA | NA | 16,060 | 0.0002 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Trichloroethylene | 79016 | 530 | 151 | 4E-6 | 443 | 1.2 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Cumulative Risk | | | | 3E-4 | | | | | |
| Hazard Index | | | | | | 4.9 | | | |

Notes:

* based on the pure component water solubility limit

µg/L denotes micrograms per liter

ca denotes carcinogenic

CAS denotes Chemical Abstract Service

conc. denotes concentration

ELCR denotes excess lifetime cancer risk

NA denotes none available

nc denotes non-carcinogenic

RBSL denotes risk-based screening level

AECOM, 2012 denotes the report prepared by AECOM titled *2012 Groundwater Monitoring Report, Montrose Superfund Site, 20201 South Normandie Avenue, Los Angeles, California* , dated October, 2012.

VOC denotes volatile organic compound

Table 9
Area 2, Residential Exposure Scenario for Vapor Intrusion Screening
Dual Site Groundwater Operable Unit, Montrose and Del Amo Superfund Sites, Torrance, California

| Detected VOCs | CAS Number | Detected Conc. (µg/L) | RBSL(ca) (µg/L) | Risk (ELCR) | RBSL(nc) (µg/L) | Hazard Quotient (HQ) | Well ID | Sample Collection Date | Source of Sample Data |
|---|---|---|---|---|---|---|---|---|---|
| 1,1,1,2-Tetrachloroethane | 630206 | 6.2 | 39 | 2E-7 | 13,021 | 0.0005 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,1,2-Trichloro-1,2,2-trifluoroethane | 76131 | 11 | NA | NA | 17,179 | 0.0006 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,1,2-Trichloroethane | 79005 | 15 | 42 | 4E-7 | 57 | 0.3 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,1-Dichloroethane | 75343 | 39 | 74 | 5E-7 | 35,451 | 0.001 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,1-Dichloroethylene | 75354 | 110 | NA | NA | 638 | 0.2 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,2,3-Trichloropropane | 96184 | 4.3 | 0.18 | 2E-5 | 200 | 0.02 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,2,4-Trichlorobenzene | 120821 | 3.7 | NA | NA | 922 | 0.004 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,2-Dichlorobenzene | 95501 | 7.9 | NA | NA | 32,271 | 0.0002 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,2-Dichloroethane | 107062 | 38 | 18 | 2E-6 | 1,429 | 0.03 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,2-Dichloropropane | 78875 | 1.1 | 23 | 5E-8 | 386 | 0.003 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,3-Dichlorobenzene | 541731 | 0.78 | NA | NA | 10,460 | 0.00007 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| 1,4-Dichlorobenzene | 106467 | 11 | 27 | 4E-7 | 79,000 * | 0.0001 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Benzene | 71432 | 17 | 3.5 | 5E-6 | 1,315 | 0.01 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Bromodichloromethane | 75274 | 0.9 | 25 | 4E-8 | 27,821 | 0.00003 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Carbon tetrachloride | 56235 | 81 | 0.50 | 2E-4 | 362 | 0.2 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Chlorobenzene | 108907 | 26 | NA | NA | 3,943 | 0.007 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Chloroform | 67663 | 2,400 | 5.7 | 4E-4 | 5,505 | 0.4 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| cis-1,2-Dichloroethylene | 156592 | 57 | NA | NA | 2,448 | 0.02 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Diisopropyl ether | 108203 | 4.3 | NA | NA | 86,812 | 0.00005 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| m-Xylene | 108383 | 0.53 | NA | NA | 4,191 | 0.0001 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Methylene chloride | 75092 | 3.9 | 222 | 2E-8 | 38,054 | 0.0001 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| o-Xylene | 95476 | 1.7 | NA | NA | 4,795 | 0.0004 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| tertiary-Butylalcohol | 75650 | 260 | NA | NA | 1,018,620 | 0.0003 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Tetrachloroethylene | 127184 | 17,000 | 6.4 | 3E-3 | 570 | 30 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| trans-1,2-Dichloroethylene | 156605 | 2.6 | NA | NA | 1,912 | 0.001 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Trichloroethylene | 79016 | 530 | 15 | 4E-5 | 53 | 10 | XMW-06 | 1/24/2012 | AECOM, 2012 |
| Cumulative Risk | | | | 3E-3 | | | | | |
| Hazard Index | | | | | | 41 | | | |

Notes:

* based on the pure component water solubility limit

µg/L denotes micrograms per liter

ca denotes carcinogenic

CAS denotes Chemical Abstract Service

conc. denotes concentration

ELCR denotes excess lifetime cancer risk

NA denotes none available

nc denotes non-carcinogenic

RBSL denotes risk-based screening level

AECOM, 2012 denotes the report prepared by AECOM titled *2012 Groundwater Monitoring Report, Montrose Superfund Site, 20201 South Normandie Avenue, Los Angeles, California* , dated October, 2012.

VOC denotes volatile organic compound

Table 10
Area 3, Residential Exposure Scenario for Vapor Intrusion Screening
Dual Site Groundwater Operable Unit, Montrose and Del Amo Superfund Sites, Torrance, California

| Detected VOCs | CAS Number | Detected Conc. (µg/L) | RBSL(ca) (µg/L) | Risk (ELCR) | RBSL(nc) (µg/L) | Hazard Quotient (HQ) | Well ID | Sample Collection Date | Source of Sample Data |
|---|---|---|---|---|---|---|---|---|---|
| 1,2-Dichloroethane | 107062 | 4.0 | 29 | 1E-7 | 2,225 | 0.002 | SWL0008 | Feb. 2012 | URS, 2012 |
| Benzene | 71432 | 52 | 6.2 | 8E-6 | 2,326 | 0.02 | SWL0008 | Feb. 2012 | URS, 2012 |
| Ethylbenzene | 100414 | 10 | 61 | 2E-7 | 65,731 | 0.0002 | SWL0008 | Feb. 2012 | URS, 2012 |
| Cumene | 98828 | 35 | NA | NA | 216 | 0.2 | SWL0008 | Feb. 2012 | URS, 2012 |
| Naphthalene | 91203 | 15 | 63 | 2E-7 | 2,763 | 0.005 | SWL0008 | Feb. 2012 | URS, 2012 |
| Toluene | 108883 | 2.9 | NA | NA | 20,041 | 0.0001 | SWL0008 | Feb. 2012 | URS, 2012 |
| Trichloroethylene | 79016 | 5.3 | 27 | 2E-7 | 95 | 0.06 | SWL0008 | Feb. 2012 | URS, 2012 |
| m-Xylene | 108383 | 1.6 | NA | NA | 7,513 | 0.0002 | SWL0008 | Feb. 2012 | URS, 2012 |
| cis-1,2-Dichloroethylene | 156592 | 1.1 | NA | NA | 4,199 | 0.0003 | SWL0008 | Feb. 2012 | URS, 2012 |
| n-Butylbenzene | 104518 | 13 | NA | NA | 2,000 * | 0.007 | SWL0008 | Feb. 2012 | URS, 2012 |
| n-Propylbenzene | 103651 | 82 | NA | NA | 8,514 | 0.01 | SWL0008 | Feb. 2012 | URS, 2012 |
| sec-Butylbenzene | 135988 | 18 | NA | NA | 3,940 * | 0.005 | SWL0008 | Feb. 2012 | URS, 2012 |
| tertiary-Butyl Alcohol | 75650 | 68 | NA | NA | 1,074,633 | 0.00006 | SWL0008 | Feb. 2012 | URS, 2012 |
| Cumulative Risk | | | | 9E-6 | | | | | |
| Hazard Index | | | | | | 0.3 | | | |

Notes:

* based on the pure component water solubility limit

µg/L denotes micrograms per liter

ca denotes carcinogenic

CAS denotes Chemical Abstract Service

conc. denotes concentration

ELCR denotes excess lifetime cancer risk

NA denotes none available

nc denotes non-carcinogenic

RBSL denotes risk-based screening level

URS, 2012 denotes the report prepared by URS titled *Groundwater Monitoring Report, Dual Site Groundwater Operable Unit, Montrose Chemical and Del Amo Superfund Sites, Los Angeles, California* , dated June 18, 2012.

VOC denotes volatile organic compound

Table 11

Area 3, Residential Exposure Scenario for Vapor Intrusion Screening - Assumed Aerobic Biodegradation of Petroleum Hydrocarbons
Dual Site Groundwater Operable Unit, Montrose and Del Amo Superfund Sites, Torrance, California

| Detected VOCs | CAS Number | Detected Conc. (µg/L) | RBSL(ca) (µg/L) | Risk (ELCR) | RBSL(nc) (µg/L) | Hazard Quotient (HQ) | Well ID | Sample Collection Date | Source of Sample Data |
|---|---|---|---|---|---|---|---|---|---|
| 1,2-Dichloroethane | 107062 | 4.0 | 29 | 1E-7 | 2,225 | 0.002 | SWL0008 | Feb. 2012 | URS, 2012 |
| Benzene | 71432 | 52 | 5,645 | 9E-9 | 1,790,000 * | 0.00003 | SWL0008 | Feb. 2012 | URS, 2012 |
| Ethylbenzene | 100414 | 10 | 23,499 | 4E-10 | 169,000 * | 0.00006 | SWL0008 | Feb. 2012 | URS, 2012 |
| Cumene | 98828 | 35 | NA | NA | 61,300 * | 0.0006 | SWL0008 | Feb. 2012 | URS, 2012 |
| Naphthalene | 91203 | 15 | 31,000 * | 5E-10 | 31,000 * | 0.0005 | SWL0008 | Feb. 2012 | URS, 2012 |
| Toluene | 108883 | 2.9 | NA | NA | 526,000 * | 0.000006 | SWL0008 | Feb. 2012 | URS, 2012 |
| Trichloroethylene | 79016 | 5.3 | 27 | 2E-7 | 95 | 0.06 | SWL0008 | Feb. 2012 | URS, 2012 |
| m-Xylene | 108383 | 1.6 | NA | NA | 161,000 * | 0.00001 | SWL0008 | Feb. 2012 | URS, 2012 |
| cis-1,2-Dichloroethylene | 156592 | 1.1 | NA | NA | 4,199 | 0.0003 | SWL0008 | Feb. 2012 | URS, 2012 |
| n-Butylbenzene | 104518 | 13 | NA | NA | 2,000 * | 0.007 | SWL0008 | Feb. 2012 | URS, 2012 |
| n-Propylbenzene | 103651 | 82 | NA | NA | 60,000 * | 0.001 | SWL0008 | Feb. 2012 | URS, 2012 |
| sec-Butylbenzene | 135988 | 18 | NA | NA | 3,940 * | 0.005 | SWL0008 | Feb. 2012 | URS, 2012 |
| tertiary-Butyl Alcohol | 75650 | 68 | NA | NA | 1,074,633 | 0.00006 | SWL0008 | Feb. 2012 | URS, 2012 |
| Cumulative Risk | | | | 3E-7 | | | | | |
| Hazard Index | | | | | | 0.1 | | | |

Notes:

* based on the pure component water solubility limit

µg/L denotes micrograms per liter

ca denotes carcinogenic

CAS denotes Chemical Abstract Service

conc. denotes concentration

ELCR denotes excess lifetime cancer risk

NA denotes none available

nc denotes non-carcinogenic

RBSL denotes risk-based screening level

URS, 2012 denotes the report prepared by URS titled *Groundwater Monitoring Report, Dual Site Groundwater Operable Unit, Montrose Chemical and Del Amo Superfund Sites, Los Angeles, California* , dated June 18, 2012.

VOC denotes volatile organic compound

# Appendix A
# Enhanced Johnson and Ettinger Model Spreadsheet Description

(provided on electronic copy only)

# *Appendix A. Using An Enhanced Johnson-Ettinger Model EPA Spreadsheet for Groundwater-Volatilization-to-Indoor-Air Exposure Evaluation*

Modeling of volatile organic chemicals (VOCs) for vapor intrusion to indoor air can be accomplished using screening models (DTSC, 2011; EPA, 2004a) or advanced models (EPA, 2004a), described below. In the vapor intrusion (VI) modeling for the Montrose and Del Amo off-site groundwater, the Advanced EPA spreadsheet has been used with enhancements to accommodate up to three soil strata, to allow evaluation of multiple detected analytes (up to 60) in the same model run (MR), and to calculate chemical-specific attenuation factors (AFs), individual- and cumulative-risk/hazard, and individual-chemical risk-based screening levels (RBSLs). The spreadsheets for modeling of groundwater-volatilization-to-indoor-air and soil-gas-to-indoor-air utilize the same algorithm, except that the groundwater spreadsheet also includes calculation of the capillary fringe rise from the water table and an effective diffusion coefficient for conversion of each groundwater constituent concentration in the capillary fringe to the concentration in the soil gas immediately above the capillary fringe. The groundwater and soil gas spreadsheets are otherwise the same.

The description below pertains to both the soil gas and the groundwater spreadsheets.

## *1.1 The Enhanced Johnson-Ettinger Model Spreadsheet*

The evaluation of groundwater (or soil gas) VI is conducted via a model developed by Paul Johnson and Robert Ettinger, commonly called the Johnson-Ettinger (J-E) model (Johnson and Ettinger, 1991). The J-E model was first incorporated in a publicly-available spreadsheet by the EPA in 1998 (EPA, 2004b). Subsequently, the model was adapted by the California Department of Toxic Substances Control (DTSC), Human and Ecological Risk Division (DTSC-HERD; now Human and Ecological Risk Office [HERO]) for California cases. DTSC-HERO has released a California version of the J-E spreadsheet for soil gas (SG-SCREEN) and for groundwater volatilization (GW-SCREEN) (DTSC-HERD, 2009a). The latest DTSC-HERO version is designated as *DTSC, Vapor Intrusion Guidance, Interim Final December 4 (last modified December 2, 2011)* and contains chemical, soil, and building parameters, as well as toxicity factors recommended for use by DTSC-HERO. CB&I (formerly Shaw) has updated the toxicity factors in the VLOOKUP table of J-E as new values or listings become available.[1]

1 New toxicity factors for trichloroethylene (TCE) were released on September 28, 2011, and corresponding toxicity factors for tetrachloroethylene (PCE) were released on February 10, 2012. The new toxicity values for the inhalation unit risk (IUR) and the reference concentration (RfC) for TCE are incorporated into the VLOOKUP table of the Enhanced Johnson-Ettinger model spreadsheet, but those for PCE have not been incorporated because DTSC-HERO has not accepted those values.

The EPA J-E spreadsheet (GW-ADV, Version 3.1, 02/04) with the current DTSC-HERO VLOOKUP table (December 2, 2011) is used for modeling of volatilization of groundwater into soil gas and subsequently into indoor air. An enhancement of the spreadsheet will run up to 60 detections in a single model run with risk/hazard results that are identical to those from either GW-ADV with appropriate California parameters or the DTSC spreadsheet GW-SCREEN (2009) for modeling of a single soil type. Unlike the screening models, GW-ADV can accommodate multiple soil layers and different building air exchange rates.

Also, additional capabilities have been added to J-E for the following:

- Individual analyte risk/hazard for multiple detected analytes or a site-wide listing of analytes with maximum or other representative concentrations.
- Summed analyte risks (increased lifetime cancer risk [ILCR]) for cumulative risk (also denoted ILCR) and summed chemical-specific hazard quotients (HQs), denoted as a hazard index for sample-by-sample or site-wide analytes with maximum or other representative concentrations.
- Percent contribution of each detected analyte to total ILCR or hazard index for the model run.
- Linear apportionment of ILCR for a target risk (*e.g.*, 1E-6 ILCR) and/or chemical-specific HQ for a target hazard (*e.g.*, 1.0), as for preliminary remediation goals in the *National Oil and Hazardous Substances Pollution Contingency Plan* (EPA, 1990); these RBSLs are depth-specific because of the sampling depth entered in the spreadsheet, and they are site-specific because of the soil type and exposure scenario parameters entered in the spreadsheet.
- The J-E screening spreadsheets do not normally account for exposure time (ET; hours per day) in estimating risk/hazard for a commercial-industrial (C/I) exposure scenario. For a residential exposure scenario, ET is 24 hours per 24-hour-day, a factor of 1, so modification for risk/hazard is moot. In a C/I scenario, ET is 8 hours per 24-hour day, a factor of one-third in the chemical-specific risk/hazard with a factor of 3 correction for the RBSLs. J-E contains a cell for ET on the DATENTER SHEET and carries this correction on the RESULTS SHEET with a note in the column header for transparency. Also note, if nonstandard exposure scenarios, such as an ET of 1 hour per day, the correction factor is incorporated on the DATENTER and RESULTS pages and identified for transparency.

### *1.1.1 Using the Johnson-Ettinger Model Spreadsheet*

The spreadsheet model is used in the "forward" direction for estimating indoor air risk/hazard from groundwater concentrations in µg/L measured in groundwater samples at depth.2

2 J-E could be used in a "reverse" fashion by interactively varying the entered concentration to meet a target risk such as 1E-6 incremental lifetime cancer risk or a target hazard quotient such as 1. Entries in the spreadsheet for soil

The following description can be applied to any of the J-E prints associated with this report. Starting with the first page/tab of the spreadsheet, the Chemical Abstracts Service number of the chemical is entered on the first page, the DATA ENTRY (DATENTER) SHEET, to retrieve the chemical-specific data from the VLOOKUP tables (chemical and soil) for the chemical properties itemization on page/tab 2. By policy, the maximum analyte concentration is usually entered in the appropriate cell as a representative concentration for risk/hazard estimation (DTSC-HERD, 2009a).[3] The concentrations entered on page 1 correspond to the maximum concentrations or the result obtained from groundwater sampling. It is professional judgment as to how far back in time groundwater concentrations should be used for modeling compared to groundwater travel time and attenuation effects on the analyte(s).

The sampling depth to groundwater is entered in centimeters (cm). Other depths appropriate to the site investigation could also be used separately in the spreadsheet to generate nonstandard depth RBSLs for additional purposes.

The depth below grade is accepted as 15 cm for a slab-on-grade building, and the groundwater sampling depth is listed as implemented (*i.e.*, 152.4 cm for 5 feet nominal depth per DTSC and California Regional Water Quality Control Board Advisory [2003][4]). On the Data Entry Sheet, the sampling depth below grade is listed in centimeters for the model and in feet in the cell below that for ease in converting the depths. Groundwater sampling is usually conducted at the upper surface or just above the capillary fringe helps to mimic the potential accumulated soil gas concentration beneath a building slab (California Department of Toxic Substances Control and California Environmental Protection Agency, 2011)[5].

The average soil temperature is accepted as 24 degrees Celsius, the appropriate temperature for Southern California[6] (EPA, 2004).

The user-defined stratum A soil vapor permeability, $k_v$, of 1E-8 centimeters squared in the downloaded spreadsheet GW-ADV was substituted with a soil stratum A Soil Conservation

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and exposure parameters are the same for application in "forward" or "reverse" directions. In Sections 1.2.1 and 1.2.2, the basis is described for setting up Johnson-Ettinger to calculate "forward" risk/hazard and to set up the spreadsheet to apportion the concentration for the target risk and/or the target hazard quotient to determine depth-specific Risk-Based Screening Levels (RBSLs) based on a target risk of 1E-6 incremental lifetime cancer risk/1 hazard quotient.

3 If the reporting limit is higher than a J-qualified maximum concentration, the reporting limit can be used for the Johnson-Ettinger Model Spreadsheet evaluation as a conservative measure.

4 The 2012 Advisory was not in effect during the field work in 2011.

5 It has been found that soil gas at 15 – 20 feet bgs most closely mimics soil gas concentrations that may accumulate beneath a building slab. Sampling at 5 feet bgs is a useful depth beneath the aerobic zone where detection of soil gas constituents greater than that in the 15 – 20 foot soil gas indicates contribution to soil gas from the shallow vadose zone.

6 Note for comparison that the default soil temperature in the U.S. Environmental Protection Agency Johnson-Ettinger soil gas screening spreadsheet is only 10 degrees Celsius.

Service[7] soil type (used to estimate soil vapor permeability) per the near-surface soil profiles for each of the soil vapor probe locations in the investigation. The Stratum A Soil Conservation Service soil type for the vapor probe location is entered again on the data entry sheet to retrieve the values of the soil dry bulk density, soil total porosity, and soil water-filled porosity from the VLOOKUP table for soil parameters. On GW-ADV (J-E), the groundwater sampling depth below grade, $L_s$, in centimeters is equivalent to the soil vapor migration distance to the building foundation or slab. The thickness of the soil strata, Stratum A and Stratum B (if appropriate) for the site, is entered on the spreadsheet, and the sum of the strata thicknesses must equal the sampling depth.

Based on soil type, the following parameters are examples of soil data that may be retrieved from VLOOKUP as follows:

| VLOOKUP | Soil Type | | | | |
|---|---|---|---|---|---|
| Parameter Values | Sand | Silt | Loam | Sandy Loam | Loamy Sand |
| Bulk Density, $\rho_b$ ($g/cm^3$) | 1.66 | 1.82 | 1.59 | 1.62 | 1.62 |
| Total Soil Porosity, n (unitless) | 0.375 | 0.489 | 0.399 | 0.387 | 0.39 |
| Soil Water-filled Porosity, $\theta_w$, ($cm^3/cm^3$) | 0.054 | 0.167 | 0.148 | 0.103 | 0.076 |

*Notes:*

*$cm^3/cm^3$ cubic centimeter per cubic centimeter*

*$g/cm^3$ gram per cubic centimeter*

The retrieved parameter values above are loaded automatically into the DATENTER page in the row for soil strata parameters.

GW-ADV accommodates up to three layers (strata) of different soil type. Combinations of the three soil types could be used for modeling if appropriate at each of the sampling locations, but it is important that the stratum providing the capillary fringe above the groundwater and the stratum providing the surface soil permeability be properly designated. The surface soil stratum is the A stratum upon which permeability for volatilization is estimated. The groundwater stratum may be either B or C, depending on the number of strata.

7 The Soil Conservation Service of the U.S. Department of Agriculture is prominently cited throughout the guidance (2004) and Johnson-Ettinger model spreadsheets and is used is this report. It is understood that the Soil Conservation Service is now the National Resource Conservation System under the U.S. Department of Agriculture.

For modeling risk/hazard and developing RBSLs, default building parameters were accepted as follows:

| J-E Parameter | Symbol | Default Value | Units |
|---|---|---|---|
| Enclosed space floor thickness | $L_{crack}$ | 15 | Centimeters (cm) (5.9 inches, (Table 3 of DTSC and Cal/EPA, 2005) |
| Soil-building pressure differential | $\Delta P$ | 40 | Grams/centimeter-seconds squared (gm/cm-s$^2$) |
| Crack-to-total area ratio | $\eta$ | 0.005 | Johnson, 2002 per DTSC, 2011, Table 3 |
| Enclosed space floor length | $L_R$ | 1,000 | Centimeters (cm); (32.8 feet) |
| Enclosed space floor width | $W_R$ | 1,000 | Centimeters (cm); (32.8 feet) |
| Enclosed space height | HR | 244 | Centimeters (cm); (8 feet); residential ceiling height; used as default for both residential and commercial-industrial |
| Floor-wall seam crack width | W | 0.1 | Centimeters (cm); (0.039 inches) |
| Indoor air exchange rate | ER | 1 | 1 per Hour (1/h) (per hour) (Appendix D of DTSC and Cal/EPA, 2011) |
| Average vapor flow rate into bldg. | $Q_{soil}$ | 5 | Liters per minute (L/m) (Table 3 of DTSC and Cal/EPA, 2011) to be used for either residential or commercial buildings. |

The average vapor flow rate into the building, $Q_{soil}$, is listed as 5 liters per minute, the default value for a residence. If the cell were left blank, $Q_{soil}$ would be calculated in the model as the product of soil permeability, building seam crack length, vapor viscosity, crack depth, and crack radius. Because the DTSC favors use of 5 liters per minute, the default value was accepted in all the model runs. The indoor air exchange rate of 0.5 per hour was chosen for the residential buildings, per DTSC guidance (DTSC and Cal/EPA, 2011). Commercial buildings could be modeled using an air exchange rate of 1 corresponding to C/I buildings in the guidance (DTSC and Cal/EPA, 2011).

Exposure parameters are usually chosen corresponding to a residential land use exposure scenario, but based on the dedicated land use as C/I, exposure parameters for a C/I land use exposure scenario may be chosen for the spreadsheet:

| | Residential Buildings* | Commercial-Industrial Buildings |
|---|---|---|
| Parameters | Adults and Children | Adult Workers |
| ET (hours/day) | 24 | 8 |
| EF (days/year) | 350 | 250 |
| ED (years) | 30 | 25 |
| $AT_c$ (days, 70 years x 365 days/year) | 25,550 | 25,550 |
| $AT_{nc}$ (days = ED x 365 days/year) | 10,950 | 9,125 |

*Because Inhalation Unit Risk (also called Unit Risk Factor) and Reference Concentration are independent of

body weight and inhalation rate, adults and children are modeled together for a residential scenario.

Page 2 of J-E is the CHEMICAL PROPERTIES SHEET listing of chemical properties used in calculating the migration of chemical concentrations through the soil matrix.

Page 3 of J-E is the INTERCALCS SHEET and contains the cells for the calculations of the J-E model that result in a value for α, the attenuation factor for modeling the concentration of the analyte in indoor air based on the soil gas concentration at the depth bgs.

Page 4 of J-E is the RESULTS SHEET where the modeled indoor air concentration is compared to the chemical-specific toxicity factor(s) to yield ILCR and chemical-specific HQ. The results are quoted to 1 significant figure (EPA, 1989). The percent contribution to the total risk or hazard is calculated in adjoining columns.

In addition to the INCREMENTAL RISK CALCULTIONS shown on page 4 of J-E, columns have been added for chemical-specific RBSLs calculated by linear apportioning of risk/hazard calculated in the model for the target risk (cancer) of 1E-6 ILCR and target hazard (non-cancer) of 1, as appropriate. Since a linear apportionment step has not been commonly practiced in the past, it is important to explain the validity and value of its use. This is presented in Sections D.2.1 and D.2.2.

Pages 5 and 6 of J-E show the VLOOKUP tables with technical parameters for soil retrieved to the DATA ENTRY SHEET and for the chemicals of potential concern that are retrieved to the CHEMICAL PROPERTIES SHEET as called out by the Chemical Abstracts Service number on the DATA ENTRY SHEET.

### *1.1.2 Calculation of Risk-Based Screening Levels in the Enhanced Johnson-Ettinger Model Spreadsheet*

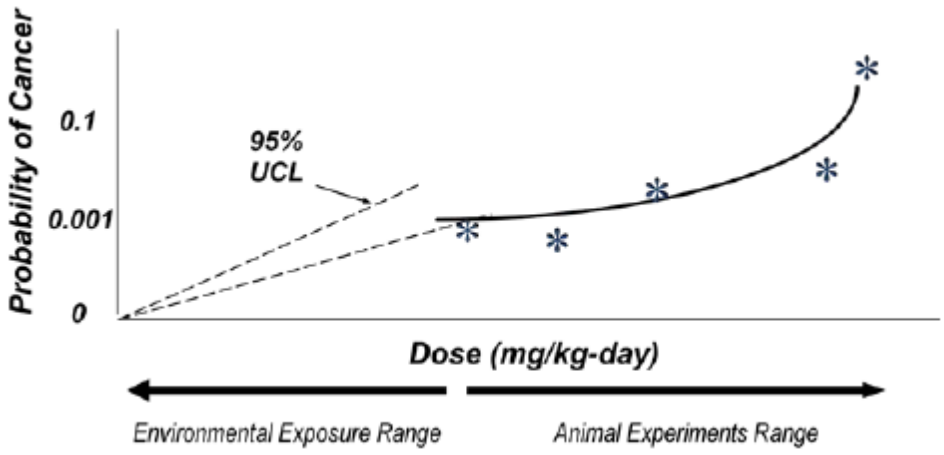
Once the chemical, concentration, soil, building, and exposure information is entered in the DATA ENTER SHEET, the CHEMICAL PROPERTIES SHEET is also populated for the chemicals specified, and the INTERMEDIATE CALCULATIONS SHEET executes automatically based on the macros in the model. The RESULTS SHEET then shows itemized risk/hazard that is keyed to the chemical-specific concentrations, soil type and sample depth, and the exposure scenario chosen. In addition, J-E calculates cumulative risk/hazard with chemical-specific percent contribution to total risk/hazard and the chemical-specific, RBSLs based on all the parameters chosen. Because the RBSLs are keyed to target risk and hazard, they can be compared to monitoring soil gas data from the same depths and soil type(s) on the site.

## 1.2 Basis for Linear Apportionment of Risk/Hazard

The linear gradient relationship between dose and carcinogenic response and the linear gradient for diffusion of soil gas in the soil matrix are the basis for interpolating risk-based concentrations of soil gas corresponding to target risks and hazards.

### 1.2.1 Linear No-Threshold Model of Carcinogenicity

Current cancer risk evaluation practice is based on a straight-line approximation of dose-response at low doses of chronic environmental exposure experienced by humans. In that range of exposure doses a straight line is used to approximate the dose/occurrence relationship where data are not available. As shown in the following graphic, data from animal exposure experiments that might yield a nonlinear dose-response curve for carcinogenicity at the higher doses of animal experiments is augmented with a straight-line approximation of the dose-response relationship from the lowest data point to the zero-zero origin in the range of human environmental exposures.

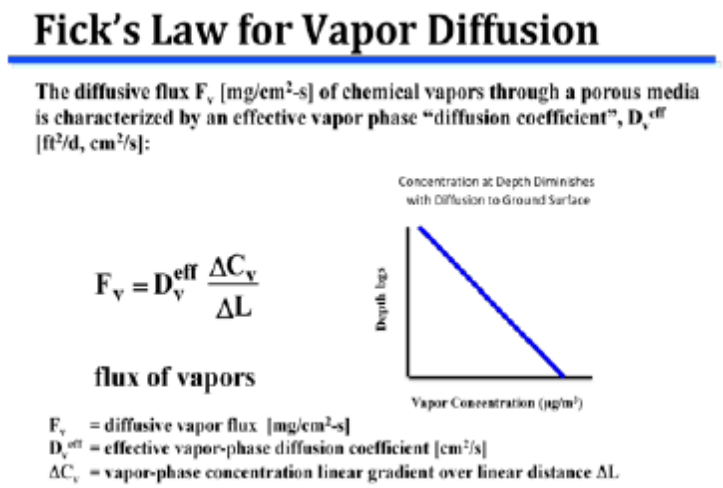



To account for uncertainties in this approximation, the 95 percent upper confidence limit on the slope of that straight line is used as a conservative estimate of the cancer potency using the linear no-threshold model. The current practice is based on a linear model of carcinogenicity in the concentration range of environmental exposure to humans, and that supports the linear apportionment (interpolation) of risk and risk-based concentrations of soil gas corresponding to a designated chemical-specific target risk, 1E-6 ILCR, or other designated target risk.

### 1.2.2 Fick's Law for Vapor Diffusion

Characterization of vapor dissipation during diffusive flux through the soil matrix is afforded by Fick's First Law as incorporated in the J-E Model Spreadsheet, J-E. As shown in the following

graphic, the relationship between vapor concentration and distance in diffusive flux through soil is characterized by an effective vapor phase diffusion coefficient.




The key point from the expression for diffusive vapor flux is that $\Delta C_v$ and $\Delta L$ establish linear gradients for variation of vapor concentration, as shown in the graph. This is linear apportionment of soil gas risk-based concentrations.

The linear variation of risk and concentration in vapor diffusive flux is the basis for extending the risk/hazard estimates of the J-E spreadsheet to the determination of RBSLs.

### *1.2.3 Conservatisms in the Enhanced J-E Model Spreadsheet*

There is conservatism incorporated in the estimates of RBSLs. Substitution of exposure parameters for a C/I exposure scenario does not include a modification for exposure time. Residential exposure is assumed, conservatively, to be 24 hours per day, *i.e.* 1 day/day, so the J-E model spreadsheet accounts for exposure time for a residential scenario, but it does not account for exposure time for a C/I scenario with a typical work day of 10 hours per 24-hour day. Risk/hazard calculated using the J-E model spreadsheet for C/I is over-estimated by the factor of 24 hours/10 hours. On this basis, the RBSLs each should be 3 times higher. That is included in the J-E spreadsheet by multiplying each of the risk/hazard results on the RESULTS SHEET by 2.4 (24/10) and including a notice in the label for the results column on the page.

In addition, the spreadsheet contains sensitive parameters based on a residential exposure scenario that are not typically changed in the model. The parameters are the air exchange rate, the building size (1,000 cm length by 1,000 cm width, ceiling height (8 feet, 244 cm), and building perimeter (floor wall-seam perimeter, 4,000 cm). SD-ADV upon which the enhanced spreadsheet is built has a data entry cell for the C/I exchange rate of 1 (DTSC, 2011, Appendix D, Page D-6), and the C/I exchange rate is appropriate for restaurant buildings and the special patron exposure scenarios evaluated.

The default building dimensions for a residence were used even though more appropriate dimensions for a C/I building could be more favorable in calculating risk/hazard by as much as an order of magnitude8. Retaining the default calculation provides assurance that the risk/hazard results are conservative and provide a margin of safety in the results calculated.

## *1.3 Use of Site-Specific RBSLs*

Because the RBSLs have been standardized to a site-specific target risk at the depth specified in the Data Enter page, future soil gas monitoring at the same depth can be conducted using the site-specific RBSLs to evaluate future soil gas concentrations at the same depths for monitoring soil gas risk/hazard during the course of monitored natural attenuation of groundwater.

## *1.4 Quality Control for Enhanced Johnson-Ettinger Model Spreadsheet*

Comparison of the analyte-specific reporting limit in the laboratory report to the corresponding depth- and soil-RBSL for the sample on the results page of the enhanced J-E model spreadsheet indicates that the analytical reporting limits meet the data quality objectives for one-in-a-million-based data quality. If this were not the case, the analytical method employed for analysis would require additional attention.

The risk/hazard results obtained from the enhanced Johnson-Ettinger model spreadsheet were corroborated for quality control. For instance, a single, measured soil gas analyte concentration was modeled for vapor intrusion using the DTSC screening spreadsheet, HERD_Soil_Gas_Screening_Model.xls at *http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm*. The risk/hazard results were corroborated exactly by also modeling the soil gas analyte concentration in SG-ADV, the EPA J-E screening spreadsheet (EPA, 2004; *http://www.epa.gov/oswer/riskassessment/airmodel/johnson_ettinger.htm*) with the same parameters. The enhanced J-E spreadsheet is based on SG-ADV elaborated as described in this appendix. Quality control was attained by obtaining identical risk/hazard results from SG-ADV and from the same data in the enhanced J-E spreadsheet.

8 Modification of the default building dimensions (footprint length and width, and ceiling height) require a proportional correction in $Q_{soil}$, the flux rate from soil into the building (DTSC, 2011, Table 3 footnotes).

## *References*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# Appendix B
# Area 1, Enhanced Johnson and Ettinger Model Spreadsheet Input and Output Sheets

(provided on electronic copy only)

Input Parameters to the J&E Algorithm for Groundwater-to-Indoor Air Vapor
Residential Exposure Scenario, Area 1
Dual Site Groundwater, Montrose and Del Amo Superfund Sites

| Input Parameters to J&E Model GW-ADV Version 3.0 | | Units | J&E Spreadsheet Defaults | Site-Specific Evaluation Groundwater Samples | Basis for Parameter |
|---|---|---|---|---|---|
| $L_{WT}$ | Depth below grade to water table | cm (feet) | - (-) | 1,309 (43) | Site-specific, based on evaluation of historical water levels in CH2M HILL database. |
| Vadose Zone Properties (Without Engineered Fill) | | | | | |
| $T_s$ | Average groundwater temperature | °C | 22 | 24 | 75°F, California average shallow groundwater temperature (p. 48, EPA, 2004); DTSC, 2011, page D-6 |
| $h_A$ | Thickness of soil stratum A | cm (feet) | TBD | 712 (23.35) | Boring log for well SWL0049 |
| $h_B$ | Thickness of soil stratum B | cm (feet) | TBD | 454 (14.9) | Boring log for well SWL0049 |
| $h_C$ | Thickness of soil stratum C | cm (feet) | TBD | 143 (4.7) | Boring log for well SWL0049 |
| - | Stratum A soil type | -- | TBD | Loamy Sand | Boring log for well SWL0049 |
| $\rho_B^A$ | Stratum A soil dry bulk density | $g/cm^3$ | TBD | 1.62 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^A$ | Stratum A soil total porosity | unitless | TBD | 0.39 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^A$ | Stratum A soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.076 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum B soil type | -- | TBD | Sand | Boring log for well SWL0049 |
| $\rho_B^B$ | Stratum B soil dry bulk density | $g/cm^3$ | TBD | 1.66 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^B$ | Stratum B soil total porosity | unitless | TBD | 0.375 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^B$ | Stratum B soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.054 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum C soil type | -- | TBD | Loam | SCS Soil Name equivalent to Silty Sand with 20-50% fines; Boring log for well SWL0049 |
| $\rho_B^C$ | Stratum C soil dry bulk density | $g/cm^3$ | TBD | 1.59 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^C$ | Stratum C soil total porosity | unitless | TBD | 0.399 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^C$ | Stratum C soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.148 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| Building Parameters | | | | | |
| $L_F$ | Depth below grade to bottom of enclosed space floor - slab on grade (building with no basement) | cm | 15 | 15 | default, EPA, 2004, page 47 |
| $L_{crack}$ | Enclosed space floor thickness | cm | 10 | 9 | DTSC, 2011, Table 3; EPA, 2004 uses 10 cm, but California value of 9 cm is more conservative |
| $\Delta P$ | Soil-building pressure differential | $g/cm\text{-}s^2$ | 40 | 40 | OEHHA, 2005, page B-13; DTSC accepts EPA default in absence of California-specific measurements |
| $L_B$ | Enclosed space floor length | cm (feet) | 1,000 | 1000 (33) | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $W_B$ | Enclosed space floor width | cm (feet) | 1,000 | 1000 (33) | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $H_B$ | Enclosed space height | cm (feet) | 244 | 244 (8) | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| w | Floor-wall seam crack width | cm | 0.1 | 0.1 | OEHHA, 2005, page B-13; EPA, 2004, page 55. |
| $\eta$ | Crack-to-total area ratio | unitless | model calculated | 0.005 | California default, DTSC, 2011, Table 3. |
| ER | Indoor air exchange rate | 1/hour | 0.25 | 0.5 | Original EPA default 0.5 adopted for California residential building (DTSC, 2011) and retained after EPA adopted value of 0.25/hour, EPA, 1997 |
| $Q_{soil}$ | Average vapor flow rate into building | L/min | 5 | 5 | OEHHA, 2005, page B-13; California accepts EPA default, EPA, 2004; left blank when site-specific permeability is used. |
| $\alpha$ | Infinite Source - Indoor Attenuation Coefficient | unitless | model calculated | model calculated | Product of Johnson-Ettinger algorithm on INTERCALCS page incorporating site-specific information, EPA, 2004. |
| Physical-Chemical & Toxicity Parameters | | | | | |
| The values were derived from the 'Chemical Properties Look Up Table' spreadsheet of *HERD_Groundwater_Screening_Model.xls* (updated December 2, 2011), *<http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm>*. | | | | | |
| Exposure Parameters - Residential Scenario | | | | | |
| $AT_c$ | Averaging time for carcinogens | years | 70 | 70 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| $AT_{NC}$ | Averaging time for noncarcinogens | years | 30 | 30 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ED | Exposure duration | years | 30 | 30 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| EF | Exposure frequency | days/year | 350 | 350 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ET | Exposure time | hours/day | 24 | 24 | U.S. EPA, 1991; DTSC, 2011, Appendix C |

General notes follow on next page.

References:


DTSC, 2011, *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance*, October.
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DATA ENTRY SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

GW-ADV
Version 3.0; 02/03

Reset to

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

**Area 1: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Qualifier | Chemicals Evaluated (COPCs and Surrogates) | Surrogate? | Chemical Detected in Groundwater: COPC Detected | Chemical Detected in Groundwater: CAS No. |
|---|---|---|---|---|---|---|---|
| 1 | 75354 | 1.3 | | 1,1-Dichloroethylene | NO | | |
| 2 | 120821 | 3.6 | | 1,2,4-Trichlorobenzene | NO | | |
| 3 | 95501 | 3.9 | | 1,2-Dichlorobenzene | NO | | |
| 4 | 107062 | 280 | | 1,2-Dichloroethane | NO | | |
| 5 | 106467 | 11 | | 1,4-Dichlorobenzene | NO | | |
| 6 | 71432 | 39 | | Benzene | NO | | |
| 7 | 108907 | 2,900 | | Chlorobenzene | NO | | |
| 8 | 110827 | 130 | | Cyclohexane | NO | | |
| 9 | 100414 | 6.5 | | Ethylbenzene | NO | | |
| 10 | 98828 | 7.2 | | Cumene | NO | | |
| 11 | 78933 | 10 | | Methylethylketone (2-butanone) | NO | | |
| 12 | 127184 | 61 | | Tetrachloroethylene | NO | | |
| 13 | 108883 | 3.5 | | Toluene | NO | | |
| 14 | 79016 | 91 | | Trichloroethylene | NO | | |
| 15 | 156592 | 3.5 | | cis-1,2-Dichloroethylene | NO | | |
| 16 | 108383 | 2.8 | | m-Xylene | YES | m,p-Xylenes | 179601231 |
| 17 | 104518 | 4.6 | | n-Butylbenzene | NO | | |
| 18 | 135988 | 5.6 | | sec-Butylbenzene | NO | | |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Totals must add up to value of $L_{WT}$ (cell G28) | | | | | | | |
| 24.0 | 15.0 | 1,309 | 712 | 454 | 143 | C | L | LS | | |
| Southern Cal. | slab-on-grade | 42.95 feet | 23.35 feet | 14.9 feet | 4.7 feet | | | | | |

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ ($cm^3/cm^3$) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ ($g/cm^3$) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ ($cm^3/cm^3$) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ ($g/cm^3$) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ ($cm^3/cm^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LS | 1.62 | 0.39 | 0.076 | S | 1.66 | 0.375 | 0.054 | L | 1.59 | 0.399 | 0.148 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 9.0 | 40.0 | 1,000 | 1,000 | 244 | 0.10 | 0.5 | 5 |
| 3.5 inches | 4 Pa | 33 feet | 33 feet | 8 feet | default | Residential | default |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Exposure Time, ET (hrs/day) | Target risk for carcinogens, TR (unitless) | Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 24 | 1.0E-06 | 1 |
| Residential Exposure Scenario | | | | | Used to calculate risk-based groundwater concentration. | |

END

CHEMICAL PROPERTIES SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER AREA 1

| Diffusivity in air, $D_a$ ($cm^2/s$) | Diffusivity in water, $D_w$ ($cm^2/s$) | Henry's law constant at reference temperature, H (atm-$m^3$/mol) | Henry's law constant reference temperature, $T_R$ ($^oC$) | Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol) | Normal boiling point, $T_B$ ($^oK$) | Critical temperature, $T_C$ ($^oK$) | Organic carbon partition coefficient, $K_{oc}$ ($cm^3/g$) | Pure component water solubility, S (mg/L) | Unit risk factor, URF ($\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.00E-02 | 1.04E-05 | 2.60E-02 | 25 | 6,247 | 304.75 | 576.05 | 5.89E+01 | 2.25E+03 | 0.0E+00 | 7.0E-02 | 1,1-Dichloroethylene | 1 |
| 3.00E-02 | 8.23E-06 | 1.42E-03 | 25 | 10,471 | 486.15 | 725.00 | 1.78E+03 | 4.88E+01 | 0.0E+00 | 2.0E-03 | 1,2,4-Trichlorobenzene | 2 |
| 6.90E-02 | 7.90E-06 | 1.90E-03 | 25 | 9,700 | 453.57 | 705.00 | 6.17E+02 | 1.56E+02 | 0.0E+00 | 2.0E-01 | 1,2-Dichlorobenzene | 3 |
| 1.04E-01 | 9.90E-06 | 9.77E-04 | 25 | 7,643 | 356.65 | 561.00 | 1.74E+01 | 8.52E+03 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 4 |
| 6.90E-02 | 7.90E-06 | 2.39E-03 | 25 | 9,271 | 447.21 | 684.75 | 6.17E+02 | 7.90E+01 | 1.1E-05 | 8.0E-01 | 1,4-Dichlorobenzene | 5 |
| 8.80E-02 | 9.80E-06 | 5.54E-03 | 25 | 7,342 | 353.24 | 562.16 | 5.89E+01 | 1.79E+03 | 2.9E-05 | 3.0E-02 | Benzene | 6 |
| 7.30E-02 | 8.70E-06 | 3.69E-03 | 25 | 8,410 | 404.87 | 632.40 | 2.19E+02 | 4.72E+02 | 0.0E+00 | 5.0E-02 | Chlorobenzene | 7 |
| 7.40E-02 | 8.50E-06 | 1.00E-01 | 25 | 7,474 | 353.90 | 572.20 | 9.63E+02 | 5.50E+01 | 0.0E+00 | 6.0E+00 | Cyclohexane | 8 |
| 7.50E-02 | 7.80E-06 | 7.86E-03 | 25 | 8,501 | 409.34 | 617.20 | 3.63E+02 | 1.69E+02 | 2.5E-06 | 1.0E+00 | Ethylbenzene | 9 |
| 6.50E-02 | 7.10E-06 | 1.16E+00 | 25 | 10,335 | 425.56 | 631.10 | 4.89E+02 | 6.13E+01 | 0.0E+00 | 4.0E-01 | Cumene | 10 |
| 8.08E-02 | 9.80E-06 | 5.58E-05 | 25 | 7,481 | 352.50 | 536.78 | 2.30E+00 | 2.23E+05 | 0.0E+00 | 5.0E+00 | Methylethylketone (2-butanone) | 11 |
| 7.20E-02 | 8.20E-06 | 1.84E-02 | 25 | 8,288 | 394.40 | 620.20 | 1.55E+02 | 2.00E+02 | 5.9E-06 | 3.5E-02 | Tetrachloroethylene | 12 |
| 8.70E-02 | 8.60E-06 | 6.62E-03 | 25 | 7,930 | 383.78 | 591.79 | 1.82E+02 | 5.26E+02 | 0.0E+00 | 3.0E-01 | Toluene | 13 |
| 7.90E-02 | 9.10E-06 | 1.03E-02 | 25 | 7,505 | 360.36 | 544.20 | 1.66E+02 | 1.47E+03 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 14 |
| 7.36E-02 | 1.13E-05 | 4.07E-03 | 25 | 7,192 | 333.65 | 544.00 | 3.55E+01 | 3.50E+03 | 0.0E+00 | 3.5E-02 | cis-1,2-Dichloroethylene | 15 |
| 7.00E-02 | 7.80E-06 | 7.32E-03 | 25 | 8,523 | 412.27 | 617.05 | 4.07E+02 | 1.61E+02 | 0.0E+00 | 1.0E-01 | m-Xylene | 16 |
| 5.70E-02 | 8.12E-06 | 1.31E-02 | 25 | 9,290 | 456.46 | 660.50 | 1.11E+03 | 2.00E+00 | 0.0E+00 | 1.4E-01 | n-Butylbenzene | 17 |
| 5.70E-02 | 8.12E-06 | 1.39E-02 | 25 | 88,730 | 446.50 | 679.00 | 9.66E+02 | 3.94E+00 | 0.0E+00 | 1.4E-01 | sec-Butylbenzene | 18 |

**Area 1: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

**END**

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**Area 1: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) | **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | 1,1-Dichloroethylene | 1 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | 1,2,4-Trichlorobenzene | 2 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | 1,2-Dichlorobenzene | 3 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | 1,2-Dichloroethane | 4 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | 1,4-Dichlorobenzene | 5 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Benzene | 6 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Chlorobenzene | 7 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Cyclohexane | 8 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Ethylbenzene | 9 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Cumene | 10 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Methylethylketone (2-butanone) | 11 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Tetrachloroethylene | 12 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Toluene | 13 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Trichloroethylene | 14 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | cis-1,2-Dichloroethylene | 15 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | m-Xylene | 16 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | n-Butylbenzene | 17 |
| 9.46E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | sec-Butylbenzene | 18 |

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ ($atm\text{-}m^3/mol$) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) | **Area 1: Residential Exposure Scenario**<br>**Preparation Date: 1/21/2014**<br>**Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 6,299 | 2.51E-02 | 1.03E+00 | 1.80E-04 | 1.25E-02 | 1.45E-02 | 5.67E-03 | 7.26E-05 | 2.08E-03 | 1294.116 | 1,1-Dichloroethylene | 1 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 13,069 | 1.32E-03 | 5.39E-02 | 1.80E-04 | 4.17E-03 | 4.85E-03 | 1.89E-03 | 4.79E-05 | 1.18E-03 | 1294.116 | 1,2,4-Trichlorobenzene | 2 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,546 | 1.77E-03 | 7.28E-02 | 1.80E-04 | 9.58E-03 | 1.12E-02 | 4.34E-03 | 7.17E-05 | 1.96E-03 | 1294.116 | 1,2-Dichlorobenzene | 3 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,368 | 9.31E-04 | 3.82E-02 | 1.80E-04 | 1.44E-02 | 1.68E-02 | 6.55E-03 | 1.23E-04 | 3.27E-03 | 1294.116 | 1,2-Dichloroethane | 4 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,098 | 2.25E-03 | 9.22E-02 | 1.80E-04 | 9.58E-03 | 1.12E-02 | 4.34E-03 | 6.81E-05 | 1.88E-03 | 1294.116 | 1,4-Dichlorobenzene | 5 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,977 | 5.29E-03 | 2.17E-01 | 1.80E-04 | 1.22E-02 | 1.42E-02 | 5.54E-03 | 7.66E-05 | 2.17E-03 | 1294.116 | Benzene | 6 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,661 | 3.49E-03 | 1.43E-01 | 1.80E-04 | 1.01E-02 | 1.18E-02 | 4.60E-03 | 6.72E-05 | 1.88E-03 | 1294.116 | Chlorobenzene | 7 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,088 | 9.55E-02 | 3.92E+00 | 1.80E-04 | 1.03E-02 | 1.20E-02 | 4.66E-03 | 5.87E-05 | 1.69E-03 | 1294.116 | Cyclohexane | 8 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,994 | 7.43E-03 | 3.05E-01 | 1.80E-04 | 1.04E-02 | 1.21E-02 | 4.72E-03 | 6.32E-05 | 1.80E-03 | 1294.116 | Ethylbenzene | 9 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 12,447 | 1.08E+00 | 4.42E+01 | 1.80E-04 | 9.03E-03 | 1.05E-02 | 4.09E-03 | 5.13E-05 | 1.47E-03 | 1294.116 | Cumene | 10 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,244 | 5.32E-05 | 2.18E-03 | 1.80E-04 | 1.12E-02 | 1.31E-02 | 5.13E-03 | 7.79E-04 | 7.82E-03 | 1294.116 | Methylethylketone (2-butanone) | 11 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,410 | 1.74E-02 | 7.14E-01 | 1.80E-04 | 1.00E-02 | 1.16E-02 | 4.53E-03 | 5.86E-05 | 1.68E-03 | 1294.116 | Tetrachloroethylene | 12 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,001 | 6.29E-03 | 2.58E-01 | 1.80E-04 | 1.21E-02 | 1.41E-02 | 5.48E-03 | 7.39E-05 | 2.10E-03 | 1294.116 | Toluene | 13 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,382 | 9.80E-03 | 4.02E-01 | 1.80E-04 | 1.10E-02 | 1.28E-02 | 4.97E-03 | 6.59E-05 | 1.88E-03 | 1294.116 | Trichloroethylene | 14 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,592 | 3.90E-03 | 1.60E-01 | 1.80E-04 | 1.02E-02 | 1.19E-02 | 4.63E-03 | 6.93E-05 | 1.93E-03 | 1294.116 | cis-1,2-Dichloroethylene | 15 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 10,090 | 6.91E-03 | 2.84E-01 | 1.80E-04 | 9.72E-03 | 1.13E-02 | 4.41E-03 | 5.96E-05 | 1.69E-03 | 1294.116 | m-Xylene | 16 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,671 | 1.23E-02 | 5.04E-01 | 1.80E-04 | 7.92E-03 | 9.21E-03 | 3.59E-03 | 4.75E-05 | 1.35E-03 | 1294.116 | n-Butylbenzene | 17 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 106,642 | 7.56E-03 | 3.10E-01 | 1.80E-04 | 7.92E-03 | 9.21E-03 | 3.59E-03 | 4.91E-05 | 1.39E-03 | 1294.116 | sec-Butylbenzene | 18 |
| | | Cal default | | | | | | | | | | | | | |

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**Area 1: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.34E+03 | 1.33 | 8.33E+01 | 1.25E-02 | 5.30E+03 | 8.26E+04 | 4.93E-05 | 6.60E-02 | NA | 7.0E-02 | 1,1-Dichloroethylene | 1 |
| 15 | 1.94E+02 | 1.33 | 8.33E+01 | 4.17E-03 | 5.30E+03 | 5.62E+14 | 2.82E-05 | 5.47E-03 | NA | 2.0E-03 | 1,2,4-Trichlorobenzene | 2 |
| 15 | 2.84E+02 | 1.33 | 8.33E+01 | 9.58E-03 | 5.30E+03 | 2.59E+06 | 4.65E-05 | 1.32E-02 | NA | 2.0E-01 | 1,2-Dichlorobenzene | 3 |
| 15 | 1.07E+04 | 1.33 | 8.33E+01 | 1.44E-02 | 5.30E+03 | 1.80E+04 | 7.67E-05 | 8.20E-01 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 4 |
| 15 | 1.01E+03 | 1.33 | 8.33E+01 | 9.58E-03 | 5.30E+03 | 2.59E+06 | 4.46E-05 | 4.52E-02 | 1.1E-05 | 8.0E-01 | 1,4-Dichlorobenzene | 5 |
| 15 | 8.46E+03 | 1.33 | 8.33E+01 | 1.22E-02 | 5.30E+03 | 1.07E+05 | 5.13E-05 | 4.34E-01 | 2.9E-05 | 3.0E-02 | Benzene | 6 |
| 15 | 4.15E+05 | 1.33 | 8.33E+01 | 1.01E-02 | 5.30E+03 | 1.15E+06 | 4.47E-05 | 1.86E+01 | NA | 5.0E-02 | Chlorobenzene | 7 |
| 15 | 5.09E+05 | 1.33 | 8.33E+01 | 1.03E-02 | 5.30E+03 | 9.55E+05 | 4.01E-05 | 2.04E+01 | NA | 6.0E+00 | Cyclohexane | 8 |
| 15 | 1.98E+03 | 1.33 | 8.33E+01 | 1.04E-02 | 5.30E+03 | 7.95E+05 | 4.27E-05 | 8.46E-02 | 2.5E-06 | 1.0E+00 | Ethylbenzene | 9 |
| 15 | 3.18E+05 | 1.33 | 8.33E+01 | 9.03E-03 | 5.30E+03 | 6.42E+06 | 3.52E-05 | 1.12E+01 | NA | 4.0E-01 | Cumene | 10 |
| 15 | 2.18E+01 | 1.33 | 8.33E+01 | 1.12E-02 | 5.30E+03 | 2.98E+05 | 1.76E-04 | 3.83E-03 | NA | 5.0E+00 | Methylethylketone (2-butanone) | 11 |
| 15 | 4.35E+04 | 1.33 | 8.33E+01 | 1.00E-02 | 5.30E+03 | 1.40E+06 | 3.99E-05 | 1.74E+00 | 5.9E-06 | 3.5E-02 | Tetrachloroethylene | 12 |
| 15 | 9.03E+02 | 1.33 | 8.33E+01 | 1.21E-02 | 5.30E+03 | 1.22E+05 | 4.97E-05 | 4.49E-02 | NA | 3.0E-01 | Toluene | 13 |
| 15 | 3.66E+04 | 1.33 | 8.33E+01 | 1.10E-02 | 5.30E+03 | 3.99E+05 | 4.46E-05 | 1.63E+00 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 14 |
| 15 | 5.60E+02 | 1.33 | 8.33E+01 | 1.02E-02 | 5.30E+03 | 1.03E+06 | 4.58E-05 | 2.56E-02 | NA | 3.5E-02 | cis-1,2-Dichloroethylene | 15 |
| 15 | 7.94E+02 | 1.33 | 8.33E+01 | 9.72E-03 | 5.30E+03 | 2.10E+06 | 4.02E-05 | 3.19E-02 | NA | 1.0E-01 | m-Xylene | 16 |
| 15 | 2.32E+03 | 1.33 | 8.33E+01 | 7.92E-03 | 5.30E+03 | 5.80E+07 | 3.23E-05 | 7.49E-02 | NA | 1.4E-01 | n-Butylbenzene | 17 |
| 15 | 1.74E+03 | 1.33 | 8.33E+01 | 7.92E-03 | 5.30E+03 | 5.80E+07 | 3.32E-05 | 5.76E-02 | NA | 1.4E-01 | sec-Butylbenzene | 18 |

**END**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:**

**Area 1: Residential Exposure Scenario**

**INCREMENTAL RISK CALCULATIONS:**

**Preparation Date: 1/21/2014**

| | Indoor exposure groundwater conc., carcinogen (µg/L) | Indoor exposure groundwater conc., noncarcinogen (µg/L) | Risk-based indoor exposure groundwater conc., (µg/L) | Pure component water solubility, S (µg/L) | Final indoor exposure groundwater conc., (µg/L) | Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Percent of Total Risk (%) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) | Percent of Total Health Hazard (%) | Risk-Based Screening Level (RBSL) Cancer µg/L TR = 1E-6 | Risk-Based Screening Level (RBSL) Non-cancer µg/L THQ = 1 | COPCs Evaluated | CAS No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | NA | NA | NA | 2.25E+06 | NA | NA | 0% | 9E-4 | 0.07% | NA | 1,438 | 1,1-Dichloroethylene | 75354 |
| 2 | NA | NA | NA | 4.88E+04 | NA | NA | 0% | 3E-3 | 0.2% | NA | 1,374 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | NA | NA | NA | 1.56E+05 | NA | NA | 0% | 6E-5 | 0.005% | NA | 61,667 | 1,2-Dichlorobenzene | 95501 |
| 4 | NA | NA | NA | 8.52E+06 | NA | 9E-6 | 41% | 1E-1 | 8% | 32 | 2,494 | 1,2-Dichloroethane | 107062 |
| 5 | NA | NA | NA | 7.90E+04 | NA | 2E-7 | 1% | 5E-5 | 0.004% | 54 | 79,000 | 1,4-Dichlorobenzene | 106467 |
| 6 | NA | NA | NA | 1.79E+06 | NA | 5E-6 | 24% | 1E-2 | 1% | 7.5 | 2,812 | Benzene | 71432 |
| 7 | NA | NA | NA | 4.72E+05 | NA | NA | 0% | 4E-1 | 26% | NA | 8,148 | Chlorobenzene | 108907 |
| 8 | NA | NA | NA | 5.50E+04 | NA | NA | 0% | 3E-3 | 0.2% | NA | 39,812 | Cyclohexane | 110827 |
| 9 | NA | NA | NA | 1.69E+05 | NA | 9E-8 | 0.4% | 8E-5 | 0.006% | 75 | 80,151 | Ethylbenzene | 100414 |
| 10 | NA | NA | NA | 6.13E+04 | NA | NA | 0% | 3E-2 | 2% | NA | 268 | Cumene | 98828 |
| 11 | NA | NA | NA | 2.23E+08 | NA | NA | 0% | 7E-7 | 0.00005% | NA | 13,612,799 | Methylethylketone (2-butanone) | 78933 |
| 12 | NA | NA | NA | 2.00E+05 | NA | 4E-6 | 20% | 5E-2 | 4% | 14 | 1,282 | Tetrachloroethylene | 127184 |
| 13 | NA | NA | NA | 5.26E+05 | NA | NA | 0% | 1E-4 | 0.01% | NA | 24,375 | Toluene | 108883 |
| 14 | NA | NA | NA | 1.47E+06 | NA | 3E-6 | 13% | 8E-1 | 58% | 33 | 116 | Trichloroethylene | 79016 |
| 15 | NA | NA | NA | 3.50E+06 | NA | NA | 0% | 7E-4 | 0.05% | NA | 4,983 | cis-1,2-Dichloroethylene | 156592 |
| 16 | NA | NA | NA | 1.61E+05 | NA | NA | 0% | 3E-4 | 0.02% | NA | 9,142 | m-Xylene | 108383 |
| 17 | NA | NA | NA | 2.00E+03 | NA | NA | 0% | 5E-4 | 0.04% | NA | 2,000 | n-Butylbenzene | 104518 |
| 18 | NA | NA | NA | 3.94E+03 | NA | NA | 0% | 4E-4 | 0.03% | NA | 3,940 | sec-Butylbenzene | 135988 |
| Total | | | | | | 2E-5 | 100.0% | 1.3 | 100.0% | | | | |

**Area 1: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

**SCROLL TO "END"** **MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**SOIL AND GROUNDWATER-BASED ERROR STATEMENTS** **(DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

**CHEMICAL-BASED ERROR STATEMENTS** **(DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

**Area 1: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
| 2 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
| 5 | 1,4-Dichlorobenzene | 106467 |
| 6 | Benzene | 71432 |
| 7 | Chlorobenzene | 108907 |
| 8 | Cyclohexane | 110827 |
| 9 | Ethylbenzene | 100414 |
| 10 | Cumene | 98828 |
| 11 | Methylethylketone (2-butanone) | 78933 |
| 12 | Tetrachloroethylene | 127184 |
| 13 | Toluene | 108883 |
| 14 | Trichloroethylene | 79016 |
| 15 | cis-1,2-Dichloroethylene | 156592 |
| 16 | m-Xylene | 108383 |
| 17 | n-Butylbenzene | 104518 |
| 18 | sec-Butylbenzene | 135988 |

**Area 1: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
| 2 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
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| 12 | Tetrachloroethylene | 127184 |
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| 14 | Trichloroethylene | 79016 |
| 15 | cis-1,2-Dichloroethylene | 156592 |
| 16 | m-Xylene | 108383 |
| 17 | n-Butylbenzene | 104518 |
| 18 | sec-Butylbenzene | 135988 |

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**Area 1: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
| 2 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
| 5 | 1,4-Dichlorobenzene | 106467 |
| 6 | Benzene | 71432 |
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| 8 | Cyclohexane | 110827 |
| 9 | Ethylbenzene | 100414 |
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| 11 | Methylethylketone (2-butanone) | 78933 |
| 12 | Tetrachloroethylene | 127184 |
| 13 | Toluene | 108883 |
| 14 | Trichloroethylene | 79016 |
| 15 | cis-1,2-Dichloroethylene | 156592 |
| 16 | m-Xylene | 108383 |
| 17 | n-Butylbenzene | 104518 |
| 18 | sec-Butylbenzene | 135988 |

**Area 1: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
| 2 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
| 5 | 1,4-Dichlorobenzene | 106467 |
| 6 | Benzene | 71432 |
| 7 | Chlorobenzene | 108907 |
| 8 | Cyclohexane | 110827 |
| 9 | Ethylbenzene | 100414 |
| 10 | Cumene | 98828 |
| 11 | Methylethylketone (2-butanone) | 78933 |
| 12 | Tetrachloroethylene | 127184 |
| 13 | Toluene | 108883 |
| 14 | Trichloroethylene | 79016 |
| 15 | cis-1,2-Dichloroethylene | 156592 |
| 16 | m-Xylene | 108383 |
| 17 | n-Butylbenzene | 104518 |
| 18 | sec-Butylbenzene | 135988 |

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**Area 1: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
| 2 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
| 5 | 1,4-Dichlorobenzene | 106467 |
| 6 | Benzene | 71432 |
| 7 | Chlorobenzene | 108907 |
| 8 | Cyclohexane | 110827 |
| 9 | Ethylbenzene | 100414 |
| 10 | Cumene | 98828 |
| 11 | Methylethylketone (2-butanone) | 78933 |
| 12 | Tetrachloroethylene | 127184 |
| 13 | Toluene | 108883 |
| 14 | Trichloroethylene | 79016 |
| 15 | cis-1,2-Dichloroethylene | 156592 |
| 16 | m-Xylene | 108383 |
| 17 | n-Butylbenzene | 104518 |
| 18 | sec-Butylbenzene | 135988 |

**END**

Input Parameters to the J&E Algorithm for Groundwater-to-Indoor Air Vapor
Commercial/Industrial Exposure Scenario, Area 1
Dual Site Groundwater, Montrose and Del Amo Superfund Sites

| Input Parameters to J&E Model GW-ADV Version 3.0 | | Units | J&E Spreadsheet Defaults | Site-Specific Evaluation Groundwater Samples | Basis for Parameter |
|---|---|---|---|---|---|
| $L_{WT}$ | Depth below grade to water table | cm (feet) | - (-) | 1,309 (43) | Site-specific, based on evaluation of historical water levels in CH2M HILL database. |
| Vadose Zone Properties (Without Engineered Fill) | | | | | |
| $T_s$ | Average groundwater temperature | °C | 22 | 24 | 75°F, California average shallow groundwater temperature (p. 48, EPA, 2004); DTSC, 2011, page D-6 |
| $h_A$ | Thickness of soil stratum A | cm (feet) | TBD | 712 (23.35) | Boring log for well SWL0049 |
| $h_B$ | Thickness of soil stratum B | cm (feet) | TBD | 454 (14.9) | Boring log for well SWL0049 |
| $h_C$ | Thickness of soil stratum C | cm (feet) | TBD | 143 (4.7) | Boring log for well SWL0049 |
| - | Stratum A soil type | -- | TBD | Loamy Sand | Boring log for well SWL0049 |
| $\rho_B^A$ | Stratum A soil dry bulk density | $g/cm^3$ | TBD | 1.62 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^A$ | Stratum A soil total porosity | unitless | TBD | 0.39 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^A$ | Stratum A soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.076 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum B soil type | -- | TBD | Sand | Boring log for well SWL0049 |
| $\rho_B^B$ | Stratum B soil dry bulk density | $g/cm^3$ | TBD | 1.66 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^B$ | Stratum B soil total porosity | unitless | TBD | 0.38 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^B$ | Stratum B soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.054 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum C soil type | -- | TBD | Loam | SCS Soil Name equivalent to Silty Sand with 20-50% fines; Boring log for well SWL0049 |
| $\rho_B^C$ | Stratum C soil dry bulk density | $g/cm^3$ | TBD | 1.59 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^C$ | Stratum C soil total porosity | unitless | TBD | 0.399 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^C$ | Stratum C soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.148 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| Building Parameters | | | | | |
| $L_F$ | Depth below grade to bottom of enclosed space floor - slab on grade (building with no basement) | cm | 15 | 15 | default, EPA, 2004, page 47 |
| $L_{crack}$ | Enclosed space floor thickness | cm | 10 | 9 | DTSC, 2011, Table 3; EPA, 2004 uses 10 cm, but California value of 9 cm is more conservative |
| $\Delta P$ | Soil-building pressure differential | $g/cm\text{-}s^2$ | 40 | 40 | OEHHA, 2005, page B-13; DTSC accepts EPA default in absence of California-specific measurements |
| $L_B$ | Enclosed space floor length | cm | 1,000 | 1,000 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $W_B$ | Enclosed space floor width | cm | 1,000 | 1,000 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $H_B$ | Enclosed space height | cm | 244 | 244 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| w | Floor-wall seam crack width | cm | 0.1 | 0.1 | OEHHA, 2005, page B-13; EPA, 2004, page 55. |
| $\eta$ | Crack-to-total area ratio | unitless | model calculated | 0.005 | California default, DTSC, 2011, Table 3. |
| ER | Indoor air exchange rate | 1/hour | 0.25 | 1.0 | California Energy Commission (CEC), 2001; DTSC, 2011, Appendix D, page D-6. |
| $Q_{soil}$ | Average vapor flow rate into building | L/min | 5 | 5 | OEHHA, 2005, page B-13; California accepts EPA default, EPA, 2004, except when site-specific permeability is used. |
| $\alpha$ | Infinite Source - Indoor Attenuation Coefficient | unitless | model calculated | model calculated | Product of Johnson-Ettinger algorithm on INTERCALCS page incorporating site-specific information, EPA, 2004. |
| Physical-Chemical & Toxicity Parameters | | | | | |
| | The values were derived from the 'Chemical Properties Look Up Table' spreadsheet of *HERD_Groundwater_Screening_Model.xls* (updated December 2, 2011), <*http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm*> . | | | | |
| Exposure Parameters -Commercial-Industrial Scenario | | | | | |
| $AT_c$ | Averaging time for carcinogens | years | 70 | 70 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| $AT_{NC}$ | Averaging time for noncarcinogens | years | 25 | 25 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ED | Exposure duration | years | 25 | 25 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| EF | Exposure frequency | days/year | 250 | 250 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ET | Exposure time | hours/day | 8 | 8 | U.S. EPA, 1991; DTSC, 2011, Appendix C |

General notes follow on next page.

References:


CEC, 2001, *Manual for Compliance with the 2001 Energy Efficiency Staqndards (for Nonresidential Buildings, High-Rise Residential Buildings, and Hotels/Motels)* , Document No. P400-01-032, August

DTSC, 2011, *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)* , October.

OEHHA, 2005, *Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil* , January.

U.S. EPA Office of Emergency and Remedial Response, 1991, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part B), Interim Final* , EPA/540/R-92/003, December.

U.S. EPA Office of Research and Development, National Center for Environmental Assessment, 1997, Exposure Factors Handbook, EPA/600/P-95/002Fa, August.

U.S. EPA Region IX, 1999, EPA Superfund Record of Decision for Dual Site Groundwater Operable Unit, Montrose Chemical and Del Amo Superfund Sites, EPA/ROD/R09-99/035, March.

U.S. EPA Office of Solid Waste and Emergency Response, 2002, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December.

DATA ENTRY SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

R GW-ADV
Version 3.0; 02/03

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| | ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Qualifier | Chemicals Evaluated (COPCs and Surrogates) | Surrogate? | Chemical Detected in Groundwater: COPC Detected | Chemical Detected in Groundwater: CAS No. |
|---|---|---|---|---|---|---|---|
| 1 | 75354 | 1.3 | | 1,1-Dichloroethylene | NO | | |
| 2 | 120821 | 3.6 | | 1,2,4-Trichlorobenzene | NO | | |
| 3 | 95501 | 3.9 | | 1,2-Dichlorobenzene | NO | | |
| 4 | 107062 | 280 | | 1,2-Dichloroethane | NO | | |
| 5 | 106467 | 11 | | 1,4-Dichlorobenzene | NO | | |
| 6 | 71432 | 39 | | Benzene | NO | | |
| 7 | 108907 | 2,900 | | Chlorobenzene | NO | | |
| 8 | 110827 | 130 | | Cyclohexane | NO | | |
| 9 | 100414 | 6.5 | | Ethylbenzene | NO | | |
| 10 | 98828 | 7.2 | | Cumene | NO | | |
| 11 | 78933 | 10 | | Methylethylketone (2-butanone) | NO | | |
| 12 | 127184 | 61 | | Tetrachloroethylene | NO | | |
| 13 | 108883 | 3.5 | | Toluene | NO | | |
| 14 | 79016 | 91 | | Trichloroethylene | NO | | |
| 15 | 156592 | 3.5 | | cis-1,2-Dichloroethylene | NO | | |
| 16 | 108383 | 2.8 | | m-Xylene | YES | m,p-Xylenes | 179601231 |
| 17 | 104518 | 4.6 | | n-Butylbenzene | NO | | |
| 18 | 135988 | 5.6 | | sec-Butylbenzene | NO | | |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Totals must add up to value of $L_{WT}$ (cell G28) | | | | | | | |
| 24.0 | 15.0 | 1,309 | 712 | 454 | 143 | C | L | LS | | |
| Southern Cal. | slab-on-grade | 42.95 feet | 23.35 feet | 14.9 feet | 4.7 feet | | | | | |

MORE ↓

| ENTER Stratum A SCS soil type (Look) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ ($cm^3/cm^3$) | ENTER Stratum B SCS soil type (Look) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ ($g/cm^3$) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ ($cm^3/cm^3$) | ENTER Stratum C SCS soil type (Look) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ ($g/cm^3$) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ ($cm^3/cm^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LS | 1.62 | 0.39 | 0.076 | S | 1.66 | 0.375 | 0.054 | L | 1.59 | 0.399 | 0.148 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 9.0 | 40.0 | 1,000 | 1,000 | 244 | 0.10 | 1.0 | 5 |
| 3.5 inches | 4 Pa | 33 feet | 33 feet | 8 feet | default | Commercial/Industrial | default |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Exposure Time, ET (hrs/day) | Target risk for carcinogens, TR (unitless) | Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|---|
| 70 | 25 | 25 | 250 | 8 | 1.0E-06 | 1 |
| Commercial/Industrial Exposure Scenario | | | | | Used to calculate risk-based groundwater concentration. | |

END

CHEMICAL PROPERTIES SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER AREA 1

| Diffusivity in air, $D_a$ ($cm^2/s$) | Diffusivity in water, $D_w$ ($cm^2/s$) | Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$) | Henry's law constant reference temperature, $T_R$ ($^oC$) | Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol) | Normal boiling point, $T_B$ ($^oK$) | Critical temperature, $T_C$ ($^oK$) | Organic carbon partition coefficient, $K_{oc}$ ($cm^3/g$) | Pure component water solubility, S (mg/L) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.00E-02 | 1.04E-05 | 2.60E-02 | 25 | 6,247 | 304.75 | 576.05 | 5.89E+01 | 2.25E+03 | 0.0E+00 | 7.0E-02 | 1,1-Dichloroethylene | 1 |
| 3.00E-02 | 8.23E-06 | 1.42E-03 | 25 | 10,471 | 486.15 | 725.00 | 1.78E+03 | 4.88E+01 | 0.0E+00 | 2.0E-03 | 1,2,4-Trichlorobenzene | 2 |
| 6.90E-02 | 7.90E-06 | 1.90E-03 | 25 | 9,700 | 453.57 | 705.00 | 6.17E+02 | 1.56E+02 | 0.0E+00 | 2.0E-01 | 1,2-Dichlorobenzene | 3 |
| 1.04E-01 | 9.90E-06 | 9.77E-04 | 25 | 7,643 | 356.65 | 561.00 | 1.74E+01 | 8.52E+03 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 4 |
| 6.90E-02 | 7.90E-06 | 2.39E-03 | 25 | 9,271 | 447.21 | 684.75 | 6.17E+02 | 7.90E+01 | 1.1E-05 | 8.0E-01 | 1,4-Dichlorobenzene | 5 |
| 8.80E-02 | 9.80E-06 | 5.54E-03 | 25 | 7,342 | 353.24 | 562.16 | 5.89E+01 | 1.79E+03 | 2.9E-05 | 3.0E-02 | Benzene | 6 |
| 7.30E-02 | 8.70E-06 | 3.69E-03 | 25 | 8,410 | 404.87 | 632.40 | 2.19E+02 | 4.72E+02 | 0.0E+00 | 5.0E-02 | Chlorobenzene | 7 |
| 7.40E-02 | 8.50E-06 | 1.00E-01 | 25 | 7,474 | 353.90 | 572.20 | 9.63E+02 | 5.50E+01 | 0.0E+00 | 6.0E+00 | Cyclohexane | 8 |
| 7.50E-02 | 7.80E-06 | 7.86E-03 | 25 | 8,501 | 409.34 | 617.20 | 3.63E+02 | 1.69E+02 | 2.5E-06 | 1.0E+00 | Ethylbenzene | 9 |
| 6.50E-02 | 7.10E-06 | 1.16E+00 | 25 | 10,335 | 425.56 | 631.10 | 4.89E+02 | 6.13E+01 | 0.0E+00 | 4.0E-01 | Cumene | 10 |
| 8.08E-02 | 9.80E-06 | 5.58E-05 | 25 | 7,481 | 352.50 | 536.78 | 2.30E+00 | 2.23E+05 | 0.0E+00 | 5.0E+00 | Methylethylketone (2-butanone) | 11 |
| 7.20E-02 | 8.20E-06 | 1.84E-02 | 25 | 8,288 | 394.40 | 620.20 | 1.55E+02 | 2.00E+02 | 5.9E-06 | 3.5E-02 | Tetrachloroethylene | 12 |
| 8.70E-02 | 8.60E-06 | 6.62E-03 | 25 | 7,930 | 383.78 | 591.79 | 1.82E+02 | 5.26E+02 | 0.0E+00 | 3.0E-01 | Toluene | 13 |
| 7.90E-02 | 9.10E-06 | 1.03E-02 | 25 | 7,505 | 360.36 | 544.20 | 1.66E+02 | 1.47E+03 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 14 |
| 7.36E-02 | 1.13E-05 | 4.07E-03 | 25 | 7,192 | 333.65 | 544.00 | 3.55E+01 | 3.50E+03 | 0.0E+00 | 3.5E-02 | cis-1,2-Dichloroethylene | 15 |
| 7.00E-02 | 7.80E-06 | 7.32E-03 | 25 | 8,523 | 412.27 | 617.05 | 4.07E+02 | 1.61E+02 | 0.0E+00 | 1.0E-01 | m-Xylene | 16 |
| 5.70E-02 | 8.12E-06 | 1.31E-02 | 25 | 9,290 | 456.46 | 660.50 | 1.11E+03 | 2.00E+00 | 0.0E+00 | 1.4E-01 | n-Butylbenzene | 17 |
| 5.70E-02 | 8.12E-06 | 1.39E-02 | 25 | 88,730 | 446.50 | 679.00 | 9.66E+02 | 3.94E+00 | 0.0E+00 | 1.4E-01 | sec-Butylbenzene | 18 |

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

**END**

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) | **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | 1,1-Dichloroethylene | 1 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | 1,2,4-Trichlorobenzene | 2 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | 1,2-Dichlorobenzene | 3 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | 1,2-Dichloroethane | 4 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | 1,4-Dichlorobenzene | 5 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Benzene | 6 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Chlorobenzene | 7 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Cyclohexane | 8 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Ethylbenzene | 9 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Cumene | 10 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Methylethylketone (2-butanone) | 11 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Tetrachloroethylene | 12 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Toluene | 13 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | Trichloroethylene | 14 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | cis-1,2-Dichloroethylene | 15 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | m-Xylene | 16 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | n-Butylbenzene | 17 |
| 7.88E+08 | 1294.116 | 0.314 | 0.321 | 0.251 | 0.079 | 1.66E-08 | 0.957 | 1.59E-08 | 37.50 | 0.399 | 0.067 | 0.332 | 4,000 | sec-Butylbenzene | 18 |

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-$m^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 6,299 | 2.51E-02 | 1.03E+00 | 1.80E-04 | 1.25E-02 | 1.45E-02 | 5.67E-03 | 7.26E-05 | 2.08E-03 | 1294.116 | 1,1-Dichloroethylene | 1 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 13,069 | 1.32E-03 | 5.39E-02 | 1.80E-04 | 4.17E-03 | 4.85E-03 | 1.89E-03 | 4.79E-05 | 1.18E-03 | 1294.116 | 1,2,4-Trichlorobenzene | 2 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,546 | 1.77E-03 | 7.28E-02 | 1.80E-04 | 9.58E-03 | 1.12E-02 | 4.34E-03 | 7.17E-05 | 1.96E-03 | 1294.116 | 1,2-Dichlorobenzene | 3 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,368 | 9.31E-04 | 3.82E-02 | 1.80E-04 | 1.44E-02 | 1.68E-02 | 6.55E-03 | 1.23E-04 | 3.27E-03 | 1294.116 | 1,2-Dichloroethane | 4 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,098 | 2.25E-03 | 9.22E-02 | 1.80E-04 | 9.58E-03 | 1.12E-02 | 4.34E-03 | 6.81E-05 | 1.88E-03 | 1294.116 | 1,4-Dichlorobenzene | 5 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,977 | 5.29E-03 | 2.17E-01 | 1.80E-04 | 1.22E-02 | 1.42E-02 | 5.54E-03 | 7.66E-05 | 2.17E-03 | 1294.116 | Benzene | 6 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,661 | 3.49E-03 | 1.43E-01 | 1.80E-04 | 1.01E-02 | 1.18E-02 | 4.60E-03 | 6.72E-05 | 1.88E-03 | 1294.116 | Chlorobenzene | 7 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,088 | 9.55E-02 | 3.92E+00 | 1.80E-04 | 1.03E-02 | 1.20E-02 | 4.66E-03 | 5.87E-05 | 1.69E-03 | 1294.116 | Cyclohexane | 8 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,994 | 7.43E-03 | 3.05E-01 | 1.80E-04 | 1.04E-02 | 1.21E-02 | 4.72E-03 | 6.32E-05 | 1.80E-03 | 1294.116 | Ethylbenzene | 9 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 12,447 | 1.08E+00 | 4.42E+01 | 1.80E-04 | 9.03E-03 | 1.05E-02 | 4.09E-03 | 5.13E-05 | 1.47E-03 | 1294.116 | Cumene | 10 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,244 | 5.32E-05 | 2.18E-03 | 1.80E-04 | 1.12E-02 | 1.31E-02 | 5.13E-03 | 7.79E-04 | 7.82E-03 | 1294.116 | Methylethylketone (2-butanone) | 11 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,410 | 1.74E-02 | 7.14E-01 | 1.80E-04 | 1.00E-02 | 1.16E-02 | 4.53E-03 | 5.86E-05 | 1.68E-03 | 1294.116 | Tetrachloroethylene | 12 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,001 | 6.29E-03 | 2.58E-01 | 1.80E-04 | 1.21E-02 | 1.41E-02 | 5.48E-03 | 7.39E-05 | 2.10E-03 | 1294.116 | Toluene | 13 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,382 | 9.80E-03 | 4.02E-01 | 1.80E-04 | 1.10E-02 | 1.28E-02 | 4.97E-03 | 6.59E-05 | 1.88E-03 | 1294.116 | Trichloroethylene | 14 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,592 | 3.90E-03 | 1.60E-01 | 1.80E-04 | 1.02E-02 | 1.19E-02 | 4.63E-03 | 6.93E-05 | 1.93E-03 | 1294.116 | cis-1,2-Dichloroethylene | 15 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 10,090 | 6.91E-03 | 2.84E-01 | 1.80E-04 | 9.72E-03 | 1.13E-02 | 4.41E-03 | 5.96E-05 | 1.69E-03 | 1294.116 | m-Xylene | 16 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,671 | 1.23E-02 | 5.04E-01 | 1.80E-04 | 7.92E-03 | 9.21E-03 | 3.59E-03 | 4.75E-05 | 1.35E-03 | 1294.116 | n-Butylbenzene | 17 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 106,642 | 7.56E-03 | 3.10E-01 | 1.80E-04 | 7.92E-03 | 9.21E-03 | 3.59E-03 | 4.91E-05 | 1.39E-03 | 1294.116 | sec-Butylbenzene | 18 |
| | | Cal default | | | | | | | | | | | | | |

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.34E+03 | 1.33 | 8.33E+01 | 1.25E-02 | 5.30E+03 | 8.26E+04 | 2.46E-05 | 3.30E-02 | NA | 7.0E-02 | 1,1-Dichloroethylene | 1 |
| 15 | 1.94E+02 | 1.33 | 8.33E+01 | 4.17E-03 | 5.30E+03 | 5.62E+14 | 1.41E-05 | 2.73E-03 | NA | 2.0E-03 | 1,2,4-Trichlorobenzene | 2 |
| 15 | 2.84E+02 | 1.33 | 8.33E+01 | 9.58E-03 | 5.30E+03 | 2.59E+06 | 2.32E-05 | 6.60E-03 | NA | 2.0E-01 | 1,2-Dichlorobenzene | 3 |
| 15 | 1.07E+04 | 1.33 | 8.33E+01 | 1.44E-02 | 5.30E+03 | 1.80E+04 | 3.83E-05 | 4.10E-01 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 4 |
| 15 | 1.01E+03 | 1.33 | 8.33E+01 | 9.58E-03 | 5.30E+03 | 2.59E+06 | 2.23E-05 | 2.26E-02 | 1.1E-05 | 8.0E-01 | 1,4-Dichlorobenzene | 5 |
| 15 | 8.46E+03 | 1.33 | 8.33E+01 | 1.22E-02 | 5.30E+03 | 1.07E+05 | 2.56E-05 | 2.17E-01 | 2.9E-05 | 3.0E-02 | Benzene | 6 |
| 15 | 4.15E+05 | 1.33 | 8.33E+01 | 1.01E-02 | 5.30E+03 | 1.15E+06 | 2.23E-05 | 9.28E+00 | NA | 5.0E-02 | Chlorobenzene | 7 |
| 15 | 5.09E+05 | 1.33 | 8.33E+01 | 1.03E-02 | 5.30E+03 | 9.55E+05 | 2.01E-05 | 1.02E+01 | NA | 6.0E+00 | Cyclohexane | 8 |
| 15 | 1.98E+03 | 1.33 | 8.33E+01 | 1.04E-02 | 5.30E+03 | 7.95E+05 | 2.14E-05 | 4.23E-02 | 2.5E-06 | 1.0E+00 | Ethylbenzene | 9 |
| 15 | 3.18E+05 | 1.33 | 8.33E+01 | 9.03E-03 | 5.30E+03 | 6.42E+06 | 1.76E-05 | 5.60E+00 | NA | 4.0E-01 | Cumene | 10 |
| 15 | 2.18E+01 | 1.33 | 8.33E+01 | 1.12E-02 | 5.30E+03 | 2.98E+05 | 8.78E-05 | 1.92E-03 | NA | 5.0E+00 | Methylethylketone (2-butanone) | 11 |
| 15 | 4.35E+04 | 1.33 | 8.33E+01 | 1.00E-02 | 5.30E+03 | 1.40E+06 | 1.99E-05 | 8.68E-01 | 5.9E-06 | 3.5E-02 | Tetrachloroethylene | 12 |
| 15 | 9.03E+02 | 1.33 | 8.33E+01 | 1.21E-02 | 5.30E+03 | 1.22E+05 | 2.49E-05 | 2.25E-02 | NA | 3.0E-01 | Toluene | 13 |
| 15 | 3.66E+04 | 1.33 | 8.33E+01 | 1.10E-02 | 5.30E+03 | 3.99E+05 | 2.23E-05 | 8.15E-01 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 14 |
| 15 | 5.60E+02 | 1.33 | 8.33E+01 | 1.02E-02 | 5.30E+03 | 1.03E+06 | 2.29E-05 | 1.28E-02 | NA | 3.5E-02 | cis-1,2-Dichloroethylene | 15 |
| 15 | 7.94E+02 | 1.33 | 8.33E+01 | 9.72E-03 | 5.30E+03 | 2.10E+06 | 2.01E-05 | 1.60E-02 | NA | 1.0E-01 | m-Xylene | 16 |
| 15 | 2.32E+03 | 1.33 | 8.33E+01 | 7.92E-03 | 5.30E+03 | 5.80E+07 | 1.62E-05 | 3.74E-02 | NA | 1.4E-01 | n-Butylbenzene | 17 |
| 15 | 1.74E+03 | 1.33 | 8.33E+01 | 7.92E-03 | 5.30E+03 | 5.80E+07 | 1.66E-05 | 2.88E-02 | NA | 1.4E-01 | sec-Butylbenzene | 18 |

**END**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:**

**Area 1: Comm-Ind Exposure Scenario**

| | Indoor exposure groundwater conc., carcinogen (µg/L) | Indoor exposure groundwater conc., noncarcinogen (µg/L) | Risk-based indoor exposure groundwater conc., (µg/L) | Pure component water solubility, S (µg/L) | Final indoor exposure groundwater conc., (µg/L) |
|---|---|---|---|---|---|
| 1 | NA | NA | NA | 2.25E+06 | NA |
| 2 | NA | NA | NA | 4.88E+04 | NA |
| 3 | NA | NA | NA | 1.56E+05 | NA |
| 4 | NA | NA | NA | 8.52E+06 | NA |
| 5 | NA | NA | NA | 7.90E+04 | NA |
| 6 | NA | NA | NA | 1.79E+06 | NA |
| 7 | NA | NA | NA | 4.72E+05 | NA |
| 8 | NA | NA | NA | 5.50E+04 | NA |
| 9 | NA | NA | NA | 1.69E+05 | NA |
| 10 | NA | NA | NA | 6.13E+04 | NA |
| 11 | NA | NA | NA | 2.23E+08 | NA |
| 12 | NA | NA | NA | 2.00E+05 | NA |
| 13 | NA | NA | NA | 5.26E+05 | NA |
| 14 | NA | NA | NA | 1.47E+06 | NA |
| 15 | NA | NA | NA | 3.50E+06 | NA |
| 16 | NA | NA | NA | 1.61E+05 | NA |
| 17 | NA | NA | NA | 2.00E+03 | NA |
| 18 | NA | NA | NA | 3.94E+03 | NA |

**INCREMENTAL RISK CALCULATIONS:**

**Preparation Date: 1/21/2014**

| | Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Percent of Total Risk (%) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) | Percent of Total Health Hazard (%) |
|---|---|---|---|---|
| 1 | NA | 0% | 1E-4 | 0.07% |
| 2 | NA | 0% | 3E-4 | 0.2% |
| 3 | NA | 0% | 8E-6 | 0.005% |
| 4 | 9E-7 | 41% | 1E-2 | 8% |
| 5 | 2E-8 | 1% | 6E-6 | 0.004% |
| 6 | 5E-7 | 24% | 2E-3 | 1% |
| 7 | NA | 0% | 4E-2 | 26% |
| 8 | NA | 0% | 4E-4 | 0.2% |
| 9 | 9E-9 | 0.4% | 1E-5 | 0.006% |
| 10 | NA | 0% | 3E-3 | 2% |
| 11 | NA | 0% | 9E-8 | 0.00005% |
| 12 | 4E-7 | 20% | 6E-3 | 4% |
| 13 | NA | 0% | 2E-5 | 0.01% |
| 14 | 3E-7 | 13% | 9E-2 | 58% |
| 15 | NA | 0% | 8E-5 | 0.05% |
| 16 | NA | 0% | 4E-5 | 0.02% |
| 17 | NA | 0% | 6E-5 | 0.04% |
| 18 | NA | 0% | 5E-5 | 0.03% |
| **Total** | **2E-6** | **100.0%** | **0.2** | **100.0%** |

**Risk-Based Screening Level (RBSL)**

| | Cancer µg/L TR = 1E-6 | Non-cancer µg/L THQ = 1 |
|---|---|---|
| 1 | NA | 12,077 |
| 2 | NA | 11,538 |
| 3 | NA | 156,000 |
| 4 | 322 | 20,947 |
| 5 | 542 | 79,000 |
| 6 | 76 | 23,621 |
| 7 | NA | 68,441 |
| 8 | NA | 55,000 |
| 9 | 754 | 169,000 |
| 10 | NA | 2,254 |
| 11 | NA | 114,347,510 |
| 12 | 146 | 10,772 |
| 13 | NA | 204,752 |
| 14 | 334 | 978 |
| 15 | NA | 41,858 |
| 16 | NA | 76,791 |
| 17 | NA | 2,000 |
| 18 | NA | 3,940 |

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
| 2 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
| 5 | 1,4-Dichlorobenzene | 106467 |
| 6 | Benzene | 71432 |
| 7 | Chlorobenzene | 108907 |
| 8 | Cyclohexane | 110827 |
| 9 | Ethylbenzene | 100414 |
| 10 | Cumene | 98828 |
| 11 | Methylethylketone (2-butanone) | 78933 |
| 12 | Tetrachloroethylene | 127184 |
| 13 | Toluene | 108883 |
| 14 | Trichloroethylene | 79016 |
| 15 | cis-1,2-Dichloroethylene | 156592 |
| 16 | m-Xylene | 108383 |
| 17 | n-Butylbenzene | 104518 |
| 18 | sec-Butylbenzene | 135988 |

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

**SCROLL TO "END"** **MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**SOIL AND GROUNDWATER-BASED ERROR STATEMENTS** **(DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

**CHEMICAL-BASED ERROR STATEMENTS** **(DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
| 2 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
| 5 | 1,4-Dichlorobenzene | 106467 |
| 6 | Benzene | 71432 |
| 7 | Chlorobenzene | 108907 |
| 8 | Cyclohexane | 110827 |
| 9 | Ethylbenzene | 100414 |
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| 15 | cis-1,2-Dichloroethylene | 156592 |
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| 17 | n-Butylbenzene | 104518 |
| 18 | sec-Butylbenzene | 135988 |

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
| 2 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
| 5 | 1,4-Dichlorobenzene | 106467 |
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| 12 | Tetrachloroethylene | 127184 |
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RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
| 2 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
| 5 | 1,4-Dichlorobenzene | 106467 |
| 6 | Benzene | 71432 |
| 7 | Chlorobenzene | 108907 |
| 8 | Cyclohexane | 110827 |
| 9 | Ethylbenzene | 100414 |
| 10 | Cumene | 98828 |
| 11 | Methylethylketone (2-butanone) | 78933 |
| 12 | Tetrachloroethylene | 127184 |
| 13 | Toluene | 108883 |
| 14 | Trichloroethylene | 79016 |
| 15 | cis-1,2-Dichloroethylene | 156592 |
| 16 | m-Xylene | 108383 |
| 17 | n-Butylbenzene | 104518 |
| 18 | sec-Butylbenzene | 135988 |

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
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| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
| 5 | 1,4-Dichlorobenzene | 106467 |
| 6 | Benzene | 71432 |
| 7 | Chlorobenzene | 108907 |
| 8 | Cyclohexane | 110827 |
| 9 | Ethylbenzene | 100414 |
| 10 | Cumene | 98828 |
| 11 | Methylethylketone (2-butanone) | 78933 |
| 12 | Tetrachloroethylene | 127184 |
| 13 | Toluene | 108883 |
| 14 | Trichloroethylene | 79016 |
| 15 | cis-1,2-Dichloroethylene | 156592 |
| 16 | m-Xylene | 108383 |
| 17 | n-Butylbenzene | 104518 |
| 18 | sec-Butylbenzene | 135988 |

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 1

**Area 1: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1-Dichloroethylene | 75354 |
| 2 | 1,2,4-Trichlorobenzene | 120821 |
| 3 | 1,2-Dichlorobenzene | 95501 |
| 4 | 1,2-Dichloroethane | 107062 |
| 5 | 1,4-Dichlorobenzene | 106467 |
| 6 | Benzene | 71432 |
| 7 | Chlorobenzene | 108907 |
| 8 | Cyclohexane | 110827 |
| 9 | Ethylbenzene | 100414 |
| 10 | Cumene | 98828 |
| 11 | Methylethylketone (2-butanone) | 78933 |
| 12 | Tetrachloroethylene | 127184 |
| 13 | Toluene | 108883 |
| 14 | Trichloroethylene | 79016 |
| 15 | cis-1,2-Dichloroethylene | 156592 |
| 16 | m-Xylene | 108383 |
| 17 | n-Butylbenzene | 104518 |
| 18 | sec-Butylbenzene | 135988 |

**END**

**VLOOKUP TABLES**

| Soil Properties Lookup Table | | | | | | | Bulk Density | | |
|---|---|---|---|---|---|---|---|---|---|
| SCS Soil Type | $K_s$ (cm/h) | $a_L$ (1/cm) | N (unitless) | M (unitless) | n ($cm^3/cm^3$) | $q_r$ ($cm^3/cm^3$) | Mean Grain Diameter (cm) | ($g/cm^3$) | $q_w$ ($cm^3/cm^3$) | SCS Soil Name |
| C | 0.61 | 0.01496 | 1.253 | 0.2019 | 0.459 | 0.098 | 0.0092 | 1.43 | 0.215 | Clay |
| CL | 0.34 | 0.01581 | 1.416 | 0.2938 | 0.442 | 0.079 | 0.016 | 1.48 | 0.168 | Clay Loam |
| L | 0.50 | 0.01112 | 1.472 | 0.3207 | 0.399 | 0.061 | 0.020 | 1.59 | 0.148 | Loam |
| LS | 4.38 | 0.03475 | 1.746 | 0.4273 | 0.390 | 0.049 | 0.040 | 1.62 | 0.076 | Loamy Sand |
| S | 26.78 | 0.03524 | 3.177 | 0.6852 | 0.375 | 0.053 | 0.044 | 1.66 | 0.054 | Sand |
| SC | 0.47 | 0.03342 | 1.208 | 0.1722 | 0.385 | 0.117 | 0.025 | 1.63 | 0.197 | Sandy Clay |
| SCL | 0.55 | 0.02109 | 1.330 | 0.2481 | 0.384 | 0.063 | 0.029 | 1.63 | 0.146 | Sandy Clay Loam |
| SI | 1.82 | 0.00658 | 1.679 | 0.4044 | 0.489 | 0.050 | 0.0046 | 1.35 | 0.167 | Silt |
| SIC | 0.40 | 0.01622 | 1.321 | 0.2430 | 0.481 | 0.111 | 0.0039 | 1.38 | 0.216 | Silty Clay |
| SICL | 0.46 | 0.00839 | 1.521 | 0.3425 | 0.482 | 0.090 | 0.0056 | 1.37 | 0.198 | Silty Clay Loam |
| SIL | 0.76 | 0.00506 | 1.663 | 0.3987 | 0.439 | 0.065 | 0.011 | 1.49 | 0.180 | Silt Loam |
| SL | 1.60 | 0.02667 | 1.449 | 0.3099 | 0.387 | 0.039 | 0.030 | 1.62 | 0.103 | Sandy Loam |

| Chemical Properties Lookup Table | | | | | | | | | | | | CalEPA Toxicity Criteria in bold (last updated 12/2/11 DTSC/HERO) | | | | | Original EPA Values | | | | Original 2011 DTSC-HERO Values | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAS No. | Chemical | Organic carbon partition coefficient, $K_{oc}$ ($cm^3/g$) | Diffusivity in air, $D_a$ ($cm^2/s$) | Diffusivity in water, $D_w$ ($cm^2/s$) | Pure component water solubility, S (mg/L) | Henry's law constant H' (unitless) | Henry's law constant at reference temperature, H (atm-$m^3$/mol) | Henry's law constant reference temperature, $T_R$ (°C) | Normal boiling point, $T_B$ (°K) | Critical temperature, $T_C$ (°K) | Enthalpy of vaporization at the normal boiling point, $DH_{vb}$ (cal/mol) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Molecular weight, MW (g/mol) | URF extrapolated (X) | RfC extrapolated (X) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | URF extrapolated (X) | RfC extrapolated (X) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
| 56235 | Carbon tetrachloride | 1.74E+02 | 7.80E-02 | 8.80E-06 | 7.93E+02 | 1.24E+00 | 3.03E-02 | 25 | 349.90 | 556.60 | 7,127 | 4.2E-05 | 4.0E-02 | 1.54E+02 | | | 1.5E-05 | 0.0E+00 | | | | |
| 67641 | Acetone | 5.75E-01 | 1.24E-01 | 1.14E-05 | 1.00E+06 | 1.59E-03 | 3.87E-05 | 25 | 329.20 | 508.10 | 6,955 | 0.0E+00 | 3.1E+01 | 5.81E+01 | | X | 3.7E-04 | 3.5E-01 | | X | | |
| 67663 | Chloroform | 3.98E+01 | 1.04E-01 | 1.00E-05 | 7.92E+03 | 1.50E-01 | 3.66E-03 | 25 | 334.32 | 536.40 | 6,988 | 2.3E-05 | 9.8E-02 | 1.19E+02 | | | 3.7E-04 | 0.0E+00 | | | 5.3E-06 | 3.0E-01 |
| 71432 | Benzene | 5.89E+01 | 8.80E-02 | 9.80E-06 | 1.79E+03 | 2.27E-01 | 5.54E-03 | 25 | 353.24 | 562.16 | 7,342 | 2.9E-05 | 3.0E-02 | 7.81E+01 | | | 3.7E-04 | 0.0E+00 | | | | |
| 75092 | Methylene chloride | 1.17E+01 | 1.01E-01 | 1.17E-05 | 1.30E+04 | 8.96E-02 | 2.18E-03 | 25 | 313.00 | 510.00 | 6,706 | 1.0E-06 | 4.0E-01 | 8.49E+01 | | | 3.7E-04 | 3.0E+00 | | | | |
| 75274 | Bromodichloromethane | 5.50E+01 | 2.98E-02 | 1.06E-05 | 6.74E+03 | 6.54E-02 | 1.60E-03 | 25 | 363.15 | 585.85 | 7,800 | 3.7E-05 | 7.0E-02 | 1.64E+02 | ? | X | 3.7E-04 | 7.0E-02 | X | X | | |
| 75343 | 1,1-Dichloroethane | 3.16E+01 | 7.42E-02 | 1.05E-05 | 5.06E+03 | 2.30E-01 | 5.61E-03 | 25 | 330.55 | 523.00 | 6,895 | 1.6E-06 | 7.0E-01 | 9.90E+01 | | X | 3.7E-04 | 5.0E-01 | | | | |
| 75354 | 1,1-Dichloroethylene | 5.89E+01 | 9.00E-02 | 1.04E-05 | 2.25E+03 | 1.07E+00 | 2.60E-02 | 25 | 304.75 | 576.05 | 6,247 | 0.0E+00 | 7.0E-02 | 9.69E+01 | | | 3.7E-04 | 2.0E-01 | | | | |
| 75650 | tertiary-Butyl Alcohol | 2.11E+00 | 9.85E-02 | 1.14E-05 | 1.00E+06 | 3.70E-04 | 9.02E-06 | 25 | 355.55 | 508.00 | 9.338 | 0.0E+00 | 6.9E-02 | 7.41E+01 | | | | | | | | |
| 76131 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 1.11E+04 | 7.80E-02 | 8.20E-06 | 1.70E+02 | 1.97E+01 | 4.80E-01 | 25 | 320.70 | 487.30 | 6,463 | 0.0E+00 | 3.0E+01 | 1.87E+02 | | | 3.7E-04 | 3.0E+01 | | | | |
| 78875 | 1,2-Dichloropropane | 4.37E+01 | 7.82E-02 | 8.73E-06 | 2.80E+03 | 1.15E-01 | 2.79E-03 | 25 | 369.52 | 572.00 | 7,590 | 1.0E-05 | 4.0E-03 | 1.13E+02 | ? | | 3.7E-04 | 4.0E-03 | X | | | |
| 78933 | Methylethylketone (2-butanone) | 2.30E+00 | 8.08E-02 | 9.80E-06 | 2.23E+05 | 2.29E-03 | 5.58E-05 | 25 | 352.50 | 536.78 | 7,481 | 0.0E+00 | 5.0E+00 | 7.21E+01 | | | 3.7E-04 | 1.0E+00 | | | | |
| 79005 | 1,1,2-Trichloroethane | 5.01E+01 | 7.80E-02 | 8.80E-06 | 4.42E+03 | 3.73E-02 | 9.11E-04 | 25 | 386.15 | 602.00 | 8,322 | 1.6E-05 | 2.0E-04 | 1.33E+02 | | X | 3.7E-04 | 1.4E-02 | | X | | 1.4E-02 |
| 79016 | Trichloroethylene | 1.66E+02 | 7.90E-02 | 9.10E-06 | 1.47E+03 | 4.21E-01 | 1.03E-02 | 25 | 360.36 | 544.20 | 7,505 | 4.1E-06 | 2.0E-03 | 1.31E+02 | | | 3.7E-04 | 4.0E-02 | X | | | |
| 91203 | Naphthalene | 2.00E+03 | 5.90E-02 | 7.50E-06 | 3.10E+01 | 1.98E-02 | 4.82E-04 | 25 | 491.14 | 748.40 | 10,373 | 3.4E-05 | 3.0E-03 | 1.28E+02 | | | 3.7E-04 | 3.0E-03 | | | | |
| 95476 | o-Xylene | 3.63E+02 | 8.70E-02 | 1.00E-05 | 1.78E+02 | 2.12E-01 | 5.18E-03 | 25 | 417.60 | 630.30 | 8,661 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | | 3.7E-04 | 1.0E-01 | | | | |
| 95501 | 1,2-Dichlorobenzene | 6.17E+02 | 6.90E-02 | 7.90E-06 | 1.56E+02 | 7.77E-02 | 1.90E-03 | 25 | 453.57 | 705.00 | 9,700 | 0.0E+00 | 2.0E-01 | 1.47E+02 | | | 3.7E-04 | 2.0E-01 | | | | |
| 95636 | 1,2,4-Trimethylbenzene | 1.35E+03 | 6.06E-02 | 7.92E-06 | 5.70E+01 | 2.52E-01 | 6.14E-03 | 25 | 442.30 | 649.17 | 9,369 | 0.0E+00 | 7.0E-03 | 1.20E+02 | | | 3.7E-04 | 6.0E-03 | | | | |
| 96184 | 1,2,3-Trichloropropane | 2.20E+01 | 7.10E-02 | 7.90E-06 | 1.75E+03 | 1.67E-02 | 4.08E-04 | 25 | 430.00 | 652.00 | 9,171 | 8.6E-03 | 3.0E-04 | 1.47E+02 | X | | 3.7E-04 | 4.9E-03 | X | | | |
| 98828 | Cumene | 4.89E+02 | 6.50E-02 | 7.10E-06 | 6.13E+01 | 4.74E+01 | 1.16E+00 | 25 | 425.56 | 631.10 | 10,335 | 0.0E+00 | 4.0E-01 | 1.20E+02 | | | 3.7E-04 | 4.0E-01 | | | | |
| 100414 | Ethylbenzene | 3.63E+02 | 7.50E-02 | 7.80E-06 | 1.69E+02 | 3.22E-01 | 7.86E-03 | 25 | 409.34 | 617.20 | 8,501 | 2.5E-06 | 1.0E+00 | 1.06E+02 | | | 3.7E-04 | 1.0E+00 | | | | |
| 103651 | n-Propylbenzene | 5.62E+02 | 6.01E-02 | 7.83E-06 | 6.00E+01 | 4.37E-01 | 1.07E-02 | 25 | 432.20 | 630.00 | 9,123 | 0.0E+00 | 1.4E-01 | 1.20E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 104518 | n-Butylbenzene | 1.11E+03 | 5.70E-02 | 8.12E-06 | 2.00E+00 | 5.38E-01 | 1.31E-02 | 25 | 456.46 | 660.50 | 9,290 | 0.0E+00 | 1.4E-01 | 1.34E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 106423 | p-Xylene | 3.89E+02 | 7.69E-02 | 8.44E-06 | 1.85E+02 | 3.13E-01 | 7.64E-03 | 25 | 411.52 | 616.20 | 8,525 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | ? | 3.7E-04 | 1.0E-01 | | | | |
| 106467 | 1,4-Dichlorobenzene | 6.17E+02 | 6.90E-02 | 7.90E-06 | 7.90E+01 | 9.82E-02 | 2.39E-03 | 25 | 447.21 | 684.75 | 9,271 | 1.1E-05 | 8.0E-01 | 1.47E+02 | | | 3.7E-04 | 8.0E-01 | | | | |
| 107062 | 1,2-Dichloroethane | 1.74E+01 | 1.04E-01 | 9.90E-06 | 8.52E+03 | 4.00E-02 | 9.77E-04 | 25 | 356.65 | 561.00 | 7,643 | 2.6E-05 | 7.0E-03 | 9.90E+01 | | | 3.7E-04 | 0.0E+00 | | | 2.1E-05 | 4.0E-01 |
| 108203 | Diisopropyl ether | 2.28E+01 | 6.54E-02 | 7.76E-06 | 8.80E+03 | 1.05E-01 | 2.56E-03 | 25 | 341.50 | 500.00 | 6,960 | 0.0E+00 | 7.0E-01 | 1.02E+02 | | | | | | | | |
| 108383 | m-Xylene | 4.07E+02 | 7.00E-02 | 7.80E-06 | 1.61E+02 | 3.00E-01 | 7.32E-03 | 25 | 412.27 | 617.05 | 8,523 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | ? | 3.7E-04 | 1.0E-01 | | | | |
| 108883 | Toluene | 1.82E+02 | 8.70E-02 | 8.60E-06 | 5.26E+02 | 2.72E-01 | 6.62E-03 | 25 | 383.78 | 591.79 | 7,930 | 0.0E+00 | 3.0E-01 | 9.21E+01 | | | 3.7E-04 | 4.0E-01 | | | | |
| 108907 | Chlorobenzene | 2.19E+02 | 7.30E-02 | 8.70E-06 | 4.72E+02 | 1.51E-01 | 3.69E-03 | 25 | 404.87 | 632.40 | 8,410 | 0.0E+00 | 5.0E-02 | 1.13E+02 | | | 3.7E-04 | 6.0E-02 | | | | 1.0E+00 |
| 110827 | Cyclohexane | 9.63E+02 | 7.40E-02 | 8.50E-06 | 5.50E+01 | 7.84E+00 | 1.00E-01 | 25 | 353.90 | 572.20 | 7,474 | 0.0E+00 | 6.0E+00 | 8.42E+01 | | | | | | | | |
| 120821 | 1,2,4-Trichlorobenzene | 1.78E+03 | 3.00E-02 | 8.23E-06 | 4.88E+01 | 5.81E-02 | 1.42E-03 | 25 | 486.15 | 725.00 | 10,471 | 0.0E+00 | 2.0E-03 | 1.81E+02 | | | 3.7E-04 | 2.0E-01 | | | | 4.0E-03 |
| 127184 | Tetrachloroethylene | 1.55E+02 | 7.20E-02 | 8.20E-06 | 2.00E+02 | 7.53E-01 | 1.84E-02 | 25 | 394.40 | 620.20 | 8,288 | 5.9E-06 | 3.5E-02 | 1.66E+02 | | | 3.7E-04 | 0.0E+00 | | | | |
| 135988 | sec-Butylbenzene | 9.66E+02 | 5.70E-02 | 8.12E-06 | 3.94E+00 | 5.68E-01 | 1.39E-02 | 25 | 446.5 | 679 | 88730 | 0.0E+00 | 1.4E-01 | 1.34E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 156592 | cis-1,2-Dichloroethylene | 3.55E+01 | 7.36E-02 | 1.13E-05 | 3.50E+03 | 1.67E-01 | 4.07E-03 | 25 | 333.65 | 544 | 7192 | 0.0E+00 | 3.5E-02 | 9.69E+01 | | X | 3.7E-04 | 3.5E-02 | | X | | |
| 156605 | trans-1,2-Dichloroethylene | 5.25E+01 | 7.07E-02 | 1.19E-05 | 6.30E+03 | 3.84E-01 | 9.36E-03 | 25 | 320.85 | 516.5 | 6717 | 0.0E+00 | 6.0E-02 | 9.69E+01 | | X | 3.7E-04 | 7.0E-02 | | X | | |
| 541731 | 1,3-Dichlorobenzene | 1.98E+03 | 6.92E-02 | 7.86E-06 | 1.34E+02 | 1.27E-01 | 3.09E-03 | 25 | 446 | 684 | 9230 | 0.0E+00 | 1.1E-01 | 1.47E+02 | | X | 3.7E-04 | 1.1E-01 | | X | | |
| 630206 | 1,1,1,2-Tetrachloroethane | 1.16E+02 | 7.10E-02 | 7.90E-06 | 1.10E+03 | 9.90E-02 | 2.41E-03 | 25 | 403.5 | 624 | 9768 | 7.4E-06 | 1.1E-01 | 1.68E+02 | | X | 3.7E-04 | 1.1E-01 | | X | | |

Brown = 2009 updates
Blue = Evaluated as a carcinogen.
**Bold = CalEPA OEHHA Values**
Red = OEHHA URF < USEPA URF
Green = IRIS RfC < OEHHA REL
new data for VLOOKUP based on June 2013 VISL Chem Props tab obtained from *www.epa.gov/oswer/vaporintrusion/documents/VISL-Calculator.xlsm*
indicates replaced with the 2013 EPA Region 9 RSL value which is more stringent than 2011 DTSC-HERO value.

## General Notes to Tables

% denotes percent.

% v/v denotes percent by volume.

$\mu g/m^3$ denotes microgram(s) per cubic meter.

1,1-DFA denotes 1,1-Difluoroethane.

ASTM denotes American Society for Testing and Materials.

C/I denotes commercial/industrial.

Cal/EPA denotes California Environmental Protection Agency.

cm denotes centimeter.

$cm^3$ denotes cubic centimeters.

DTSC denotes California Department of Toxic Substances Control.

ELCR denotes excess lifetime cancer risk.

EPA denotes U.S. Environmental Protection Agency.

ft denotes feet.

ft bgs denotes feet below ground surface.

HHRA denotes Human Health Risk Assessment.

HI denotes hazard index.

HQ denotes hazard quotient.

ID denotes identification.

in denotes inches.

IR denotes installation restoration.

IUR denotes inhalation unit risk.

J denotes estimated value below the analysis reporting limit.

Max denotes maximum.

MDL denotes method detection limit.

Min denotes minimum.

n/a denotes not applicable.

na denotes not analyzed.

NA denotes none available.

ND denotes not detected.

No. denotes number.

PCE denotes tetrachloroethene.

ppmv denotes parts per million by volume.

RBSL denotes risk-based screening level.

$RfC_i$ denotes inhalation reference concentration.

RL denotes analysis reporting limit.

TCE denotes trichloroethene.

U denotes not detected at or above the analysis reporting limit.

VC denotes vinyl chloride.

VOCs denotes volatile organic compounds.

y/n denotes yes/no.

TBD denotes spreadsheet cell to be loaded with data

# Appendix C
# Area 2, Enhanced Johnson and Ettinger Model Spreadsheet Input and Output Sheets

(provided on electronic copy only)

Input Parameters to the J&E Algorithm for Groundwater-to-Indoor Air Vapor
Commercial/Industrial Exposure Scenario, Area 2
Dual Site Groundwater, Montrose and Del Amo Superfund Sites

| Input Parameters to J&E Model GW-ADV Version 3.0 | | Units | J&E Spreadsheet Defaults | Site-Specific Evaluation Groundwater Samples | Basis for Parameter |
|---|---|---|---|---|---|
| $L_{WT}$ | Depth below grade to water table | cm (feet) | - (-) | 1,682 (55) | Site-specific, based on evaluation of historical water levels in CH2M HILL database. |
| Vadose Zone Properties (Without Engineered Fill) | | | | | |
| $T_s$ | Average groundwater temperature | °C | 22 | 24 | 75°F, California average shallow groundwater temperature (p. 48, EPA, 2004); DTSC, 2011, page D-6 |
| $h_A$ | Thickness of soil stratum A | cm (feet) | TBD | 914 (30) | Boring log for well XMW-6 |
| $h_B$ | Thickness of soil stratum B | cm (feet) | TBD | 768 (25.2) | Boring log for well XMW-6 |
| $h_C$ | Thickness of soil stratum C | cm (feet) | TBD | 0.0 (0) | Boring log for well XMW-6 |
| - | Stratum A soil type | -- | TBD | Silt | Boring log for well XMW-6 |
| $\rho_B^A$ | Stratum A soil dry bulk density | $g/cm^3$ | TBD | 1.35 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^A$ | Stratum A soil total porosity | unitless | TBD | 0.489 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^A$ | Stratum A soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.167 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum B soil type | -- | TBD | Loamy Sand | Boring log for well XMW-6 |
| $\rho_B^B$ | Stratum B soil dry bulk density | $g/cm^3$ | TBD | 1.62 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^B$ | Stratum B soil total porosity | unitless | TBD | 0.39 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^B$ | Stratum B soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.076 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum C soil type | -- | TBD | none | |
| $\rho_B^C$ | Stratum C soil dry bulk density | $g/cm^3$ | TBD | n/a | |
| $n^C$ | Stratum C soil total porosity | unitless | TBD | n/a | |
| $\Theta_W^C$ | Stratum C soil water-filled porosity | $cm^3/cm^3$ | TBD | n/a | |
| Building Parameters | | | | | |
| $L_F$ | Depth below grade to bottom of enclosed space floor - slab on grade (building with no basement) | cm | 15 | 15 | default, EPA, 2004, page 47 |
| $L_{crack}$ | Enclosed space floor thickness | cm | 10 | 9 | DTSC, 2011, Table 3; EPA, 2004 uses 10 cm, but California value of 9 cm is more conservative |
| $\Delta P$ | Soil-building pressure differential | $g/cm\text{-}s^2$ | 40 | 40 | OEHHA, 2005, page B-13; DTSC accepts EPA default in absence of California-specific measurements |
| $L_B$ | Enclosed space floor length | cm | 1,000 | 1,000 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $W_B$ | Enclosed space floor width | cm | 1,000 | 1,000 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $H_B$ | Enclosed space height | cm | 244 | 244 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| w | Floor-wall seam crack width | cm | 0.1 | 0.1 | OEHHA, 2005, page B-13; EPA, 2004, page 55. |
| $\eta$ | Crack-to-total area ratio | unitless | model calculated | 0.005 | California default, DTSC, 2011, Table 3. |
| ER | Indoor air exchange rate | 1/hour | 0.25 | 1.0 | California Energy Commission (CEC), 2001; DTSC, 2011, Appendix D, page D-6. |
| $Q_{soil}$ | Average vapor flow rate into building | L/min | 5 | 5 | OEHHA, 2005, page B-13; California accepts EPA default, EPA, 2004, except when site-specific permeability is used. |
| $\alpha$ | Infinite Source - Indoor Attenuation Coefficient | unitless | model calculated | model calculated | Product of Johnson-Ettinger algorithm on INTERCALCS page incorporating site-specific information, EPA, 2004. |
| Physical-Chemical & Toxicity Parameters | | | | | |
| | The values were derived from the 'Chemical Properties Look Up Table' spreadsheet of *HERD_Groundwater_Screening_Model.xls* (updated December 2, 2011), <*http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm*> . | | | | |
| Exposure Parameters -Commercial-Industrial Scenario | | | | | |
| $AT_c$ | Averaging time for carcinogens | years | 70 | 70 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| $AT_{NC}$ | Averaging time for noncarcinogens | years | 25 | 25 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ED | Exposure duration | years | 25 | 25 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| EF | Exposure frequency | days/year | 250 | 250 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ET | Exposure time | hours/day | 8 | 8 | U.S. EPA, 1991; DTSC, 2011, Appendix C |

General notes follow on next page.

References:


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DTSC, 2011, *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance)* , October.

OEHHA, 2005, *Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soil* , January.

U.S. EPA Office of Emergency and Remedial Response, 1991, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part B), Interim Final* , EPA/540/R-92/003, December.

U.S. EPA Office of Research and Development, National Center for Environmental Assessment, 1997, Exposure Factors Handbook, EPA/600/P-95/002Fa, August.

U.S. EPA Region IX, 1999, EPA Superfund Record of Decision for Dual Site Groundwater Operable Unit, Montrose Chemical and Del Amo Superfund Sites, EPA/ROD/R09-99/035, March.

U.S. EPA Office of Solid Waste and Emergency Response, 2002, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, December.

DATA ENTRY SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

GW-ADV
Version 3.0; 02/03

Res

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| | ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Qualifier | Chemicals Evaluated (COPCs and Surrogates) | Surrogate? | Chemical Detected in Groundwater: COPC Detected | Chemical Detected in Groundwater: CAS No. |
|---|---|---|---|---|---|---|---|
| 1 | 630206 | 6.2 | | 1,1,1,2-Tetrachloroethane | NO | | |
| 2 | 76131 | 11 | | 1,1,2-Trichloro-1,2,2-trifluoroethane | NO | | |
| 3 | 79005 | 15 | | 1,1,2-Trichloroethane | NO | | |
| 4 | 75343 | 39 | | 1,1-Dichloroethane | NO | | |
| 5 | 75354 | 110 | | 1,1-Dichloroethylene | NO | | |
| 6 | 96184 | 4.3 | | 1,2,3-Trichloropropane | NO | | |
| 7 | 120821 | 3.7 | | 1,2,4-Trichlorobenzene | NO | | |
| 8 | 95501 | 7.9 | | 1,2-Dichlorobenzene | NO | | |
| 9 | 107062 | 38 | | 1,2-Dichloroethane | NO | | |
| 10 | 78875 | 1.1 | | 1,2-Dichloropropane | NO | | |
| 11 | 541731 | 0.78 | | 1,3-Dichlorobenzene | NO | | |
| 12 | 106467 | 11 | | 1,4-Dichlorobenzene | NO | | |
| 13 | 71432 | 17 | | Benzene | NO | | |
| 14 | 75274 | 0.9 | | Bromodichloromethane | NO | | |
| 15 | 56235 | 81 | | Carbon tetrachloride | NO | | |
| 16 | 108907 | 26 | | Chlorobenzene | NO | | |
| 17 | 67663 | 2,400 | | Chloroform | YES | | |
| 18 | 156592 | 57 | | cis-1,2-Dichloroethylene | NO | | |
| 19 | 108203 | 4.3 | | Diisopropyl ether | NO | | |
| 20 | 108383 | 0.53 | | m-Xylene | YES | Xylenes, total | 1330207 |
| 21 | 75092 | 3.9 | | Methylene chloride | NO | | |
| 22 | 95476 | 1.7 | | o-Xylene | NO | | |
| 23 | 75650 | 260 | | tertiary-Butylalcohol | NO | | |
| 24 | 127184 | 17,000 | | Tetrachloroethylene | NO | | |
| 25 | 156605 | 2.6 | | trans-1,2-Dichloroethylene | NO | | |
| 26 | 79016 | 530 | | Trichloroethylene | NO | | |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Totals must add up to value of $L_{WT}$ (cell G28) | | | | | | | |
| 24.0 | 15.0 | 1,682 | 914 | 768 | 0.0 | B | LS | SI | | |
| Southern Cal. | slab-on-grade | 55.2 feet | 30 feet | 25.2 feet | 0 feet | | | | | |

MORE ↓

| ENTER Stratum A SCS soil type (Look) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ ($cm^3/cm^3$) | ENTER Stratum B SCS soil type (Look) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ ($g/cm^3$) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ ($cm^3/cm^3$) | ENTER Stratum C SCS soil type (Look) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ ($g/cm^3$) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ ($cm^3/cm^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SI | 1.35 | 0.489 | 0.167 | LS | 1.62 | 0.39 | 0.076 | | | | |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 9.0 | 40.0 | 1,000 | 1,000 | 244 | 0.10 | 1.0 | 5 |
| 3.5 inches | 4 Pa | 33 feet | 33 feet | 8 feet | default | Commercial/Industrial | default |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Exposure Time, ET (hrs/day) | Target risk for carcinogens, TR (unitless) | Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|---|
| 70 | 25 | 25 | 250 | 8 | 1.0E-06 | 1 |
| Commercial/Industrial Exposure Scenario | | | | | Used to calculate risk-based groundwater concentration. | |

END

CHEMICAL PROPERTIES SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER AREA 2

| Diffusivity in air, $D_a$ ($cm^2/s$) | Diffusivity in water, $D_w$ ($cm^2/s$) | Henry's law constant at reference temperature, H ($atm\text{-}m^3/mol$) | Henry's law constant reference temperature, $T_R$ ($^oC$) | Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol) | Normal boiling point, $T_B$ ($^oK$) | Critical temperature, $T_C$ ($^oK$) | Organic carbon partition coefficient, $K_{oc}$ ($cm^3/g$) | Pure component water solubility, S (mg/L) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.10E-02 | 7.90E-06 | 2.41E-03 | 25 | 9,768 | 403.50 | 624.00 | 1.16E+02 | 1.10E+03 | 7.4E-06 | 1.1E-01 | 1,1,1,2-Tetrachloroethane | 1 |
| 7.80E-02 | 8.20E-06 | 4.80E-01 | 25 | 6,463 | 320.70 | 487.30 | 1.11E+04 | 1.70E+02 | 0.0E+00 | 3.0E+01 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 2 |
| 7.80E-02 | 8.80E-06 | 9.11E-04 | 25 | 8,322 | 386.15 | 602.00 | 5.01E+01 | 4.42E+03 | 1.6E-05 | 2.0E-04 | 1,1,2-Trichloroethane | 3 |
| 7.42E-02 | 1.05E-05 | 5.61E-03 | 25 | 6,895 | 330.55 | 523.00 | 3.16E+01 | 5.06E+03 | 1.6E-06 | 7.0E-01 | 1,1-Dichloroethane | 4 |
| 9.00E-02 | 1.04E-05 | 2.60E-02 | 25 | 6,247 | 304.75 | 576.05 | 5.89E+01 | 2.25E+03 | 0.0E+00 | 7.0E-02 | 1,1-Dichloroethylene | 5 |
| 7.10E-02 | 7.90E-06 | 4.08E-04 | 25 | 9,171 | 430.00 | 652.00 | 2.20E+01 | 1.75E+03 | 8.6E-03 | 3.0E-04 | 1,2,3-Trichloropropane | 6 |
| 3.00E-02 | 8.23E-06 | 1.42E-03 | 25 | 10,471 | 486.15 | 725.00 | 1.78E+03 | 4.88E+01 | 0.0E+00 | 2.0E-03 | 1,2,4-Trichlorobenzene | 7 |
| 6.90E-02 | 7.90E-06 | 1.90E-03 | 25 | 9,700 | 453.57 | 705.00 | 6.17E+02 | 1.56E+02 | 0.0E+00 | 2.0E-01 | 1,2-Dichlorobenzene | 8 |
| 1.04E-01 | 9.90E-06 | 9.77E-04 | 25 | 7,643 | 356.65 | 561.00 | 1.74E+01 | 8.52E+03 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 9 |
| 7.82E-02 | 8.73E-06 | 2.79E-03 | 25 | 7,590 | 369.52 | 572.00 | 4.37E+01 | 2.80E+03 | 1.0E-05 | 4.0E-03 | 1,2-Dichloropropane | 10 |
| 6.92E-02 | 7.86E-06 | 3.09E-03 | 25 | 9,230 | 446.00 | 684.00 | 1.98E+03 | 1.34E+02 | 0.0E+00 | 1.1E-01 | 1,3-Dichlorobenzene | 11 |
| 6.90E-02 | 7.90E-06 | 2.39E-03 | 25 | 9,271 | 447.21 | 684.75 | 6.17E+02 | 7.90E+01 | 1.1E-05 | 8.0E-01 | 1,4-Dichlorobenzene | 12 |
| 8.80E-02 | 9.80E-06 | 5.54E-03 | 25 | 7,342 | 353.24 | 562.16 | 5.89E+01 | 1.79E+03 | 2.9E-05 | 3.0E-02 | Benzene | 13 |
| 2.98E-02 | 1.06E-05 | 1.60E-03 | 25 | 7,800 | 363.15 | 585.85 | 5.50E+01 | 6.74E+03 | 3.7E-05 | 7.0E-02 | Bromodichloromethane | 14 |
| 7.80E-02 | 8.80E-06 | 3.03E-02 | 25 | 7,127 | 349.90 | 556.60 | 1.74E+02 | 7.93E+02 | 4.2E-05 | 4.0E-02 | Carbon tetrachloride | 15 |
| 7.30E-02 | 8.70E-06 | 3.69E-03 | 25 | 8,410 | 404.87 | 632.40 | 2.19E+02 | 4.72E+02 | 0.0E+00 | 5.0E-02 | Chlorobenzene | 16 |
| 1.04E-01 | 1.00E-05 | 3.66E-03 | 25 | 6,988 | 334.32 | 536.40 | 3.98E+01 | 7.92E+03 | 2.3E-05 | 9.8E-02 | Chloroform | 17 |
| 7.36E-02 | 1.13E-05 | 4.07E-03 | 25 | 7,192 | 333.65 | 544.00 | 3.55E+01 | 3.50E+03 | 0.0E+00 | 3.5E-02 | cis-1,2-Dichloroethylene | 18 |
| 6.54E-02 | 7.76E-06 | 2.56E-03 | 25 | 6,960 | 341.50 | 500.00 | 2.28E+01 | 8.80E+03 | 0.0E+00 | 7.0E-01 | Diisopropyl ether | 19 |
| 7.00E-02 | 7.80E-06 | 7.32E-03 | 25 | 8,523 | 412.27 | 617.05 | 4.07E+02 | 1.61E+02 | 0.0E+00 | 1.0E-01 | m-Xylene | 20 |
| 1.01E-01 | 1.17E-05 | 2.18E-03 | 25 | 6,706 | 313.00 | 510.00 | 1.17E+01 | 1.30E+04 | 1.0E-06 | 4.0E-01 | Methylene chloride | 21 |
| 8.70E-02 | 1.00E-05 | 5.18E-03 | 25 | 8,661 | 417.60 | 630.30 | 3.63E+02 | 1.78E+02 | 0.0E+00 | 1.0E-01 | o-Xylene | 22 |
| 9.85E-02 | 1.14E-05 | 9.02E-06 | 25 | 9 | 355.55 | 508.00 | 2.11E+00 | 1.00E+06 | 0.0E+00 | 6.9E-02 | tertiary-Butylalcohol | 23 |
| 7.20E-02 | 8.20E-06 | 1.84E-02 | 25 | 8,288 | 394.40 | 620.20 | 1.55E+02 | 2.00E+02 | 5.9E-06 | 3.5E-02 | Tetrachloroethylene | 24 |
| 7.07E-02 | 1.19E-05 | 9.36E-03 | 25 | 6,717 | 320.85 | 516.50 | 5.25E+01 | 6.30E+03 | 0.0E+00 | 6.0E-02 | trans-1,2-Dichloroethylene | 25 |
| 7.90E-02 | 9.10E-06 | 1.03E-02 | 25 | 7,505 | 360.36 | 544.20 | 1.66E+02 | 1.47E+03 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 26 |

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

**END**

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) | **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,1,1,2-Tetrachloroethane | 1 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 2 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,1,2-Trichloroethane | 3 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,1-Dichloroethane | 4 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,1-Dichloroethylene | 5 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,2,3-Trichloropropane | 6 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,2,4-Trichlorobenzene | 7 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,2-Dichlorobenzene | 8 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,2-Dichloroethane | 9 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,2-Dichloropropane | 10 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,3-Dichlorobenzene | 11 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,4-Dichlorobenzene | 12 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Benzene | 13 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Bromodichloromethane | 14 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Carbon tetrachloride | 15 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Chlorobenzene | 16 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Chloroform | 17 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | cis-1,2-Dichloroethylene | 18 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Diisopropyl ether | 19 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | m-Xylene | 20 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Methylene chloride | 21 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | o-Xylene | 22 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | tertiary-Butylalcohol | 23 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Tetrachloroethylene | 24 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | trans-1,2-Dichloroethylene | 25 |
| 7.88E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Trichloroethylene | 26 |

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-$m^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,266 | 2.26E-03 | 9.29E-02 | 1.80E-04 | 6.82E-03 | 9.86E-03 | 0.00E+00 | 1.50E-04 | 5.01E-03 | 1667.496 | 1,1,1,2-Tetrachloroethane | 1 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 6,787 | 4.62E-01 | 1.89E+01 | 1.80E-04 | 7.49E-03 | 1.08E-02 | 0.00E+00 | 1.53E-04 | 5.35E-03 | 1667.496 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 2 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,419 | 8.63E-04 | 3.54E-02 | 1.80E-04 | 7.50E-03 | 1.08E-02 | 0.00E+00 | 1.84E-04 | 5.73E-03 | 1667.496 | 1,1,2-Trichloroethane | 3 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,294 | 5.38E-03 | 2.21E-01 | 1.80E-04 | 7.13E-03 | 1.03E-02 | 0.00E+00 | 1.52E-04 | 5.17E-03 | 1667.496 | 1,1-Dichloroethane | 4 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 6,299 | 2.51E-02 | 1.03E+00 | 1.80E-04 | 8.65E-03 | 1.25E-02 | 0.00E+00 | 1.78E-04 | 6.19E-03 | 1667.496 | 1,1-Dichloroethylene | 5 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 10,919 | 3.83E-04 | 1.57E-02 | 1.80E-04 | 6.83E-03 | 9.86E-03 | 0.00E+00 | 2.01E-04 | 5.54E-03 | 1667.496 | 1,2,3-Trichloropropane | 6 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 13,069 | 1.32E-03 | 5.39E-02 | 1.80E-04 | 2.88E-03 | 4.17E-03 | 0.00E+00 | 7.77E-05 | 2.27E-03 | 1667.496 | 1,2,4-Trichlorobenzene | 7 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,546 | 1.77E-03 | 7.28E-02 | 1.80E-04 | 6.63E-03 | 9.58E-03 | 0.00E+00 | 1.49E-04 | 4.91E-03 | 1667.496 | 1,2-Dichlorobenzene | 8 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,368 | 9.31E-04 | 3.82E-02 | 1.80E-04 | 9.99E-03 | 1.44E-02 | 0.00E+00 | 2.36E-04 | 7.54E-03 | 1667.496 | 1,2-Dichloroethane | 9 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,478 | 2.66E-03 | 1.09E-01 | 1.80E-04 | 7.51E-03 | 1.09E-02 | 0.00E+00 | 1.63E-04 | 5.50E-03 | 1667.496 | 1,2-Dichloropropane | 10 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,029 | 2.90E-03 | 1.19E-01 | 1.80E-04 | 6.65E-03 | 9.61E-03 | 0.00E+00 | 1.44E-04 | 4.86E-03 | 1667.496 | 1,3-Dichlorobenzene | 11 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,098 | 2.25E-03 | 9.22E-02 | 1.80E-04 | 6.63E-03 | 9.58E-03 | 0.00E+00 | 1.46E-04 | 4.87E-03 | 1667.496 | 1,4-Dichlorobenzene | 12 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,977 | 5.29E-03 | 2.17E-01 | 1.80E-04 | 8.45E-03 | 1.22E-02 | 0.00E+00 | 1.78E-04 | 6.11E-03 | 1667.496 | Benzene | 13 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,526 | 1.52E-03 | 6.24E-02 | 1.80E-04 | 2.86E-03 | 4.14E-03 | 0.00E+00 | 7.94E-05 | 2.28E-03 | 1667.496 | Bromodichloromethane | 14 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,716 | 2.90E-02 | 1.19E+00 | 1.80E-04 | 7.49E-03 | 1.08E-02 | 0.00E+00 | 1.54E-04 | 5.36E-03 | 1667.496 | Carbon tetrachloride | 15 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,661 | 3.49E-03 | 1.43E-01 | 1.80E-04 | 7.01E-03 | 1.01E-02 | 0.00E+00 | 1.51E-04 | 5.11E-03 | 1667.496 | Chlorobenzene | 16 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,407 | 3.51E-03 | 1.44E-01 | 1.80E-04 | 9.99E-03 | 1.44E-02 | 0.00E+00 | 2.13E-04 | 7.25E-03 | 1667.496 | Chloroform | 17 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,592 | 3.90E-03 | 1.60E-01 | 1.80E-04 | 7.07E-03 | 1.02E-02 | 0.00E+00 | 1.53E-04 | 5.17E-03 | 1667.496 | cis-1,2-Dichloroethylene | 18 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,662 | 2.45E-03 | 1.01E-01 | 1.80E-04 | 6.29E-03 | 9.09E-03 | 0.00E+00 | 1.38E-04 | 4.61E-03 | 1667.496 | Diisopropyl ether | 19 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 10,090 | 6.91E-03 | 2.84E-01 | 1.80E-04 | 6.72E-03 | 9.72E-03 | 0.00E+00 | 1.41E-04 | 4.85E-03 | 1667.496 | m-Xylene | 20 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 6,884 | 2.10E-03 | 8.62E-02 | 1.80E-04 | 9.70E-03 | 1.40E-02 | 0.00E+00 | 2.15E-04 | 7.15E-03 | 1667.496 | Methylene chloride | 21 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 10,245 | 4.88E-03 | 2.00E-01 | 1.80E-04 | 8.36E-03 | 1.21E-02 | 0.00E+00 | 1.77E-04 | 6.05E-03 | 1667.496 | o-Xylene | 22 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 11 | 9.02E-06 | 3.70E-04 | 1.80E-04 | 9.79E-03 | 1.37E-02 | 0.00E+00 | 3.98E-03 | 1.10E-02 | 1667.496 | tertiary-Butylalcohol | 23 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,410 | 1.74E-02 | 7.14E-01 | 1.80E-04 | 6.92E-03 | 1.00E-02 | 0.00E+00 | 1.43E-04 | 4.96E-03 | 1667.496 | Tetrachloroethylene | 24 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 6,986 | 8.99E-03 | 3.69E-01 | 1.80E-04 | 6.79E-03 | 9.82E-03 | 0.00E+00 | 1.43E-04 | 4.90E-03 | 1667.496 | trans-1,2-Dichloroethylene | 25 |
| 6.77E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,382 | 9.80E-03 | 4.02E-01 | 1.80E-04 | 7.59E-03 | 1.10E-02 | 0.00E+00 | 1.58E-04 | 5.46E-03 | 1667.496 | Trichloroethylene | 26 |

Cal default

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 5.76E+02 | 1.33 | 8.33E+01 | 6.82E-03 | 5.30E+03 | 1.02E+09 | 4.53E-05 | 2.61E-02 | 7.4E-06 | 1.1E-01 | 1,1,1,2-Tetrachloroethane | 1 |
| 15 | 2.08E+05 | 1.33 | 8.33E+01 | 7.49E-03 | 5.30E+03 | 1.59E+08 | 4.83E-05 | 1.00E+01 | NA | 3.0E+01 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 2 |
| 15 | 5.31E+02 | 1.33 | 8.33E+01 | 7.50E-03 | 5.30E+03 | 1.58E+08 | 5.15E-05 | 2.73E-02 | 1.6E-05 | 2.0E-04 | 1,1,2-Trichloroethane | 3 |
| 15 | 8.60E+03 | 1.33 | 8.33E+01 | 7.13E-03 | 5.30E+03 | 4.18E+08 | 4.67E-05 | 4.02E-01 | 1.6E-06 | 7.0E-01 | 1,1-Dichloroethane | 4 |
| 15 | 1.13E+05 | 1.33 | 8.33E+01 | 8.65E-03 | 5.30E+03 | 1.28E+07 | 5.55E-05 | 6.29E+00 | NA | 7.0E-02 | 1,1-Dichloroethylene | 5 |
| 15 | 6.76E+01 | 1.33 | 8.33E+01 | 6.83E-03 | 5.30E+03 | 1.01E+09 | 4.99E-05 | 3.37E-03 | 8.6E-03 | 3.0E-04 | 1,2,3-Trichloropropane | 6 |
| 15 | 2.00E+02 | 1.33 | 8.33E+01 | 2.88E-03 | 5.30E+03 | 2.06E+21 | 2.10E-05 | 4.19E-03 | NA | 2.0E-03 | 1,2,4-Trichlorobenzene | 7 |
| 15 | 5.75E+02 | 1.33 | 8.33E+01 | 6.63E-03 | 5.30E+03 | 1.86E+09 | 4.44E-05 | 2.55E-02 | NA | 2.0E-01 | 1,2-Dichlorobenzene | 8 |
| 15 | 1.45E+03 | 1.33 | 8.33E+01 | 9.99E-03 | 5.30E+03 | 1.41E+06 | 6.69E-05 | 9.71E-02 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 9 |
| 15 | 1.20E+02 | 1.33 | 8.33E+01 | 7.51E-03 | 5.30E+03 | 1.51E+08 | 4.95E-05 | 5.94E-03 | 1.0E-05 | 4.0E-03 | 1,2-Dichloropropane | 10 |
| 15 | 9.29E+01 | 1.33 | 8.33E+01 | 6.65E-03 | 5.30E+03 | 1.76E+09 | 4.39E-05 | 4.08E-03 | NA | 1.1E-01 | 1,3-Dichlorobenzene | 11 |
| 15 | 1.01E+03 | 1.33 | 8.33E+01 | 6.63E-03 | 5.30E+03 | 1.87E+09 | 4.41E-05 | 4.47E-02 | 1.1E-05 | 8.0E-01 | 1,4-Dichlorobenzene | 12 |
| 15 | 3.69E+03 | 1.33 | 8.33E+01 | 8.45E-03 | 5.30E+03 | 1.86E+07 | 5.48E-05 | 2.02E-01 | 2.9E-05 | 3.0E-02 | Benzene | 13 |
| 15 | 5.61E+01 | 1.33 | 8.33E+01 | 2.86E-03 | 5.30E+03 | 2.85E+21 | 2.10E-05 | 1.18E-03 | 3.7E-05 | 7.0E-02 | Bromodichloromethane | 14 |
| 15 | 9.64E+04 | 1.33 | 8.33E+01 | 7.49E-03 | 5.30E+03 | 1.59E+08 | 4.84E-05 | 4.66E+00 | 4.2E-05 | 4.0E-02 | Carbon tetrachloride | 15 |
| 15 | 3.73E+03 | 1.33 | 8.33E+01 | 7.01E-03 | 5.30E+03 | 5.80E+08 | 4.61E-05 | 1.72E-01 | NA | 5.0E-02 | Chlorobenzene | 16 |
| 15 | 3.45E+05 | 1.33 | 8.33E+01 | 9.99E-03 | 5.30E+03 | 1.42E+06 | 6.45E-05 | 2.23E+01 | 2.3E-05 | 9.8E-02 | Chloroform | 17 |
| 15 | 9.11E+03 | 1.33 | 8.33E+01 | 7.07E-03 | 5.30E+03 | 4.92E+08 | 4.66E-05 | 4.25E-01 | NA | 3.5E-02 | cis-1,2-Dichloroethylene | 18 |
| 15 | 4.32E+02 | 1.33 | 8.33E+01 | 6.29E-03 | 5.30E+03 | 5.99E+09 | 4.18E-05 | 1.81E-02 | NA | 7.0E-01 | Diisopropyl ether | 19 |
| 15 | 1.50E+02 | 1.33 | 8.33E+01 | 6.72E-03 | 5.30E+03 | 1.38E+09 | 4.39E-05 | 6.59E-03 | NA | 1.0E-01 | m-Xylene | 20 |
| 15 | 3.36E+02 | 1.33 | 8.33E+01 | 9.70E-03 | 5.30E+03 | 2.16E+06 | 6.36E-05 | 2.14E-02 | 1.0E-06 | 4.0E-01 | Methylene chloride | 21 |
| 15 | 3.41E+02 | 1.33 | 8.33E+01 | 8.36E-03 | 5.30E+03 | 2.26E+07 | 5.43E-05 | 1.85E-02 | NA | 1.0E-01 | o-Xylene | 22 |
| 15 | 9.62E+01 | 1.33 | 8.33E+01 | 9.79E-03 | 5.30E+03 | 1.88E+06 | 9.55E-05 | 9.18E-03 | NA | 6.9E-02 | tertiary-Butylalcohol | 23 |
| 15 | 1.21E+07 | 1.33 | 8.33E+01 | 6.92E-03 | 5.30E+03 | 7.68E+08 | 4.49E-05 | 5.44E+02 | 5.9E-06 | 3.5E-02 | Tetrachloroethylene | 24 |
| 15 | 9.59E+02 | 1.33 | 8.33E+01 | 6.79E-03 | 5.30E+03 | 1.12E+09 | 4.44E-05 | 4.25E-02 | NA | 6.0E-02 | trans-1,2-Dichloroethylene | 25 |
| 15 | 2.13E+05 | 1.33 | 8.33E+01 | 7.59E-03 | 5.30E+03 | 1.25E+08 | 4.92E-05 | 1.05E+01 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 26 |

**END**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:**

**Area 2: Comm-Ind Exposure Scenario**

**INCREMENTAL RISK CALCULATIONS:**

**Preparation Date: 1/21/2014**

| | Indoor exposure groundwater conc., carcinogen (µg/L) | Indoor exposure groundwater conc., noncarcinogen (µg/L) | Risk-based indoor exposure groundwater conc., (µg/L) | Pure component water solubility, S (µg/L) | Final indoor exposure groundwater conc., (µg/L) | Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Percent of Total Risk (%) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) | Percent of Total Health Hazard (%) | Risk-Based Screening Level (RBSL) Cancer µg/L TR = 1E-6 | Risk-Based Screening Level (RBSL) Non-cancer µg/L THQ = 1 | | COPCs Evaluated | CAS No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | NA | NA | NA | 1.10E+06 | NA | 2E-8 | 0.005% | 6E-5 | 0.001% | 394 | 109,375 | 1 | 1,1,1,2-Tetrachloroethane | 630206 |
| 2 | NA | NA | NA | 1.70E+05 | NA | NA | 0% | 8E-5 | 0.002% | NA | 144,303 | 2 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 76131 |
| 3 | NA | NA | NA | 4.42E+06 | NA | 4E-8 | 0.01% | 3E-2 | 0.6% | 420 | 481 | 3 | 1,1,2-Trichloroethane | 79005 |
| 4 | NA | NA | NA | 5.06E+06 | NA | 5E-8 | 0.02% | 1E-4 | 0.003% | 744 | 297,787 | 4 | 1,1-Dichloroethane | 75343 |
| 5 | NA | NA | NA | 2.25E+06 | NA | NA | 0% | 2E-2 | 0.4% | NA | 5,363 | 5 | 1,1-Dichloroethylene | 75354 |
| 6 | NA | NA | NA | 1.75E+06 | NA | 2E-6 | 0.7% | 3E-3 | 0.05% | 1.8 | 1,676 | 6 | 1,2,3-Trichloropropane | 96184 |
| 7 | NA | NA | NA | 4.88E+04 | NA | NA | 0% | 5E-4 | 0.01% | NA | 7,741 | 7 | 1,2,4-Trichlorobenzene | 120821 |
| 8 | NA | NA | NA | 1.56E+05 | NA | NA | 0% | 3E-5 | 0.0006% | NA | 156,000 | 8 | 1,2-Dichlorobenzene | 95501 |
| 9 | NA | NA | NA | 8.52E+06 | NA | 2E-7 | 0.06% | 3E-3 | 0.06% | 185 | 12,004 | 9 | 1,2-Dichloroethane | 107062 |
| 10 | NA | NA | NA | 2.80E+06 | NA | 5E-9 | 0.001% | 3E-4 | 0.007% | 227 | 3,242 | 10 | 1,2-Dichloropropane | 78875 |
| 11 | NA | NA | NA | 1.34E+05 | NA | NA | 0% | 9E-6 | 0.0002% | NA | 87,862 | 11 | 1,3-Dichlorobenzene | 541731 |
| 12 | NA | NA | NA | 7.90E+04 | NA | 4E-8 | 0.01% | 1E-5 | 0.0003% | 274 | 79,000 | 12 | 1,4-Dichlorobenzene | 106467 |
| 13 | NA | NA | NA | 1.79E+06 | NA | 5E-7 | 0.1% | 2E-3 | 0.03% | 36 | 11,048 | 13 | Benzene | 71432 |
| 14 | NA | NA | NA | 6.74E+06 | NA | 4E-9 | 0.001% | 4E-6 | 0.00008% | 253 | 233,699 | 14 | Bromodichloromethane | 75274 |
| 15 | NA | NA | NA | 7.93E+05 | NA | 2E-5 | 5% | 3E-2 | 0.5% | 5.1 | 3,043 | 15 | Carbon tetrachloride | 56235 |
| 16 | NA | NA | NA | 4.72E+05 | NA | NA | 0% | 8E-4 | 0.02% | NA | 33,124 | 16 | Chlorobenzene | 108907 |
| 17 | NA | NA | NA | 7.92E+06 | NA | 4E-5 | 13% | 5E-2 | 1% | 57 | 46,246 | 17 | Chloroform | 67663 |
| 18 | NA | NA | NA | 3.50E+06 | NA | NA | 0% | 3E-3 | 0.06% | NA | 20,561 | 18 | cis-1,2-Dichloroethylene | 156592 |
| 19 | NA | NA | NA | 8.80E+06 | NA | NA | 0% | 6E-6 | 0.0001% | NA | 729,217 | 19 | Diisopropyl ether | 108203 |
| 20 | NA | NA | NA | 1.61E+05 | NA | NA | 0% | 2E-5 | 0.0003% | NA | 35,201 | 20 | m-Xylene | 108383 |
| 21 | NA | NA | NA | 1.30E+07 | NA | 2E-9 | 0.0005% | 1E-5 | 0.0002% | 2,238 | 319,652 | 21 | Methylene chloride | 75092 |
| 22 | NA | NA | NA | 1.78E+05 | NA | NA | 0% | 4E-5 | 0.0009% | NA | 40,274 | 22 | o-Xylene | 95476 |
| 23 | NA | NA | NA | 1.00E+09 | NA | NA | 0% | 3E-5 | 0.0006% | NA | 8,556,408 | 23 | tertiary-Butylalcohol | 75650 |
| 24 | NA | NA | NA | 2.00E+05 | NA | 3E-4 | 80% | 4E+0 | 73% | 65 | 4,790 | 24 | Tetrachloroethylene | 127184 |
| 25 | NA | NA | NA | 6.30E+06 | NA | NA | 0% | 2E-4 | 0.003% | NA | 16,060 | 25 | trans-1,2-Dichloroethylene | 156605 |
| 26 | NA | NA | NA | 1.47E+06 | NA | 4E-6 | 1% | 1E+0 | 24% | 151 | 443 | 26 | Trichloroethylene | 79016 |
| | | | | | | **Total 3E-4** | **100.0%** | **4.9** | **100.0%** | | | | | |

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

**SCROLL TO "END"** **MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT-IN RED)**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**SOIL AND GROUNDWATER-BASED ERROR STATEMENTS** **(DO NOT USE RESULTS IF ERRORS ARE PRESENT-IN RED)**

**CHEMICAL-BASED ERROR STATEMENTS** **(DO NOT USE RESULTS IF ERRORS ARE PRESENT-IN RED)**

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1,1,2-Tetrachloroethane | 630206 |
| 2 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 76131 |
| 3 | 1,1,2-Trichloroethane | 79005 |
| 4 | 1,1-Dichloroethane | 75343 |
| 5 | 1,1-Dichloroethylene | 75354 |
| 6 | 1,2,3-Trichloropropane | 96184 |
| 7 | 1,2,4-Trichlorobenzene | 120821 |
| 8 | 1,2-Dichlorobenzene | 95501 |
| 9 | 1,2-Dichloroethane | 107062 |
| 10 | 1,2-Dichloropropane | 78875 |
| 11 | 1,3-Dichlorobenzene | 541731 |
| 12 | 1,4-Dichlorobenzene | 106467 |
| 13 | Benzene | 71432 |
| 14 | Bromodichloromethane | 75274 |
| 15 | Carbon tetrachloride | 56235 |
| 16 | Chlorobenzene | 108907 |
| 17 | Chloroform | 67663 |
| 18 | cis-1,2-Dichloroethylene | 156592 |
| 19 | Diisopropyl ether | 108203 |
| 20 | m-Xylene | 108383 |
| 21 | Methylene chloride | 75092 |
| 22 | o-Xylene | 95476 |
| 23 | tertiary-Butylalcohol | 75650 |
| 24 | Tetrachloroethylene | 127184 |
| 25 | trans-1,2-Dichloroethylene | 156605 |
| 26 | Trichloroethylene | 79016 |

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

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|---|---|---|
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| 3 | 1,1,2-Trichloroethane | 79005 |
| 4 | 1,1-Dichloroethane | 75343 |
| 5 | 1,1-Dichloroethylene | 75354 |
| 6 | 1,2,3-Trichloropropane | 96184 |
| 7 | 1,2,4-Trichlorobenzene | 120821 |
| 8 | 1,2-Dichlorobenzene | 95501 |
| 9 | 1,2-Dichloroethane | 107062 |
| 10 | 1,2-Dichloropropane | 78875 |
| 11 | 1,3-Dichlorobenzene | 541731 |
| 12 | 1,4-Dichlorobenzene | 106467 |
| 13 | Benzene | 71432 |
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| 16 | Chlorobenzene | 108907 |
| 17 | Chloroform | 67663 |
| 18 | cis-1,2-Dichloroethylene | 156592 |
| 19 | Diisopropyl ether | 108203 |
| 20 | m-Xylene | 108383 |
| 21 | Methylene chloride | 75092 |
| 22 | o-Xylene | 95476 |
| 23 | tertiary-Butylalcohol | 75650 |
| 24 | Tetrachloroethylene | 127184 |
| 25 | trans-1,2-Dichloroethylene | 156605 |
| 26 | Trichloroethylene | 79016 |

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

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6 MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.
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| | COPCs Evaluated | CAS No. |
|---|---|---|
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| 3 | 1,1,2-Trichloroethane | 79005 |
| 4 | 1,1-Dichloroethane | 75343 |
| 5 | 1,1-Dichloroethylene | 75354 |
| 6 | 1,2,3-Trichloropropane | 96184 |
| 7 | 1,2,4-Trichlorobenzene | 120821 |
| 8 | 1,2-Dichlorobenzene | 95501 |
| 9 | 1,2-Dichloroethane | 107062 |
| 10 | 1,2-Dichloropropane | 78875 |
| 11 | 1,3-Dichlorobenzene | 541731 |
| 12 | 1,4-Dichlorobenzene | 106467 |
| 13 | Benzene | 71432 |
| 14 | Bromodichloromethane | 75274 |
| 15 | Carbon tetrachloride | 56235 |
| 16 | Chlorobenzene | 108907 |
| 17 | Chloroform | 67663 |
| 18 | cis-1,2-Dichloroethylene | 156592 |
| 19 | Diisopropyl ether | 108203 |
| 20 | m-Xylene | 108383 |
| 21 | Methylene chloride | 75092 |
| 22 | o-Xylene | 95476 |
| 23 | tertiary-Butylalcohol | 75650 |
| 24 | Tetrachloroethylene | 127184 |
| 25 | trans-1,2-Dichloroethylene | 156605 |
| 26 | Trichloroethylene | 79016 |

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

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| | COPCs Evaluated | CAS No. |
|---|---|---|
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| 2 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 76131 |
| 3 | 1,1,2-Trichloroethane | 79005 |
| 4 | 1,1-Dichloroethane | 75343 |
| 5 | 1,1-Dichloroethylene | 75354 |
| 6 | 1,2,3-Trichloropropane | 96184 |
| 7 | 1,2,4-Trichlorobenzene | 120821 |
| 8 | 1,2-Dichlorobenzene | 95501 |
| 9 | 1,2-Dichloroethane | 107062 |
| 10 | 1,2-Dichloropropane | 78875 |
| 11 | 1,3-Dichlorobenzene | 541731 |
| 12 | 1,4-Dichlorobenzene | 106467 |
| 13 | Benzene | 71432 |
| 14 | Bromodichloromethane | 75274 |
| 15 | Carbon tetrachloride | 56235 |
| 16 | Chlorobenzene | 108907 |
| 17 | Chloroform | 67663 |
| 18 | cis-1,2-Dichloroethylene | 156592 |
| 19 | Diisopropyl ether | 108203 |
| 20 | m-Xylene | 108383 |
| 21 | Methylene chloride | 75092 |
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RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - COMMERCIAL/INDUSTRIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**Area 2: Comm-Ind Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1,1,2-Tetrachloroethane | 630206 |
| 2 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 76131 |
| 3 | 1,1,2-Trichloroethane | 79005 |
| 4 | 1,1-Dichloroethane | 75343 |
| 5 | 1,1-Dichloroethylene | 75354 |
| 6 | 1,2,3-Trichloropropane | 96184 |
| 7 | 1,2,4-Trichlorobenzene | 120821 |
| 8 | 1,2-Dichlorobenzene | 95501 |
| 9 | 1,2-Dichloroethane | 107062 |
| 10 | 1,2-Dichloropropane | 78875 |
| 11 | 1,3-Dichlorobenzene | 541731 |
| 12 | 1,4-Dichlorobenzene | 106467 |
| 13 | Benzene | 71432 |
| 14 | Bromodichloromethane | 75274 |
| 15 | Carbon tetrachloride | 56235 |
| 16 | Chlorobenzene | 108907 |
| 17 | Chloroform | 67663 |
| 18 | cis-1,2-Dichloroethylene | 156592 |
| 19 | Diisopropyl ether | 108203 |
| 20 | m-Xylene | 108383 |
| 21 | Methylene chloride | 75092 |
| 22 | o-Xylene | 95476 |
| 23 | tertiary-Butylalcohol | 75650 |
| 24 | Tetrachloroethylene | 127184 |
| 25 | trans-1,2-Dichloroethylene | 156605 |
| 26 | Trichloroethylene | 79016 |

**END**

Input Parameters to the J&E Algorithm for Groundwater-to-Indoor Air Vapor
Residential Exposure Scenario, Area 2
Dual Site Groundwater, Montrose and Del Amo Superfund Sites

| Input Parameters to J&E Model GW-ADV Version 3.0 | | Units | J&E Spreadsheet Defaults | Site-Specific Evaluation Groundwater Samples | Basis for Parameter |
|---|---|---|---|---|---|
| $L_{WT}$ | Depth below grade to water table | cm (feet) | - (-) | 1,682 (55) | Site-specific, based on evaluation of historical water levels in CH2M HILL database. |
| Vadose Zone Properties (Without Engineered Fill) | | | | | |
| $T_s$ | Average groundwater temperature | °C | 22 | 24 | 75°F, California average shallow groundwater temperature (p. 48, EPA, 2004); DTSC, 2011, page D-6 |
| $h_A$ | Thickness of soil stratum A | cm (feet) | TBD | 914 (30) | Boring log for well XMW-6 |
| $h_B$ | Thickness of soil stratum B | cm (feet) | TBD | 768 (25.2) | Boring log for well XMW-6 |
| $h_C$ | Thickness of soil stratum C | cm (feet) | TBD | 0.0 (0) | Boring log for well XMW-6 |
| - | Stratum A soil type | -- | TBD | Silt | Boring log for well XMW-6 |
| $\rho_B^A$ | Stratum A soil dry bulk density | $g/cm^3$ | TBD | 1.35 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^A$ | Stratum A soil total porosity | unitless | TBD | 0.489 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^A$ | Stratum A soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.167 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum B soil type | -- | TBD | Loamy Sand | Boring log for well XMW-6 |
| $\rho_B^B$ | Stratum B soil dry bulk density | $g/cm^3$ | TBD | 1.62 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^B$ | Stratum B soil total porosity | unitless | TBD | 0.39 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^B$ | Stratum B soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.076 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum C soil type | -- | TBD | none | |
| $\rho_B^C$ | Stratum C soil dry bulk density | $g/cm^3$ | TBD | n/a | |
| $n^C$ | Stratum C soil total porosity | unitless | TBD | n/a | |
| $\Theta_W^C$ | Stratum C soil water-filled porosity | $cm^3/cm^3$ | TBD | n/a | |
| Building Parameters | | | | | |
| $L_F$ | Depth below grade to bottom of enclosed space floor - slab on grade (building with no basement) | cm | 15 | 15 | default, EPA, 2004, page 47 |
| $L_{crack}$ | Enclosed space floor thickness | cm | 10 | 9 | DTSC, 2011, Table 3; EPA, 2004 uses 10 cm, but California value of 9 cm is more conservative |
| $\Delta P$ | Soil-building pressure differential | $g/cm\text{-}s^2$ | 40 | 40 | OEHHA, 2005, page B-13; DTSC accepts EPA default in absence of California-specific measurements |
| $L_B$ | Enclosed space floor length | cm | 1,000 | 1,000 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $W_B$ | Enclosed space floor width | cm | 1,000 | 1,000 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $H_B$ | Enclosed space height | cm | 244 | 244 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| w | Floor-wall seam crack width | cm | 0.1 | 0.1 | OEHHA, 2005, page B-13; EPA, 2004, page 55. |
| $\eta$ | Crack-to-total area ratio | unitless | model calculated | 0.005 | California default, DTSC, 2011, Table 3. |
| ER | Indoor air exchange rate | 1/hour | 0.25 | 0.5 | Original EPA default 0.5 adopted for California residential building (DTSC, 2011) and retained after EPA adopted value of 0.25/hour, EPA, 1997 |
| $Q_{soil}$ | Average vapor flow rate into building | L/min | 5 | 5 | OEHHA, 2005, page B-13; California accepts EPA default, EPA, 2004, except when site-specific permeability is used. |
| $\alpha$ | Infinite Source - Indoor Attenuation Coefficient | unitless | model calculated | model calculated | Product of Johnson-Ettinger algorithm on INTERCALCS page incorporating site-specific information, EPA, 2004. |
| Physical-Chemical & Toxicity Parameters | | | | | |
| | The values were derived from the 'Chemical Properties Look Up Table' spreadsheet of *HERD_Groundwater_Screening_Model.xls* (updated December 2, 2011), *<http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm>*. | | | | |
| Exposure Parameters - Residential Scenario | | | | | |
| $AT_c$ | Averaging time for carcinogens | years | 70 | 70 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| $AT_{NC}$ | Averaging time for noncarcinogens | years | 30 | 30 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ED | Exposure duration | years | 30 | 30 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| EF | Exposure frequency | days/year | 350 | 350 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ET | Exposure time | hours/day | 24 | 24 | U.S. EPA, 1991; DTSC, 2011, Appendix C |

General notes follow on next page.

References:


DTSC, 2011, *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance*, October.
OEHHA, 2005, *Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soi*, January.
U.S. EPA Office of Emergency and Remedial Response, 1991, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part B), Interim Fina*, EPA/540/R-92/003, December.
U.S. EPA Office of Research and Development, National Center for Environmental Assessment, 1997, Exposure Factors Handbook, EPA/600/P-95/002Fa, Augus
U.S. EPA Region IX, 1999, EPA Superfund Record of Decision for Dual Site Groundwater Operable Unit, Montrose Chemical and Del Amo Superfund Sites, EPA/ROD/R09-99/035, March
U.S. EPA Office of Solid Waste and Emergency Response, 2002, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, Decembe

DATA ENTRY SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

GW-ADV
Version 3.0; 02/03

Reset to

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [ X ]

**Area 2: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Qualifier | Chemicals Evaluated (COPCs and Surrogates) | Surrogate? | Chemical Detected in Groundwater: COPC Detected | Chemical Detected in Groundwater: CAS No. |
|---|---|---|---|---|---|---|---|
| 1 | 630206 | 6.2 | | 1,1,1,2-Tetrachloroethane | NO | | |
| 2 | 76131 | 11 | | 1,1,2-Trichloro-1,2,2-trifluoroethane | NO | | |
| 3 | 79005 | 15 | | 1,1,2-Trichloroethane | NO | | |
| 4 | 75343 | 39 | | 1,1-Dichloroethane | NO | | |
| 5 | 75354 | 110 | | 1,1-Dichloroethylene | NO | | |
| 6 | 96184 | 4.3 | | 1,2,3-Trichloropropane | NO | | |
| 7 | 120821 | 3.7 | | 1,2,4-Trichlorobenzene | NO | | |
| 8 | 95501 | 7.9 | | 1,2-Dichlorobenzene | NO | | |
| 9 | 107062 | 38 | | 1,2-Dichloroethane | NO | | |
| 10 | 78875 | 1.1 | | 1,2-Dichloropropane | NO | | |
| 11 | 541731 | 0.78 | | 1,3-Dichlorobenzene | NO | | |
| 12 | 106467 | 11 | | 1,4-Dichlorobenzene | NO | | |
| 13 | 71432 | 17 | | Benzene | NO | | |
| 14 | 75274 | 0.9 | | Bromodichloromethane | NO | | |
| 15 | 56235 | 81 | | Carbon tetrachloride | NO | | |
| 16 | 108907 | 26 | | Chlorobenzene | NO | | |
| 17 | 67663 | 2,400 | | Chloroform | YES | | |
| 18 | 156592 | 57 | | cis-1,2-Dichloroethylene | NO | | |
| 19 | 108203 | 4.3 | | Diisopropyl ether | NO | | |
| 20 | 108383 | 0.53 | | m-Xylene | YES | Xylenes, total | 1330207 |
| 21 | 75092 | 3.9 | | Methylene chloride | NO | | |
| 22 | 95476 | 1.7 | | o-Xylene | NO | | |
| 23 | 75650 | 260 | | tertiary-Butylalcohol | NO | | |
| 24 | 127184 | 17,000 | | Tetrachloroethylene | NO | | |
| 25 | 156605 | 2.6 | | trans-1,2-Dichloroethylene | NO | | |
| 26 | 79016 | 530 | | Trichloroethylene | NO | | |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Totals must add up to value of $L_{WT}$ (cell G28) | | | | | | | |
| 24.0 | 15.0 | 1,682 | 914 | 768 | 0.0 | B | LS | SI | | |
| Southern Cal. | slab-on-grade | 55.2 feet | 30 feet | 25.2 feet | 0 feet | | | | | |

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ ($cm^3/cm^3$) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ ($g/cm^3$) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ ($cm^3/cm^3$) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ ($g/cm^3$) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ ($cm^3/cm^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SI | 1.35 | 0.489 | 0.167 | LS | 1.62 | 0.39 | 0.076 | | | | |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 9.0 | 40.0 | 1,000 | 1,000 | 244 | 0.10 | 0.5 | 5 |
| 3.5 inches | 4 Pa | 33 feet | 33 feet | 8 feet | default | Residential | default |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Exposure Time, ET (hrs/day) | Target risk for carcinogens, TR (unitless) | Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 24 | 1.0E-06 | 1 |
| Residential Exposure Scenario | | | | | Used to calculate risk-based groundwater concentration. | |

END

CHEMICAL PROPERTIES SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER AREA 2

| Diffusivity in air, $D_a$ ($cm^2/s$) | Diffusivity in water, $D_w$ ($cm^2/s$) | Henry's law constant at reference temperature, H (atm-$m^3$/mol) | Henry's law constant reference temperature, $T_R$ ($^oC$) | Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol) | Normal boiling point, $T_B$ ($^oK$) | Critical temperature, $T_C$ ($^oK$) | Organic carbon partition coefficient, $K_{oc}$ ($cm^3/g$) | Pure component water solubility, S (mg/L) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7.10E-02 | 7.90E-06 | 2.41E-03 | 25 | 9,768 | 403.50 | 624.00 | 1.16E+02 | 1.10E+03 | 7.4E-06 | 1.1E-01 | 1,1,1,2-Tetrachloroethane | 1 |
| 7.80E-02 | 8.20E-06 | 4.80E-01 | 25 | 6,463 | 320.70 | 487.30 | 1.11E+04 | 1.70E+02 | 0.0E+00 | 3.0E+01 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 2 |
| 7.80E-02 | 8.80E-06 | 9.11E-04 | 25 | 8,322 | 386.15 | 602.00 | 5.01E+01 | 4.42E+03 | 1.6E-05 | 2.0E-04 | 1,1,2-Trichloroethane | 3 |
| 7.42E-02 | 1.05E-05 | 5.61E-03 | 25 | 6,895 | 330.55 | 523.00 | 3.16E+01 | 5.06E+03 | 1.6E-06 | 7.0E-01 | 1,1-Dichloroethane | 4 |
| 9.00E-02 | 1.04E-05 | 2.60E-02 | 25 | 6,247 | 304.75 | 576.05 | 5.89E+01 | 2.25E+03 | 0.0E+00 | 7.0E-02 | 1,1-Dichloroethylene | 5 |
| 7.10E-02 | 7.90E-06 | 4.08E-04 | 25 | 9,171 | 430.00 | 652.00 | 2.20E+01 | 1.75E+03 | 8.6E-03 | 3.0E-04 | 1,2,3-Trichloropropane | 6 |
| 3.00E-02 | 8.23E-06 | 1.42E-03 | 25 | 10,471 | 486.15 | 725.00 | 1.78E+03 | 4.88E+01 | 0.0E+00 | 2.0E-03 | 1,2,4-Trichlorobenzene | 7 |
| 6.90E-02 | 7.90E-06 | 1.90E-03 | 25 | 9,700 | 453.57 | 705.00 | 6.17E+02 | 1.56E+02 | 0.0E+00 | 2.0E-01 | 1,2-Dichlorobenzene | 8 |
| 1.04E-01 | 9.90E-06 | 9.77E-04 | 25 | 7,643 | 356.65 | 561.00 | 1.74E+01 | 8.52E+03 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 9 |
| 7.82E-02 | 8.73E-06 | 2.79E-03 | 25 | 7,590 | 369.52 | 572.00 | 4.37E+01 | 2.80E+03 | 1.0E-05 | 4.0E-03 | 1,2-Dichloropropane | 10 |
| 6.92E-02 | 7.86E-06 | 3.09E-03 | 25 | 9,230 | 446.00 | 684.00 | 1.98E+03 | 1.34E+02 | 0.0E+00 | 1.1E-01 | 1,3-Dichlorobenzene | 11 |
| 6.90E-02 | 7.90E-06 | 2.39E-03 | 25 | 9,271 | 447.21 | 684.75 | 6.17E+02 | 7.90E+01 | 1.1E-05 | 8.0E-01 | 1,4-Dichlorobenzene | 12 |
| 8.80E-02 | 9.80E-06 | 5.54E-03 | 25 | 7,342 | 353.24 | 562.16 | 5.89E+01 | 1.79E+03 | 2.9E-05 | 3.0E-02 | Benzene | 13 |
| 2.98E-02 | 1.06E-05 | 1.60E-03 | 25 | 7,800 | 363.15 | 585.85 | 5.50E+01 | 6.74E+03 | 3.7E-05 | 7.0E-02 | Bromodichloromethane | 14 |
| 7.80E-02 | 8.80E-06 | 3.03E-02 | 25 | 7,127 | 349.90 | 556.60 | 1.74E+02 | 7.93E+02 | 4.2E-05 | 4.0E-02 | Carbon tetrachloride | 15 |
| 7.30E-02 | 8.70E-06 | 3.69E-03 | 25 | 8,410 | 404.87 | 632.40 | 2.19E+02 | 4.72E+02 | 0.0E+00 | 5.0E-02 | Chlorobenzene | 16 |
| 1.04E-01 | 1.00E-05 | 3.66E-03 | 25 | 6,988 | 334.32 | 536.40 | 3.98E+01 | 7.92E+03 | 2.3E-05 | 9.8E-02 | Chloroform | 17 |
| 7.36E-02 | 1.13E-05 | 4.07E-03 | 25 | 7,192 | 333.65 | 544.00 | 3.55E+01 | 3.50E+03 | 0.0E+00 | 3.5E-02 | cis-1,2-Dichloroethylene | 18 |
| 6.54E-02 | 7.76E-06 | 2.56E-03 | 25 | 6,960 | 341.50 | 500.00 | 2.28E+01 | 8.80E+03 | 0.0E+00 | 7.0E-01 | Diisopropyl ether | 19 |
| 7.00E-02 | 7.80E-06 | 7.32E-03 | 25 | 8,523 | 412.27 | 617.05 | 4.07E+02 | 1.61E+02 | 0.0E+00 | 1.0E-01 | m-Xylene | 20 |
| 1.01E-01 | 1.17E-05 | 2.18E-03 | 25 | 6,706 | 313.00 | 510.00 | 1.17E+01 | 1.30E+04 | 1.0E-06 | 4.0E-01 | Methylene chloride | 21 |
| 8.70E-02 | 1.00E-05 | 5.18E-03 | 25 | 8,661 | 417.60 | 630.30 | 3.63E+02 | 1.78E+02 | 0.0E+00 | 1.0E-01 | o-Xylene | 22 |
| 9.85E-02 | 1.14E-05 | 9.02E-06 | 25 | 9 | 355.55 | 508.00 | 2.11E+00 | 1.00E+06 | 0.0E+00 | 6.9E-02 | tertiary-Butylalcohol | 23 |
| 7.20E-02 | 8.20E-06 | 1.84E-02 | 25 | 8,288 | 394.40 | 620.20 | 1.55E+02 | 2.00E+02 | 5.9E-06 | 3.5E-02 | Tetrachloroethylene | 24 |
| 7.07E-02 | 1.19E-05 | 9.36E-03 | 25 | 6,717 | 320.85 | 516.50 | 5.25E+01 | 6.30E+03 | 0.0E+00 | 6.0E-02 | trans-1,2-Dichloroethylene | 25 |
| 7.90E-02 | 9.10E-06 | 1.03E-02 | 25 | 7,505 | 360.36 | 544.20 | 1.66E+02 | 1.47E+03 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 26 |

**Area 2: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

**END**

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**Area 2: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) | **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,1,1,2-Tetrachloroethane | 1 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 2 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,1,2-Trichloroethane | 3 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,1-Dichloroethane | 4 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,1-Dichloroethylene | 5 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,2,3-Trichloropropane | 6 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,2,4-Trichlorobenzene | 7 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,2-Dichlorobenzene | 8 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,2-Dichloroethane | 9 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,2-Dichloropropane | 10 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,3-Dichlorobenzene | 11 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | 1,4-Dichlorobenzene | 12 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Benzene | 13 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Bromodichloromethane | 14 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Carbon tetrachloride | 15 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Chlorobenzene | 16 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Chloroform | 17 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | cis-1,2-Dichloroethylene | 18 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Diisopropyl ether | 19 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | m-Xylene | 20 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Methylene chloride | 21 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | o-Xylene | 22 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | tertiary-Butylalcohol | 23 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Tetrachloroethylene | 24 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | trans-1,2-Dichloroethylene | 25 |
| 9.46E+08 | 1667.496 | 0.322 | 0.314 | ERROR | 0.267 | 6.91E-09 | 0.830 | 5.73E-09 | 18.75 | 0.39 | 0.087 | 0.303 | 4,000 | Trichloroethylene | 26 |

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**Area 2: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-$m^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,266 | 2.26E-03 | 9.29E-02 | 1.80E-04 | 6.82E-03 | 9.86E-03 | 0.00E+00 | 1.50E-04 | 5.01E-03 | 1667.496 | 1,1,1,2-Tetrachloroethane | 1 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 6,787 | 4.62E-01 | 1.89E+01 | 1.80E-04 | 7.49E-03 | 1.08E-02 | 0.00E+00 | 1.53E-04 | 5.35E-03 | 1667.496 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 2 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,419 | 8.63E-04 | 3.54E-02 | 1.80E-04 | 7.50E-03 | 1.08E-02 | 0.00E+00 | 1.84E-04 | 5.73E-03 | 1667.496 | 1,1,2-Trichloroethane | 3 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,294 | 5.38E-03 | 2.21E-01 | 1.80E-04 | 7.13E-03 | 1.03E-02 | 0.00E+00 | 1.52E-04 | 5.17E-03 | 1667.496 | 1,1-Dichloroethane | 4 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 6,299 | 2.51E-02 | 1.03E+00 | 1.80E-04 | 8.65E-03 | 1.25E-02 | 0.00E+00 | 1.78E-04 | 6.19E-03 | 1667.496 | 1,1-Dichloroethylene | 5 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 10,919 | 3.83E-04 | 1.57E-02 | 1.80E-04 | 6.83E-03 | 9.86E-03 | 0.00E+00 | 2.01E-04 | 5.54E-03 | 1667.496 | 1,2,3-Trichloropropane | 6 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 13,069 | 1.32E-03 | 5.39E-02 | 1.80E-04 | 2.88E-03 | 4.17E-03 | 0.00E+00 | 7.77E-05 | 2.27E-03 | 1667.496 | 1,2,4-Trichlorobenzene | 7 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,546 | 1.77E-03 | 7.28E-02 | 1.80E-04 | 6.63E-03 | 9.58E-03 | 0.00E+00 | 1.49E-04 | 4.91E-03 | 1667.496 | 1,2-Dichlorobenzene | 8 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,368 | 9.31E-04 | 3.82E-02 | 1.80E-04 | 9.99E-03 | 1.44E-02 | 0.00E+00 | 2.36E-04 | 7.54E-03 | 1667.496 | 1,2-Dichloroethane | 9 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,478 | 2.66E-03 | 1.09E-01 | 1.80E-04 | 7.51E-03 | 1.09E-02 | 0.00E+00 | 1.63E-04 | 5.50E-03 | 1667.496 | 1,2-Dichloropropane | 10 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,029 | 2.90E-03 | 1.19E-01 | 1.80E-04 | 6.65E-03 | 9.61E-03 | 0.00E+00 | 1.44E-04 | 4.86E-03 | 1667.496 | 1,3-Dichlorobenzene | 11 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,098 | 2.25E-03 | 9.22E-02 | 1.80E-04 | 6.63E-03 | 9.58E-03 | 0.00E+00 | 1.46E-04 | 4.87E-03 | 1667.496 | 1,4-Dichlorobenzene | 12 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,977 | 5.29E-03 | 2.17E-01 | 1.80E-04 | 8.45E-03 | 1.22E-02 | 0.00E+00 | 1.78E-04 | 6.11E-03 | 1667.496 | Benzene | 13 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,526 | 1.52E-03 | 6.24E-02 | 1.80E-04 | 2.86E-03 | 4.14E-03 | 0.00E+00 | 7.94E-05 | 2.28E-03 | 1667.496 | Bromodichloromethane | 14 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,716 | 2.90E-02 | 1.19E+00 | 1.80E-04 | 7.49E-03 | 1.08E-02 | 0.00E+00 | 1.54E-04 | 5.36E-03 | 1667.496 | Carbon tetrachloride | 15 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,661 | 3.49E-03 | 1.43E-01 | 1.80E-04 | 7.01E-03 | 1.01E-02 | 0.00E+00 | 1.51E-04 | 5.11E-03 | 1667.496 | Chlorobenzene | 16 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,407 | 3.51E-03 | 1.44E-01 | 1.80E-04 | 9.99E-03 | 1.44E-02 | 0.00E+00 | 2.13E-04 | 7.25E-03 | 1667.496 | Chloroform | 17 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,592 | 3.90E-03 | 1.60E-01 | 1.80E-04 | 7.07E-03 | 1.02E-02 | 0.00E+00 | 1.53E-04 | 5.17E-03 | 1667.496 | cis-1,2-Dichloroethylene | 18 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,662 | 2.45E-03 | 1.01E-01 | 1.80E-04 | 6.29E-03 | 9.09E-03 | 0.00E+00 | 1.38E-04 | 4.61E-03 | 1667.496 | Diisopropyl ether | 19 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 10,090 | 6.91E-03 | 2.84E-01 | 1.80E-04 | 6.72E-03 | 9.72E-03 | 0.00E+00 | 1.41E-04 | 4.85E-03 | 1667.496 | m-Xylene | 20 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 6,884 | 2.10E-03 | 8.62E-02 | 1.80E-04 | 9.70E-03 | 1.40E-02 | 0.00E+00 | 2.15E-04 | 7.15E-03 | 1667.496 | Methylene chloride | 21 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 10,245 | 4.88E-03 | 2.00E-01 | 1.80E-04 | 8.36E-03 | 1.21E-02 | 0.00E+00 | 1.77E-04 | 6.05E-03 | 1667.496 | o-Xylene | 22 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11 | 9.02E-06 | 3.70E-04 | 1.80E-04 | 9.79E-03 | 1.37E-02 | 0.00E+00 | 3.98E-03 | 1.10E-02 | 1667.496 | tertiary-Butylalcohol | 23 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,410 | 1.74E-02 | 7.14E-01 | 1.80E-04 | 6.92E-03 | 1.00E-02 | 0.00E+00 | 1.43E-04 | 4.96E-03 | 1667.496 | Tetrachloroethylene | 24 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 6,986 | 8.99E-03 | 3.69E-01 | 1.80E-04 | 6.79E-03 | 9.82E-03 | 0.00E+00 | 1.43E-04 | 4.90E-03 | 1667.496 | trans-1,2-Dichloroethylene | 25 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,382 | 9.80E-03 | 4.02E-01 | 1.80E-04 | 7.59E-03 | 1.10E-02 | 0.00E+00 | 1.58E-04 | 5.46E-03 | 1667.496 | Trichloroethylene | 26 |

Cal default

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**Area 2: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 5.76E+02 | 1.33 | 8.33E+01 | 6.82E-03 | 5.30E+03 | 1.02E+09 | 9.06E-05 | 5.21E-02 | 7.4E-06 | 1.1E-01 | 1,1,1,2-Tetrachloroethane | 1 |
| 15 | 2.08E+05 | 1.33 | 8.33E+01 | 7.49E-03 | 5.30E+03 | 1.59E+08 | 9.65E-05 | 2.01E+01 | NA | 3.0E+01 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 2 |
| 15 | 5.31E+02 | 1.33 | 8.33E+01 | 7.50E-03 | 5.30E+03 | 1.58E+08 | 1.03E-04 | 5.47E-02 | 1.6E-05 | 2.0E-04 | 1,1,2-Trichloroethane | 3 |
| 15 | 8.60E+03 | 1.33 | 8.33E+01 | 7.13E-03 | 5.30E+03 | 4.18E+08 | 9.34E-05 | 8.03E-01 | 1.6E-06 | 7.0E-01 | 1,1-Dichloroethane | 4 |
| 15 | 1.13E+05 | 1.33 | 8.33E+01 | 8.65E-03 | 5.30E+03 | 1.28E+07 | 1.11E-04 | 1.26E+01 | NA | 7.0E-02 | 1,1-Dichloroethylene | 5 |
| 15 | 6.76E+01 | 1.33 | 8.33E+01 | 6.83E-03 | 5.30E+03 | 1.01E+09 | 9.98E-05 | 6.74E-03 | 8.6E-03 | 3.0E-04 | 1,2,3-Trichloropropane | 6 |
| 15 | 2.00E+02 | 1.33 | 8.33E+01 | 2.88E-03 | 5.30E+03 | 2.06E+21 | 4.20E-05 | 8.37E-03 | NA | 2.0E-03 | 1,2,4-Trichlorobenzene | 7 |
| 15 | 5.75E+02 | 1.33 | 8.33E+01 | 6.63E-03 | 5.30E+03 | 1.86E+09 | 8.88E-05 | 5.11E-02 | NA | 2.0E-01 | 1,2-Dichlorobenzene | 8 |
| 15 | 1.45E+03 | 1.33 | 8.33E+01 | 9.99E-03 | 5.30E+03 | 1.41E+06 | 1.34E-04 | 1.94E-01 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 9 |
| 15 | 1.20E+02 | 1.33 | 8.33E+01 | 7.51E-03 | 5.30E+03 | 1.51E+08 | 9.90E-05 | 1.19E-02 | 1.0E-05 | 4.0E-03 | 1,2-Dichloropropane | 10 |
| 15 | 9.29E+01 | 1.33 | 8.33E+01 | 6.65E-03 | 5.30E+03 | 1.76E+09 | 8.79E-05 | 8.17E-03 | NA | 1.1E-01 | 1,3-Dichlorobenzene | 11 |
| 15 | 1.01E+03 | 1.33 | 8.33E+01 | 6.63E-03 | 5.30E+03 | 1.87E+09 | 8.82E-05 | 8.94E-02 | 1.1E-05 | 8.0E-01 | 1,4-Dichlorobenzene | 12 |
| 15 | 3.69E+03 | 1.33 | 8.33E+01 | 8.45E-03 | 5.30E+03 | 1.86E+07 | 1.10E-04 | 4.04E-01 | 2.9E-05 | 3.0E-02 | Benzene | 13 |
| 15 | 5.61E+01 | 1.33 | 8.33E+01 | 2.86E-03 | 5.30E+03 | 2.85E+21 | 4.21E-05 | 2.36E-03 | 3.7E-05 | 7.0E-02 | Bromodichloromethane | 14 |
| 15 | 9.64E+04 | 1.33 | 8.33E+01 | 7.49E-03 | 5.30E+03 | 1.59E+08 | 9.67E-05 | 9.33E+00 | 4.2E-05 | 4.0E-02 | Carbon tetrachloride | 15 |
| 15 | 3.73E+03 | 1.33 | 8.33E+01 | 7.01E-03 | 5.30E+03 | 5.80E+08 | 9.23E-05 | 3.44E-01 | NA | 5.0E-02 | Chlorobenzene | 16 |
| 15 | 3.45E+05 | 1.33 | 8.33E+01 | 9.99E-03 | 5.30E+03 | 1.42E+06 | 1.29E-04 | 4.46E+01 | 2.3E-05 | 9.8E-02 | Chloroform | 17 |
| 15 | 9.11E+03 | 1.33 | 8.33E+01 | 7.07E-03 | 5.30E+03 | 4.92E+08 | 9.33E-05 | 8.50E-01 | NA | 3.5E-02 | cis-1,2-Dichloroethylene | 18 |
| 15 | 4.32E+02 | 1.33 | 8.33E+01 | 6.29E-03 | 5.30E+03 | 5.99E+09 | 8.37E-05 | 3.62E-02 | NA | 7.0E-01 | Diisopropyl ether | 19 |
| 15 | 1.50E+02 | 1.33 | 8.33E+01 | 6.72E-03 | 5.30E+03 | 1.38E+09 | 8.78E-05 | 1.32E-02 | NA | 1.0E-01 | m-Xylene | 20 |
| 15 | 3.36E+02 | 1.33 | 8.33E+01 | 9.70E-03 | 5.30E+03 | 2.16E+06 | 1.27E-04 | 4.28E-02 | 1.0E-06 | 4.0E-01 | Methylene chloride | 21 |
| 15 | 3.41E+02 | 1.33 | 8.33E+01 | 8.36E-03 | 5.30E+03 | 2.26E+07 | 1.09E-04 | 3.70E-02 | NA | 1.0E-01 | o-Xylene | 22 |
| 15 | 9.62E+01 | 1.33 | 8.33E+01 | 9.79E-03 | 5.30E+03 | 1.88E+06 | 1.91E-04 | 1.84E-02 | NA | 6.9E-02 | tertiary-Butylalcohol | 23 |
| 15 | 1.21E+07 | 1.33 | 8.33E+01 | 6.92E-03 | 5.30E+03 | 7.68E+08 | 8.97E-05 | 1.09E+03 | 5.9E-06 | 3.5E-02 | Tetrachloroethylene | 24 |
| 15 | 9.59E+02 | 1.33 | 8.33E+01 | 6.79E-03 | 5.30E+03 | 1.12E+09 | 8.87E-05 | 8.51E-02 | NA | 6.0E-02 | trans-1,2-Dichloroethylene | 25 |
| 15 | 2.13E+05 | 1.33 | 8.33E+01 | 7.59E-03 | 5.30E+03 | 1.25E+08 | 9.84E-05 | 2.09E+01 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 26 |

**END**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:**

**Area 2: Residential Exposure Scenario**

**INCREMENTAL RISK CALCULATIONS:**

**Preparation Date: 1/21/2014**

| | Indoor exposure groundwater conc., carcinogen (µg/L) | Indoor exposure groundwater conc., noncarcinogen (µg/L) | Risk-based indoor exposure groundwater conc., (µg/L) | Pure component water solubility, S (µg/L) | Final indoor exposure groundwater conc., (µg/L) | Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Percent of Total Risk (%) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) | Percent of Total Health Hazard (%) | Risk-Based Screening Level (RBSL) Cancer µg/L TR = 1E-6 | Risk-Based Screening Level (RBSL) Non-cancer µg/L THQ = 1 | | COPCs Evaluated | CAS No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | NA | NA | NA | 1.10E+06 | NA | 2E-7 | 0.005% | 5E-4 | 0.001% | 39 | 13,021 | 1 | 1,1,1,2-Tetrachloroethane | 630206 |
| 2 | NA | NA | NA | 1.70E+05 | NA | NA | 0% | 6E-4 | 0.002% | NA | 17,179 | 2 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 76131 |
| 3 | NA | NA | NA | 4.42E+06 | NA | 4E-7 | 0.01% | 3E-1 | 0.6% | 42 | 57 | 3 | 1,1,2-Trichloroethane | 79005 |
| 4 | NA | NA | NA | 5.06E+06 | NA | 5E-7 | 0.02% | 1E-3 | 0.003% | 74 | 35,451 | 4 | 1,1-Dichloroethane | 75343 |
| 5 | NA | NA | NA | 2.25E+06 | NA | NA | 0% | 2E-1 | 0.4% | NA | 638 | 5 | 1,1-Dichloroethylene | 75354 |
| 6 | NA | NA | NA | 1.75E+06 | NA | 2E-5 | 0.7% | 2E-2 | 0.05% | 0.18 | 200 | 6 | 1,2,3-Trichloropropane | 96184 |
| 7 | NA | NA | NA | 4.88E+04 | NA | NA | 0% | 4E-3 | 0.01% | NA | 922 | 7 | 1,2,4-Trichlorobenzene | 120821 |
| 8 | NA | NA | NA | 1.56E+05 | NA | NA | 0% | 2E-4 | 0.0006% | NA | 32,271 | 8 | 1,2-Dichlorobenzene | 95501 |
| 9 | NA | NA | NA | 8.52E+06 | NA | 2E-6 | 0.06% | 3E-2 | 0.06% | 18 | 1,429 | 9 | 1,2-Dichloroethane | 107062 |
| 10 | NA | NA | NA | 2.80E+06 | NA | 5E-8 | 0.001% | 3E-3 | 0.007% | 23 | 386 | 10 | 1,2-Dichloropropane | 78875 |
| 11 | NA | NA | NA | 1.34E+05 | NA | NA | 0% | 7E-5 | 0.0002% | NA | 10,460 | 11 | 1,3-Dichlorobenzene | 541731 |
| 12 | NA | NA | NA | 7.90E+04 | NA | 4E-7 | 0.01% | 1E-4 | 0.0003% | 27 | 79,000 | 12 | 1,4-Dichlorobenzene | 106467 |
| 13 | NA | NA | NA | 1.79E+06 | NA | 5E-6 | 0.1% | 1E-2 | 0.03% | 3.527 | 1,315 | 13 | Benzene | 71432 |
| 14 | NA | NA | NA | 6.74E+06 | NA | 4E-8 | 0.001% | 3E-5 | 0.00008% | 25 | 27,821 | 14 | Bromodichloromethane | 75274 |
| 15 | NA | NA | NA | 7.93E+05 | NA | 2E-4 | 5% | 2E-1 | 0.5% | 0.50 | 362 | 15 | Carbon tetrachloride | 56235 |
| 16 | NA | NA | NA | 4.72E+05 | NA | NA | 0% | 7E-3 | 0.02% | NA | 3,943 | 16 | Chlorobenzene | 108907 |
| 17 | NA | NA | NA | 7.92E+06 | NA | 4E-4 | 13% | 4E-1 | 1% | 5.7 | 5,505 | 17 | Chloroform | 67663 |
| 18 | NA | NA | NA | 3.50E+06 | NA | NA | 0% | 2E-2 | 0.06% | NA | 2,448 | 18 | cis-1,2-Dichloroethylene | 156592 |
| 19 | NA | NA | NA | 8.80E+06 | NA | NA | 0% | 5E-5 | 0.0001% | NA | 86,812 | 19 | Diisopropyl ether | 108203 |
| 20 | NA | NA | NA | 1.61E+05 | NA | NA | 0% | 1E-4 | 0.0003% | NA | 4,191 | 20 | m-Xylene | 108383 |
| 21 | NA | NA | NA | 1.30E+07 | NA | 2E-8 | 0.0005% | 1E-4 | 0.0002% | 222 | 38,054 | 21 | Methylene chloride | 75092 |
| 22 | NA | NA | NA | 1.78E+05 | NA | NA | 0% | 4E-4 | 0.0009% | NA | 4,795 | 22 | o-Xylene | 95476 |
| 23 | NA | NA | NA | 1.00E+09 | NA | NA | 0% | 3E-4 | 0.0006% | NA | 1,018,620 | 23 | tertiary-Butylalcohol | 75650 |
| 24 | NA | NA | NA | 2.00E+05 | NA | 3E-3 | 80% | 3E+1 | 73% | 6.4 | 570 | 24 | Tetrachloroethylene | 127184 |
| 25 | NA | NA | NA | 6.30E+06 | NA | NA | 0% | 1E-3 | 0.003% | NA | 1,912 | 25 | trans-1,2-Dichloroethylene | 156605 |
| 26 | NA | NA | NA | 1.47E+06 | NA | 4E-5 | 1% | 1E+1 | 24% | 15 | 53 | 26 | Trichloroethylene | 79016 |
| | | | | | | **Total** | **3E-3** | **100.0%** | **41** | **100.0%** | | | | |

**Area 2: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

**SCROLL TO "END"**

**MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT-IN RED)**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**SOIL AND GROUNDWATER-BASED ERROR STATEMENTS** **(DO NOT USE RESULTS IF ERRORS ARE PRESENT-IN RED)**

**CHEMICAL-BASED ERROR STATEMENTS** **(DO NOT USE RESULTS IF ERRORS ARE PRESENT-IN RED)**

**Area 2: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,1,1,2-Tetrachloroethane | 630206 |
| 2 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 76131 |
| 3 | 1,1,2-Trichloroethane | 79005 |
| 4 | 1,1-Dichloroethane | 75343 |
| 5 | 1,1-Dichloroethylene | 75354 |
| 6 | 1,2,3-Trichloropropane | 96184 |
| 7 | 1,2,4-Trichlorobenzene | 120821 |
| 8 | 1,2-Dichlorobenzene | 95501 |
| 9 | 1,2-Dichloroethane | 107062 |
| 10 | 1,2-Dichloropropane | 78875 |
| 11 | 1,3-Dichlorobenzene | 541731 |
| 12 | 1,4-Dichlorobenzene | 106467 |
| 13 | Benzene | 71432 |
| 14 | Bromodichloromethane | 75274 |
| 15 | Carbon tetrachloride | 56235 |
| 16 | Chlorobenzene | 108907 |
| 17 | Chloroform | 67663 |
| 18 | cis-1,2-Dichloroethylene | 156592 |
| 19 | Diisopropyl ether | 108203 |
| 20 | m-Xylene | 108383 |
| 21 | Methylene chloride | 75092 |
| 22 | o-Xylene | 95476 |
| 23 | tertiary-Butylalcohol | 75650 |
| 24 | Tetrachloroethylene | 127184 |
| 25 | trans-1,2-Dichloroethylene | 156605 |
| 26 | Trichloroethylene | 79016 |

**Area 2: Residential Exposure Scenario**

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RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**Area 2: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

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6 MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.
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**Area 2: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

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|---|---|---|
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RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 2

**Area 2: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

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|---|---|---|
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| 25 | trans-1,2-Dichloroethylene | 156605 |
| 26 | Trichloroethylene | 79016 |

**END**

**VLOOKUP TABLES**

**Soil Properties Lookup Table**

| SCS Soil Type | $K_s$ (cm/h) | $a_1$ (1/cm) | N (unitless) | M (unitless) | n ($cm^3/cm^3$) | $q_r$ ($cm^3/cm^3$) | Mean Grain Diameter (cm) | Bulk Density ($g/cm^3$) | $q_w$ ($cm^3/cm^3$) | **SCS** Soil Name |
|---|---|---|---|---|---|---|---|---|---|---|
| C | 0.61 | 0.01496 | 1.253 | 0.2019 | 0.459 | 0.098 | 0.0092 | 1.43 | 0.215 | Clay |
| CL | 0.34 | 0.01581 | 1.416 | 0.2938 | 0.442 | 0.079 | 0.016 | 1.48 | 0.168 | Clay Loam |
| L | 0.50 | 0.01112 | 1.472 | 0.3207 | 0.399 | 0.061 | 0.020 | 1.59 | 0.148 | Loam |
| LS | 4.38 | 0.03475 | 1.746 | 0.4273 | 0.390 | 0.049 | 0.040 | 1.62 | 0.076 | Loamy Sand |
| S | 26.78 | 0.03524 | 3.177 | 0.6852 | 0.375 | 0.053 | 0.044 | 1.66 | 0.054 | Sand |
| SC | 0.47 | 0.03342 | 1.208 | 0.1722 | 0.385 | 0.117 | 0.025 | 1.63 | 0.197 | Sandy Clay |
| SCL | 0.55 | 0.02109 | 1.330 | 0.2481 | 0.384 | 0.063 | 0.029 | 1.63 | 0.146 | Sandy Clay Loam |
| SI | 1.82 | 0.00658 | 1.679 | 0.4044 | 0.489 | 0.050 | 0.0046 | 1.35 | 0.167 | Silt |
| SIC | 0.40 | 0.01622 | 1.321 | 0.2430 | 0.481 | 0.111 | 0.0039 | 1.38 | 0.216 | Silty Clay |
| SICL | 0.46 | 0.00839 | 1.521 | 0.3425 | 0.482 | 0.090 | 0.0056 | 1.37 | 0.198 | Silty Clay Loam |
| SIL | 0.76 | 0.00506 | 1.663 | 0.3987 | 0.439 | 0.065 | 0.011 | 1.49 | 0.180 | Silt Loam |
| SL | 1.60 | 0.02667 | 1.449 | 0.3099 | 0.387 | 0.039 | 0.030 | 1.62 | 0.103 | Sandy Loam |

**Chemical Properties Lookup Table**

| CAS No. | Chemical | Organic carbon partition coefficient, $K_{oc}$ ($cm^3/g$) | Diffusivity in air, $D_a$ ($cm^2/s$) | Diffusivity in water, $D_w$ ($cm^2/s$) | Pure component water solubility, S (mg/L) | Henry's law constant H' (unitless) | Henry's law constant at reference temperature, H (atm-$m^3$/mol) | Henry's law constant reference temperature, $T_R$ (°C) | Normal boiling point, $T_B$ (°K) | Critical temperature, $T_C$ (°K) | Enthalpy of vaporization at the normal boiling point, $DH_{v,b}$ (cal/mol) | **CalEPA Toxicity Criteria in bold** (last updated 12/2/11 DTSC/HERO) Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Molecular weight, MW (g/mol) | URF extrapolated (X) | RfC extrapolated (X) | Original EPA Values: Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | URF extrapolated (X) | RfC extrapolated (X) | Original 2011 DTSC-HERO Values: Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 56235 | Carbon tetrachloride | 1.74E+02 | 7.80E-02 | 8.80E-06 | 7.93E+02 | 1.24E+00 | 3.03E-02 | 25 | 349.90 | 556.60 | 7,127 | **4.2E-05** | **4.0E-02** | 1.54E+02 | | | 1.5E-05 | 0.0E+00 | | | | |
| 67641 | Acetone | 5.75E-01 | 1.24E-01 | 1.14E-05 | 1.00E+06 | 1.59E-03 | 3.87E-05 | 25 | 329.20 | 508.10 | 6,955 | 0.0E+00 | **3.1E+01** | 5.81E+01 | | X | 3.7E-04 | 3.5E-01 | | X | | |
| 67663 | Chloroform | 3.98E+01 | 1.04E-01 | 1.00E-05 | 7.92E+03 | 1.50E-01 | 3.66E-03 | 25 | 334.32 | 536.40 | 6,988 | 2.3E-05 | 9.8E-02 | 1.19E+02 | | | 3.7E-04 | 0.0E+00 | | | **5.3E-06** | **3.0E-01** |
| 71432 | Benzene | 5.89E+01 | 8.80E-02 | 9.80E-06 | 1.79E+03 | 2.27E-01 | 5.54E-03 | 25 | 353.24 | 562.16 | 7,342 | **2.9E-05** | 3.0E-02 | 7.81E+01 | | | 3.7E-04 | 0.0E+00 | | | | |
| 75092 | Methylene chloride | 1.17E+01 | 1.01E-01 | 1.17E-05 | 1.30E+04 | 8.96E-02 | 2.18E-03 | 25 | 313.00 | 510.00 | 6,706 | **1.0E-06** | **4.0E-01** | 8.49E+01 | | | 3.7E-04 | 3.0E+00 | | | | |
| 75274 | Bromodichloromethane | 5.50E+01 | 2.98E-02 | 1.06E-05 | 6.74E+03 | 6.54E-02 | 1.60E-03 | 25 | 363.15 | 585.85 | 7,800 | **3.7E-05** | 7.0E-02 | 1.64E+02 | ? | X | 3.7E-04 | 7.0E-02 | X | X | | |
| 75343 | 1,1-Dichloroethane | 3.16E+01 | 7.42E-02 | 1.05E-05 | 5.06E+03 | 2.30E-01 | 5.61E-03 | 25 | 330.55 | 523.00 | 6,895 | **1.6E-06** | **7.0E-01** | 9.90E+01 | | X | 3.7E-04 | 5.0E-01 | | | | |
| 75354 | 1,1-Dichloroethylene | 5.89E+01 | 9.00E-02 | 1.04E-05 | 2.25E+03 | 1.07E+00 | 2.60E-02 | 25 | 304.75 | 576.05 | 6,247 | 0.0E+00 | **7.0E-02** | 9.69E+01 | | | 3.7E-04 | 2.0E-01 | | | | |
| 75650 | tertiary-Butylalcohol | 2.11E+00 | 9.85E-02 | 1.14E-05 | 1.00E+06 | 3.70E-04 | 9.02E-06 | 25 | 355.55 | 508.00 | 9.338 | 0.0E+00 | 6.9E-02 | 7.41E+01 | | | | | | | | |
| 76131 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 1.11E+04 | 7.80E-02 | 8.20E-06 | 1.70E+02 | 1.97E+01 | 4.80E-01 | 25 | 320.70 | 487.30 | 6,463 | 0.0E+00 | 3.0E+01 | 1.87E+02 | | | 3.7E-04 | 3.0E+01 | | | | |
| 78875 | 1,2-Dichloropropane | 4.37E+01 | 7.82E-02 | 8.73E-06 | 2.80E+03 | 1.15E-01 | 2.79E-03 | 25 | 369.52 | 572.00 | 7,590 | **1.0E-05** | 4.0E-03 | 1.13E+02 | ? | | 3.7E-04 | 4.0E-03 | X | | | |
| 78933 | Methylethylketone (2-butanone) | 2.30E+00 | 8.08E-02 | 9.80E-06 | 2.23E+05 | 2.29E-03 | 5.58E-05 | 25 | 352.50 | 536.78 | 7,481 | 0.0E+00 | 5.0E+00 | 7.21E+01 | | | 3.7E-04 | 1.0E+00 | | | | |
| 79005 | 1,1,2-Trichloroethane | 5.01E+01 | 7.80E-02 | 8.80E-06 | 4.42E+03 | 3.73E-02 | 9.11E-04 | 25 | 386.15 | 602.00 | 8,322 | **1.6E-05** | 2.0E-04 | 1.33E+02 | | X | 3.7E-04 | 1.4E-02 | | X | | 1.4E-02 |
| 79016 | Trichloroethylene | 1.66E+02 | 7.90E-02 | 9.10E-06 | 1.47E+03 | 4.21E-01 | 1.03E-02 | 25 | 360.36 | 544.20 | 7,505 | **4.1E-06** | **2.0E-03** | 1.31E+02 | | | 3.7E-04 | 4.0E-02 | X | | | |
| 91203 | Naphthalene | 2.00E+03 | 5.90E-02 | 7.50E-06 | 3.10E+01 | 1.98E-02 | 4.82E-04 | 25 | 491.14 | 748.40 | 10,373 | **3.4E-05** | 3.0E-03 | 1.28E+02 | | | 3.7E-04 | 3.0E-03 | | | | |
| 95476 | o-Xylene | 3.63E+02 | 8.70E-02 | 1.00E-05 | 1.78E+02 | 2.12E-01 | 5.18E-03 | 25 | 417.60 | 630.30 | 8,661 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | | 3.7E-04 | 1.0E-01 | | | | |
| 95501 | 1,2-Dichlorobenzene | 6.17E+02 | 6.90E-02 | 7.90E-06 | 1.56E+02 | 7.77E-02 | 1.90E-03 | 25 | 453.57 | 705.00 | 9,700 | 0.0E+00 | 2.0E-01 | 1.47E+02 | | | 3.7E-04 | 2.0E-01 | | | | |
| 95636 | 1,2,4-Trimethylbenzene | 1.35E+03 | 6.06E-02 | 7.92E-06 | 5.70E+01 | 2.52E-01 | 6.14E-03 | 25 | 442.30 | 649.17 | 9,369 | 0.0E+00 | **7.0E-03** | 1.20E+02 | | | 3.7E-04 | 6.0E-03 | | | | |
| 96184 | 1,2,3-Trichloropropane | 2.20E+01 | 7.10E-02 | 7.90E-06 | 1.75E+03 | 1.67E-02 | 4.08E-04 | 25 | 430.00 | 652.00 | 9,171 | **8.6E-03** | **3.0E-04** | 1.47E+02 | X | | 3.7E-04 | 4.9E-03 | X | | | |
| 98828 | Cumene | 4.89E+02 | 6.50E-02 | 7.10E-06 | 6.13E+01 | 4.74E+01 | 1.16E+00 | 25 | 425.56 | 631.10 | 10,335 | 0.0E+00 | 4.0E-01 | 1.20E+02 | | | 3.7E-04 | 4.0E-01 | | | | |
| 100414 | Ethylbenzene | 3.63E+02 | 7.50E-02 | 7.80E-06 | 1.69E+02 | 3.22E-01 | 7.86E-03 | 25 | 409.34 | 617.20 | 8,501 | **2.5E-06** | 1.0E+00 | 1.06E+02 | | | 3.7E-04 | 1.0E+00 | | | | |
| 103651 | n-Propylbenzene | 5.62E+02 | 6.01E-02 | 7.83E-06 | 6.00E+01 | 4.37E-01 | 1.07E-02 | 25 | 432.20 | 630.00 | 9,123 | 0.0E+00 | 1.4E-01 | 1.20E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 104518 | n-Butylbenzene | 1.11E+03 | 5.70E-02 | 8.12E-06 | 2.00E+00 | 5.38E-01 | 1.31E-02 | 25 | 456.46 | 660.50 | 9,290 | 0.0E+00 | 1.4E-01 | 1.34E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 106423 | p-Xylene | 3.89E+02 | 7.69E-02 | 8.44E-06 | 1.85E+02 | 3.13E-01 | 7.64E-03 | 25 | 411.52 | 616.20 | 8,525 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | ? | 3.7E-04 | 1.0E-01 | | | | |
| 106467 | 1,4-Dichlorobenzene | 6.17E+02 | 6.90E-02 | 7.90E-06 | 7.90E+01 | 9.82E-02 | 2.39E-03 | 25 | 447.21 | 684.75 | 9,271 | **1.1E-05** | **8.0E-01** | 1.47E+02 | | | 3.7E-04 | 8.0E-01 | | | | |
| 107062 | 1,2-Dichloroethane | 1.74E+01 | 1.04E-01 | 9.90E-06 | 8.52E+03 | 4.00E-02 | 9.77E-04 | 25 | 356.65 | 561.00 | 7,643 | 2.6E-05 | 7.0E-03 | 9.90E+01 | | | 3.7E-04 | 0.0E+00 | | | **2.1E-05** | **4.0E-01** |
| 108203 | Diisopropyl ether | 2.28E+01 | 6.54E-02 | 7.76E-06 | 8.80E+03 | 1.05E-01 | 2.56E-03 | 25 | 341.50 | 500.00 | 6,960 | 0.0E+00 | 7.0E-01 | 1.02E+02 | | | | | | | | |
| 108383 | m-Xylene | 4.07E+02 | 7.00E-02 | 7.80E-06 | 1.61E+02 | 3.00E-01 | 7.32E-03 | 25 | 412.27 | 617.05 | 8,523 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | ? | 3.7E-04 | 1.0E-01 | | | | |
| 108883 | Toluene | 1.82E+02 | 8.70E-02 | 8.60E-06 | 5.26E+02 | 2.72E-01 | 6.62E-03 | 25 | 383.78 | 591.79 | 7,930 | 0.0E+00 | **3.0E-01** | 9.21E+01 | | | 3.7E-04 | 4.0E-01 | | | | |
| 108907 | Chlorobenzene | 2.19E+02 | 7.30E-02 | 8.70E-06 | 4.72E+02 | 1.51E-01 | 3.69E-03 | 25 | 404.87 | 632.40 | 8,410 | 0.0E+00 | 5.0E-02 | 1.13E+02 | | | 3.7E-04 | 6.0E-02 | | | | **1.0E+00** |
| 110827 | Cyclohexane | 9.63E+02 | 7.40E-02 | 8.50E-06 | 5.50E+01 | 7.84E+00 | 1.00E-01 | 25 | 353.90 | 572.20 | 7,474 | 0.0E+00 | 6.0E+00 | 8.42E+01 | | | | | | | | |
| 120821 | 1,2,4-Trichlorobenzene | 1.78E+03 | 3.00E-02 | 8.23E-06 | 4.88E+01 | 5.81E-02 | 1.42E-03 | 25 | 486.15 | 725.00 | 10,471 | **0.0E+00** | 2.0E-03 | 1.81E+02 | | | 3.7E-04 | 2.0E-01 | | | | **4.0E-03** |
| 127184 | Tetrachloroethylene | 1.55E+02 | 7.20E-02 | 8.20E-06 | 2.00E+02 | 7.53E-01 | 1.84E-02 | 25 | 394.40 | 620.20 | 8,288 | **5.9E-06** | **3.5E-02** | 1.66E+02 | | | 3.7E-04 | 0.0E+00 | | | | |
| 135988 | sec-Butylbenzene | 9.66E+02 | 5.70E-02 | 8.12E-06 | 3.94E+00 | 5.68E-01 | 1.39E-02 | 25 | 446.5 | 679 | 88730 | 0.0E+00 | 1.4E-01 | 1.34E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 156592 | cis-1,2-Dichloroethylene | 3.55E+01 | 7.36E-02 | 1.13E-05 | 3.50E+03 | 1.67E-01 | 4.07E-03 | 25 | 333.65 | 544 | 7192 | 0.0E+00 | 3.5E-02 | 9.69E+01 | | X | 3.7E-04 | 3.5E-02 | | X | | |
| 156605 | trans-1,2-Dichloroethylene | 5.25E+01 | 7.07E-02 | 1.19E-05 | 6.30E+03 | 3.84E-01 | 9.36E-03 | 25 | 320.85 | 516.5 | 6717 | 0.0E+00 | **6.0E-02** | 9.69E+01 | | X | 3.7E-04 | 7.0E-02 | | X | | |
| 541731 | 1,3-Dichlorobenzene | 1.98E+03 | 6.92E-02 | 7.86E-06 | 1.34E+02 | 1.27E-01 | 3.09E-03 | 25 | 446 | 684 | 9230 | 0.0E+00 | 1.1E-01 | 1.47E+02 | | X | 3.7E-04 | 1.1E-01 | | X | | |
| 630206 | 1,1,1,2-Tetrachloroethane | 1.16E+02 | 7.10E-02 | 7.90E-06 | 1.10E+03 | 9.90E-02 | 2.41E-03 | 25 | 403.5 | 624 | 9768 | 7.4E-06 | 1.1E-01 | 1.68E+02 | | X | 3.7E-04 | 1.1E-01 | | X | | |

Brown = 2009 updates
Blue = Evaluated as a carcinogen.
**Bold = CalEPA OEHHA Values**
Red = OEHHA URF < USEPA URF
Green = IRIS RfC < OEHHA REL
new data for VLOOKUP based on June 2013 VISL Chem Props tab obtained from *www.epa.gov/oswer/vaporintrusion/documents/VISL-Calculator.xlsm*
indicates replaced with the 2013 EPA Region 9 RSL value which is more stringent than 2011 DTSC-HERO value.

## General Notes to Tables

% denotes percent.

% v/v denotes percent by volume.

$\mu g/m^3$ denotes microgram(s) per cubic meter.

1,1-DFA denotes 1,1-Difluoroethane.

ASTM denotes American Society for Testing and Materials.

C/I denotes commercial/industrial.

Cal/EPA denotes California Environmental Protection Agency.

cm denotes centimeter.

$cm^3$ denotes cubic centimeters.

DTSC denotes California Department of Toxic Substances Control.

ELCR denotes excess lifetime cancer risk.

EPA denotes U.S. Environmental Protection Agency.

ft denotes feet.

ft bgs denotes feet below ground surface.

HHRA denotes Human Health Risk Assessment.

HI denotes hazard index.

HQ denotes hazard quotient.

ID denotes identification.

in denotes inches.

IR denotes installation restoration.

IUR denotes inhalation unit risk.

J denotes estimated value below the analysis reporting limit.

Max denotes maximum.

MDL denotes method detection limit.

Min denotes minimum.

n/a denotes not applicable.

na denotes not analyzed.

NA denotes none available.

ND denotes not detected.

No. denotes number.

PCE denotes tetrachloroethene.

ppmv denotes parts per million by volume.

RBSL denotes risk-based screening level.

$RfC_i$ denotes inhalation reference concentration.

RL denotes analysis reporting limit.

TCE denotes trichloroethene.

U denotes not detected at or above the analysis reporting limit.

VC denotes vinyl chloride.

VOCs denotes volatile organic compounds.

y/n denotes yes/no.

TBD denotes spreadsheet cell to be loaded with data

# Appendix D
# Area 3, Enhanced Johnson and Ettinger Model Spreadsheet Input and Output Sheets

(provided on electronic copy only)

Input Parameters to the J&E Algorithm for Groundwater-to-Indoor Air Vapor
Residential Exposure Scenario, Area 3
Dual Site Groundwater, Montrose and Del Amo Superfund Sites

| Input Parameters to J&E Model GW-ADV Version 3.0 | | Units | J&E Spreadsheet Defaults | Site-Specific Evaluation Groundwater Samples | Basis for Parameter |
|---|---|---|---|---|---|
| $L_{WT}$ | Depth below grade to water table | cm (feet) | - (-) | 1,253 (41) | Site-specific, based on evaluation of historical water levels in CH2M HILL database. |
| Vadose Zone Properties (Without Engineered Fill) | | | | | |
| $T_s$ | Average groundwater temperature | °C | 22 | 24 | 75°F, California average shallow groundwater temperature (p. 48, EPA, 2004); DTSC, 2011, page D-6 |
| $h_A$ | Thickness of soil stratum A | cm (feet) | TBD | 107 (3.5) | Boring log for well SWL0008 |
| $h_B$ | Thickness of soil stratum B | cm (feet) | TBD | 701 (23) | Boring log for well SWL0008 |
| $h_C$ | Thickness of soil stratum C | cm (feet) | TBD | 445 (14.61) | Boring log for well SWL0008 |
| - | Stratum A soil type | -- | TBD | Sand | Boring log for well SWL0008 |
| $\rho_B^A$ | Stratum A soil dry bulk density | $g/cm^3$ | TBD | 1.66 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^A$ | Stratum A soil total porosity | unitless | TBD | 0.375 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^A$ | Stratum A soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.054 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum B soil type | -- | TBD | Loam | Boring log for well SWL0008 |
| $\rho_B^B$ | Stratum B soil dry bulk density | $g/cm^3$ | TBD | 1.59 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^B$ | Stratum B soil total porosity | unitless | TBD | 0.399 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^B$ | Stratum B soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.148 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum C soil type | -- | TBD | Sandy Loam | SCS Soil Name equivalent to Silty Sand with 20-50% fines; Boring log for well SWL0008 |
| $\rho_B^C$ | Stratum C soil dry bulk density | $g/cm^3$ | TBD | 1.62 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^C$ | Stratum C soil total porosity | unitless | TBD | 0.387 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^C$ | Stratum C soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.103 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| Building Parameters | | | | | |
| $L_F$ | Depth below grade to bottom of enclosed space floor - slab on grade (building with no basement) | cm | 15 | 15 | default, EPA, 2004, page 47 |
| $L_{crack}$ | Enclosed space floor thickness | cm | 10 | 9 | DTSC, 2011, Table 3; EPA, 2004 uses 10 cm, but California value of 9 cm is more conservative |
| $\Delta P$ | Soil-building pressure differential | $g/cm\text{-}s^2$ | 40 | 40 | OEHHA, 2005, page B-13; DTSC accepts EPA default in absence of California-specific measurements |
| $L_B$ | Enclosed space floor length | cm | 1,000 | 1,000 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $W_B$ | Enclosed space floor width | cm | 1,000 | 1,000 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $H_B$ | Enclosed space height | cm | 244 | 244 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| w | Floor-wall seam crack width | cm | 0.1 | 0.1 | OEHHA, 2005, page B-13; EPA, 2004, page 55. |
| $\eta$ | Crack-to-total area ratio | unitless | model calculated | 0.005 | California default, DTSC, 2011, Table 3. |
| ER | Indoor air exchange rate | 1/hour | 0.25 | 0.5 | Original EPA default 0.5 adopted for California residential building (DTSC, 2011) and retained after EPA adopted value of 0.25/hour, EPA, 1997 |
| $Q_{soil}$ | Average vapor flow rate into building | L/min | 5 | 5 | OEHHA, 2005, page B-13; California accepts EPA default, EPA, 2004, except when site-specific permeability is used. |
| $\alpha$ | Infinite Source - Indoor Attenuation Coefficient | unitless | model calculated | model calculated | Product of Johnson-Ettinger algorithm on INTERCALCS page incorporating site-specific information, EPA, 2004. |
| Physical-Chemical & Toxicity Parameters | | | | | |
| | The values were derived from the 'Chemical Properties Look Up Table' spreadsheet of *HERD_Groundwater_Screening_Model.xls* (updated December 2, 2011), *<http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm>*. | | | | |
| Exposure Parameters - Residential Scenario | | | | | |
| $AT_c$ | Averaging time for carcinogens | years | 70 | 70 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| $AT_{NC}$ | Averaging time for noncarcinogens | years | 30 | 30 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ED | Exposure duration | years | 30 | 30 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| EF | Exposure frequency | days/year | 350 | 350 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ET | Exposure time | hours/day | 24 | 24 | U.S. EPA, 1991; DTSC, 2011, Appendix C |

General notes follow on next page.

References:


DTSC, 2011, *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance*, October.
OEHHA, 2005, *Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soi*, January.
U.S. EPA Office of Emergency and Remedial Response, 1991, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part B), Interim Fina*, EPA/540/R-92/003, December.
U.S. EPA Office of Research and Development, National Center for Environmental Assessment, 1997, Exposure Factors Handbook, EPA/600/P-95/002Fa, Augus
U.S. EPA Region IX, 1999, EPA Superfund Record of Decision for Dual Site Groundwater Operable Unit, Montrose Chemical and Del Amo Superfund Sites, EPA/ROD/R09-99/035, March
U.S. EPA Office of Solid Waste and Emergency Response, 2002, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, Decembe

DATA ENTRY SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

GW-ADV
Version 3.0; 02/03

Reset to

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Qualifier | Chemicals Evaluated (COPCs and Surrogates) | Surrogate? | Chemical Detected in Groundwater: COPC Detected | Chemical Detected in Groundwater: CAS No. |
|---|---|---|---|---|---|---|---|
| 1 | 107062 | 4.0 | | 1,2-Dichloroethane | NO | | |
| 2 | 71432 | 52 | | Benzene | NO | | |
| 3 | 100414 | 10 | | Ethylbenzene | NO | | |
| 4 | 98828 | 35 | | Cumene | NO | | |
| 5 | 91203 | 15 | | Naphthalene | NO | | |
| 6 | 108883 | 2.9 | | Toluene | NO | | |
| 7 | 79016 | 5.3 | | Trichloroethylene | NO | | |
| 8 | 108383 | 1.6 | | m-Xylene | YES | Xylenes, total | 1330207 |
| 9 | 156592 | 1.1 | | cis-1,2-Dichloroethylene | NO | | |
| 10 | 104518 | 13 | | n-Butylbenzene | NO | | |
| 11 | 103651 | 82 | | n-Propylbenzene | NO | | |
| 12 | 135988 | 18 | | sec-Butylbenzene | NO | | |
| 13 | 75650 | 68 | | tertiary-Butyl Alcohol | NO | | |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Totals must add up to value of $L_{WT}$ (cell G28) | | | | | | | |
| 24.0 | 15.0 | 1,253 | 107 | 701 | 445 | C | SL | S | | |
| Southern Cal. | slab-on-grade | 41.11 feet | 3.5 feet | 23 feet | 14.61 feet | | | | | |

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ ($cm^3/cm^3$) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ ($g/cm^3$) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ ($cm^3/cm^3$) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ ($g/cm^3$) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ ($cm^3/cm^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S | 1.66 | 0.375 | 0.054 | L | 1.59 | 0.399 | 0.148 | SL | 1.62 | 0.387 | 0.103 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, $\Delta P$ ($g/cm\text{-}s^2$) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 9.0 | 40.0 | 1000 | 1000 | 244 | 0.10 | 0.5 | 5 |
| 3.5 inches | 4 Pa | 33 feet | 33 feet | 8 feet | default | Residential | default |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Exposure Time, ET (hrs/day) | Target risk for carcinogens, TR (unitless) | Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 24 | 1.0E-06 | 1 |
| Residential Exposure Scenario | | | | | Used to calculate risk-based groundwater concentration. | |

END

CHEMICAL PROPERTIES SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER AREA 3

| Diffusivity in air, $D_a$ ($cm^2/s$) | Diffusivity in water, $D_w$ ($cm^2/s$) | Henry's law constant at reference temperature, H (atm-$m^3$/mol) | Henry's law constant reference temperature, $T_R$ ($^oC$) | Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol) | Normal boiling point, $T_B$ ($^oK$) | Critical temperature, $T_C$ ($^oK$) | Organic carbon partition coefficient, $K_{oc}$ ($cm^3/g$) | Pure component water solubility, S (mg/L) | Unit risk factor, URF ($\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.04E-01 | 9.90E-06 | 9.77E-04 | 25 | 7,643 | 356.65 | 561.00 | 1.74E+01 | 8.52E+03 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 1 |
| 8.80E-02 | 9.80E-06 | 5.54E-03 | 25 | 7,342 | 353.24 | 562.16 | 5.89E+01 | 1.79E+03 | 2.9E-05 | 3.0E-02 | Benzene | 2 |
| 7.50E-02 | 7.80E-06 | 7.86E-03 | 25 | 8,501 | 409.34 | 617.20 | 3.63E+02 | 1.69E+02 | 2.5E-06 | 1.0E+00 | Ethylbenzene | 3 |
| 6.50E-02 | 7.10E-06 | 1.16E+00 | 25 | 10,335 | 425.56 | 631.10 | 4.89E+02 | 6.13E+01 | 0.0E+00 | 4.0E-01 | Cumene | 4 |
| 5.90E-02 | 7.50E-06 | 4.82E-04 | 25 | 10,373 | 491.14 | 748.40 | 2.00E+03 | 3.10E+01 | 3.4E-05 | 3.0E-03 | Naphthalene | 5 |
| 8.70E-02 | 8.60E-06 | 6.62E-03 | 25 | 7,930 | 383.78 | 591.79 | 1.82E+02 | 5.26E+02 | 0.0E+00 | 3.0E-01 | Toluene | 6 |
| 7.90E-02 | 9.10E-06 | 1.03E-02 | 25 | 7,505 | 360.36 | 544.20 | 1.66E+02 | 1.47E+03 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 7 |
| 7.00E-02 | 7.80E-06 | 7.32E-03 | 25 | 8,523 | 412.27 | 617.05 | 4.07E+02 | 1.61E+02 | 0.0E+00 | 1.0E-01 | m-Xylene | 8 |
| 7.36E-02 | 1.13E-05 | 4.07E-03 | 25 | 7,192 | 333.65 | 544.00 | 3.55E+01 | 3.50E+03 | 0.0E+00 | 3.5E-02 | cis-1,2-Dichloroethylene | 9 |
| 5.70E-02 | 8.12E-06 | 1.31E-02 | 25 | 9,290 | 456.46 | 660.50 | 1.11E+03 | 2.00E+00 | 0.0E+00 | 1.4E-01 | n-Butylbenzene | 10 |
| 6.01E-02 | 7.83E-06 | 1.07E-02 | 25 | 9,123 | 432.20 | 630.00 | 5.62E+02 | 6.00E+01 | 0.0E+00 | 1.4E-01 | n-Propylbenzene | 11 |
| 5.70E-02 | 8.12E-06 | 1.39E-02 | 25 | 88,730 | 446.50 | 679.00 | 9.66E+02 | 3.94E+00 | 0.0E+00 | 1.4E-01 | sec-Butylbenzene | 12 |
| 9.85E-02 | 1.14E-05 | 9.02E-06 | 25 | 9 | 355.55 | 508.00 | 2.11E+00 | 1.00E+06 | 0.0E+00 | 6.9E-02 | tertiary-Butyl Alcoho | 13 |

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

**END**

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) | **Area 3: Residential Exposure Scenario** / **Preparation Date: 1/21/2014** / **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | 1,2-Dichloroethane | 1 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Benzene | 2 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Ethylbenzene | 3 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Cumene | 4 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Naphthalene | 5 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Toluene | 6 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Trichloroethylene | 7 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | m-Xylene | 8 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | cis-1,2-Dichloroethylene | 9 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | n-Butylbenzene | 10 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | n-Propylbenzene | 11 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | sec-Butylbenzene | 12 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | tertiary-Butyl Alcohol | 13 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-$m^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) | **Area 3: Residential Exposure Scenario** / **Preparation Date: 1/21/2014** / **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,368 | 9.31E-04 | 3.82E-02 | 1.80E-04 | 1.68E-02 | 6.55E-03 | 1.05E-02 | 1.26E-04 | 3.52E-03 | 1238.0328 | 1,2-Dichloroethane | 1 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,977 | 5.29E-03 | 2.17E-01 | 1.80E-04 | 1.42E-02 | 5.54E-03 | 8.88E-03 | 8.02E-05 | 2.52E-03 | 1238.0328 | Benzene | 2 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,994 | 7.43E-03 | 3.05E-01 | 1.80E-04 | 1.21E-02 | 4.72E-03 | 7.57E-03 | 6.64E-05 | 2.11E-03 | 1238.0328 | Ethylbenzene | 3 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 12,447 | 1.08E+00 | 4.42E+01 | 1.80E-04 | 1.05E-02 | 4.09E-03 | 6.56E-03 | 5.42E-05 | 1.76E-03 | 1238.0328 | Cumene | 4 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 12,768 | 4.48E-04 | 1.84E-02 | 1.80E-04 | 9.54E-03 | 3.72E-03 | 5.96E-03 | 1.10E-04 | 2.50E-03 | 1238.0328 | Naphthalene | 5 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,001 | 6.29E-03 | 2.58E-01 | 1.80E-04 | 1.41E-02 | 5.48E-03 | 8.78E-03 | 7.76E-05 | 2.45E-03 | 1238.0328 | Toluene | 6 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,382 | 9.80E-03 | 4.02E-01 | 1.80E-04 | 1.28E-02 | 4.97E-03 | 7.98E-03 | 6.93E-05 | 2.20E-03 | 1238.0328 | Trichloroethylene | 7 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 10,090 | 6.91E-03 | 2.84E-01 | 1.80E-04 | 1.13E-02 | 4.41E-03 | 7.07E-03 | 6.25E-05 | 1.98E-03 | 1238.0328 | m-Xylene | 8 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,592 | 3.90E-03 | 1.60E-01 | 1.80E-04 | 1.19E-02 | 4.63E-03 | 7.43E-03 | 7.20E-05 | 2.20E-03 | 1238.0328 | cis-1,2-Dichloroethylene | 9 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,671 | 1.23E-02 | 5.04E-01 | 1.80E-04 | 9.21E-03 | 3.59E-03 | 5.75E-03 | 5.00E-05 | 1.59E-03 | 1238.0328 | n-Butylbenzene | 10 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,186 | 1.00E-02 | 4.10E-01 | 1.80E-04 | 9.72E-03 | 3.78E-03 | 6.07E-03 | 5.30E-05 | 1.68E-03 | 1238.0328 | n-Propylbenzene | 11 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 106,642 | 7.56E-03 | 3.10E-01 | 1.80E-04 | 9.21E-03 | 3.59E-03 | 5.75E-03 | 5.15E-05 | 1.62E-03 | 1238.0328 | sec-Butylbenzene | 12 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11 | 9.02E-06 | 3.70E-04 | 1.80E-04 | 1.59E-02 | 6.53E-03 | 1.01E-02 | 4.70E-03 | 7.73E-03 | 1238.0328 | tertiary-Butyl Alcohol | 13 |

Cal default

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, $exp(Pe^f)$ (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.53E+02 | 1.33 | 8.33E+01 | 1.68E-02 | 5.30E+03 | 4.52E+03 | 8.59E-05 | 1.31E-02 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 1 |
| 15 | 1.13E+04 | 1.33 | 8.33E+01 | 1.42E-02 | 5.30E+03 | 2.09E+04 | 6.20E-05 | 6.99E-01 | 2.9E-05 | 3.0E-02 | Benzene | 2 |
| 15 | 3.05E+03 | 1.33 | 8.33E+01 | 1.21E-02 | 5.30E+03 | 1.17E+05 | 5.21E-05 | 1.59E-01 | 2.5E-06 | 1.0E+00 | Ethylbenzene | 3 |
| 15 | 1.55E+06 | 1.33 | 8.33E+01 | 1.05E-02 | 5.30E+03 | 7.06E+05 | 4.36E-05 | 6.75E+01 | NA | 4.0E-01 | Cumene | 4 |
| 15 | 2.76E+02 | 1.33 | 8.33E+01 | 9.54E-03 | 5.30E+03 | 2.78E+06 | 6.16E-05 | 1.70E-02 | 3.4E-05 | 3.0E-03 | Naphthalene | 5 |
| 15 | 7.48E+02 | 1.33 | 8.33E+01 | 1.41E-02 | 5.30E+03 | 2.34E+04 | 6.05E-05 | 4.53E-02 | NA | 3.0E-01 | Toluene | 6 |
| 15 | 2.13E+03 | 1.33 | 8.33E+01 | 1.28E-02 | 5.30E+03 | 6.49E+04 | 5.45E-05 | 1.16E-01 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 7 |
| 15 | 4.54E+02 | 1.33 | 8.33E+01 | 1.13E-02 | 5.30E+03 | 2.70E+05 | 4.90E-05 | 2.22E-02 | NA | 1.0E-01 | m-Xylene | 8 |
| 15 | 1.76E+02 | 1.33 | 8.33E+01 | 1.19E-02 | 5.30E+03 | 1.46E+05 | 5.44E-05 | 9.56E-03 | NA | 3.5E-02 | cis-1,2-Dichloroethylene | 9 |
| 15 | 6.55E+03 | 1.33 | 8.33E+01 | 9.21E-03 | 5.30E+03 | 4.67E+06 | 3.95E-05 | 2.59E-01 | NA | 1.4E-01 | n-Butylbenzene | 10 |
| 15 | 3.36E+04 | 1.33 | 8.33E+01 | 9.72E-03 | 5.30E+03 | 2.12E+06 | 4.18E-05 | 1.41E+00 | NA | 1.4E-01 | n-Propylbenzene | 11 |
| 15 | 5.58E+03 | 1.33 | 8.33E+01 | 9.21E-03 | 5.30E+03 | 4.67E+06 | 4.03E-05 | 2.25E-01 | NA | 1.4E-01 | sec-Butylbenzene | 12 |
| 15 | 2.52E+01 | 1.33 | 8.33E+01 | 1.59E-02 | 5.30E+03 | 7.18E+03 | 1.81E-04 | 4.55E-03 | NA | 6.9E-02 | tertiary-Butyl Alcohol | 13 |

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

**END**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

**RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:**

**Area 3: Residential Exposure Scenario**

| | Indoor exposure groundwater conc., carcinogen (µg/L) | Indoor exposure groundwater conc., noncarcinogen (µg/L) | Risk-based indoor exposure groundwater conc., (µg/L) | Pure component water solubility, S (µg/L) | Final indoor exposure groundwater conc., (µg/L) |
|---|---|---|---|---|---|
| 1 | NA | NA | NA | 8.52E+06 | NA |
| 2 | NA | NA | NA | 1.79E+06 | NA |
| 3 | NA | NA | NA | 1.69E+05 | NA |
| 4 | NA | NA | NA | 6.13E+04 | NA |
| 5 | NA | NA | NA | 3.10E+04 | NA |
| 6 | NA | NA | NA | 5.26E+05 | NA |
| 7 | NA | NA | NA | 1.47E+06 | NA |
| 8 | NA | NA | NA | 1.61E+05 | NA |
| 9 | NA | NA | NA | 3.50E+06 | NA |
| 10 | NA | NA | NA | 2.00E+03 | NA |
| 11 | NA | NA | NA | 6.00E+04 | NA |
| 12 | NA | NA | NA | 3.94E+03 | NA |
| 13 | NA | NA | NA | 1.00E+09 | NA |

**Area 3: Residential Exposure Scenario**

**INCREMENTAL RISK CALCULATIONS:**

**Preparation Date: 1/21/2014**

| | Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Percent of Total Risk (%) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) | Percent of Total Health Hazard (%) |
|---|---|---|---|---|
| 1 | 1E-7 | 1.5% | 2E-3 | 0.7% |
| 2 | 8E-6 | 92% | 2E-2 | 9% |
| 3 | 2E-7 | 1.8% | 2E-4 | 0.06% |
| 4 | NA | 0% | 2E-1 | 62% |
| 5 | 2E-7 | 2.6% | 5E-3 | 2% |
| 6 | NA | 0% | 1E-4 | 0.06% |
| 7 | 2E-7 | 2.2% | 6E-2 | 21% |
| 8 | NA | 0% | 2E-4 | 0.08% |
| 9 | NA | 0% | 3E-4 | 0.1% |
| 10 | NA | 0% | 2E-3 | 0.7% |
| 11 | NA | 0% | 1E-2 | 4% |
| 12 | NA | 0% | 2E-3 | 0.6% |
| 13 | NA | 0% | 6E-5 | 0.02% |
| **Total** | **9E-6** | **100.0%** | **0.3** | **100.0%** |

**Preparation Date: 1/21/2014**

| | Risk-Based Screening Level (RBSL) Cancer µg/L TR = 1E-6 | Risk-Based Screening Level (RBSL) Non-cancer µg/L THQ = 1 |
|---|---|---|
| 1 | 29 | 2,225 |
| 2 | 6.2 | 2,326 |
| 3 | 61 | 65,731 |
| 4 | NA | 216 |
| 5 | 63 | 2,763 |
| 6 | NA | 20,041 |
| 7 | 27 | 95 |
| 8 | NA | 7,513 |
| 9 | NA | 4,199 |
| 10 | NA | 2,000 |
| 11 | NA | 8,514 |
| 12 | NA | 3,940 |
| 13 | NA | 1,074,633 |

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
| 12 | sec-Butylbenzene | 135988 |
| 13 | tertiary-Butyl Alcohol | 75650 |

**SCROLL TO "END"** **MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

**SOIL AND GROUNDWATER-BASED ERROR STATEMENTS (DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

**CHEMICAL-BASED ERROR STATEMENTS (DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
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| 13 | tertiary-Butyl Alcohol | 75650 |

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
| 12 | sec-Butylbenzene | 135988 |
| 13 | tertiary-Butyl Alcohol | 75650 |

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
| 12 | sec-Butylbenzene | 135988 |
| 13 | tertiary-Butyl Alcohol | 75650 |

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
| 12 | sec-Butylbenzene | 135988 |
| 13 | tertiary-Butyl Alcohol | 75650 |

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
| 12 | sec-Butylbenzene | 135988 |
| 13 | tertiary-Butyl Alcohol | 75650 |

**END**

**VLOOKUP TABLES**

| Soil Properties Lookup Table | | | | | | | | Bulk Density | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SCS Soil Type | $K_s$ (cm/h) | $a_1$ (1/cm) | N (unitless) | M (unitless) | n ($cm^3/cm^3$) | $q_r$ ($cm^3/cm^3$) | Mean Grain Diameter (cm) | ($g/cm^3$) | $q_w$ ($cm^3/cm^3$) | SCS Soil Name |
| C | 0.61 | 0.01496 | 1.253 | 0.2019 | 0.459 | 0.098 | 0.0092 | 1.43 | 0.215 | Clay |
| CL | 0.34 | 0.01581 | 1.416 | 0.2938 | 0.442 | 0.079 | 0.016 | 1.48 | 0.168 | Clay Loam |
| L | 0.50 | 0.01112 | 1.472 | 0.3207 | 0.399 | 0.061 | 0.020 | 1.59 | 0.148 | Loam |
| LS | 4.38 | 0.03475 | 1.746 | 0.4273 | 0.390 | 0.049 | 0.040 | 1.62 | 0.076 | Loamy Sand |
| S | 26.78 | 0.03524 | 3.177 | 0.6852 | 0.375 | 0.053 | 0.044 | 1.66 | 0.054 | Sand |
| SC | 0.47 | 0.03342 | 1.208 | 0.1722 | 0.385 | 0.117 | 0.025 | 1.63 | 0.197 | Sandy Clay |
| SCL | 0.55 | 0.02109 | 1.330 | 0.2481 | 0.384 | 0.063 | 0.029 | 1.63 | 0.146 | Sandy Clay Loam |
| SI | 1.82 | 0.00658 | 1.679 | 0.4044 | 0.489 | 0.050 | 0.0046 | 1.35 | 0.167 | Silt |
| SIC | 0.40 | 0.01622 | 1.321 | 0.2430 | 0.481 | 0.111 | 0.0039 | 1.38 | 0.216 | Silty Clay |
| SICL | 0.46 | 0.00839 | 1.521 | 0.3425 | 0.482 | 0.090 | 0.0056 | 1.37 | 0.198 | Silty Clay Loam |
| SIL | 0.76 | 0.00506 | 1.663 | 0.3987 | 0.439 | 0.065 | 0.011 | 1.49 | 0.180 | Silt Loam |
| SL | 1.60 | 0.02667 | 1.449 | 0.3099 | 0.387 | 0.039 | 0.030 | 1.62 | 0.103 | Sandy Loam |

| Chemical Properties Lookup Table | | | | | | | | | | | | CalEPA Toxicity Criteria in bold (last updated 12/2/11 DTSC/HERO) | | | | | Original EPA Values | | | | Original 2011 DTSC-HERO Values | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAS No. | Chemical | Organic carbon partition coefficient, $K_{oc}$ ($cm^3/g$) | Diffusivity in air, $D_a$ ($cm^2/s$) | Diffusivity in water, $D_w$ ($cm^2/s$) | Pure component water solubility, S (mg/L) | Henry's law constant H' (unitless) | Henry's law constant at reference temperature, H (atm-$m^3$/mol) | Henry's law constant reference temperature, $T_R$ (°C) | Normal boiling point, $T_B$ (°K) | Critical temperature, $T_C$ (°K) | Enthalpy of vaporization at the normal boiling point, $DH_{v,b}$ (cal/mol) | Unit risk factor, URF $(mg/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Molecular weight, MW (g/mol) | URF extrapolated (X) | RfC extrapolated (X) | Unit risk factor, URF $(mg/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | URF extrapolated (X) | RfC extrapolated (X) | Unit risk factor, URF $(mg/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
| 56235 | Carbon tetrachloride | 1.74E+02 | 7.80E-02 | 8.80E-06 | 7.93E+02 | 1.24E+00 | 3.03E-02 | 25 | 349.90 | 556.60 | 7,127 | 4.2E-05 | 4.0E-02 | 1.54E+02 | | | 1.5E-05 | 0.0E+00 | | | | |
| 67641 | Acetone | 5.75E-01 | 1.24E-01 | 1.14E-05 | 1.00E+06 | 1.59E-03 | 3.87E-05 | 25 | 329.20 | 508.10 | 6,955 | 0.0E+00 | 3.1E+01 | 5.81E+01 | | X | 3.7E-04 | 3.5E-01 | | X | | |
| 67663 | Chloroform | 3.98E+01 | 1.04E-01 | 1.00E-05 | 7.92E+03 | 1.50E-01 | 3.66E-03 | 25 | 334.32 | 536.40 | 6,988 | 2.3E-05 | 9.8E-02 | 1.19E+02 | | | 3.7E-04 | 0.0E+00 | | | 5.3E-06 | 3.0E-01 |
| 71432 | Benzene | 5.89E+01 | 8.80E-02 | 9.80E-06 | 1.79E+03 | 2.27E-01 | 5.54E-03 | 25 | 353.24 | 562.16 | 7,342 | 2.9E-05 | 3.0E-02 | 7.81E+01 | | | 3.7E-04 | 0.0E+00 | | | | |
| 75092 | Methylene chloride | 1.17E+01 | 1.01E-01 | 1.17E-05 | 1.30E+04 | 8.96E-02 | 2.18E-03 | 25 | 313.00 | 510.00 | 6,706 | 1.0E-06 | 4.0E-01 | 8.49E+01 | | | 3.7E-04 | 3.0E+00 | | | | |
| 75274 | Bromodichloromethane | 5.50E+01 | 2.98E-02 | 1.06E-05 | 6.74E+03 | 6.54E-02 | 1.60E-03 | 25 | 363.15 | 585.85 | 7,800 | 3.7E-05 | 7.0E-02 | 1.64E+02 | ? | X | 3.7E-04 | 7.0E-02 | X | X | | |
| 75343 | 1,1-Dichloroethane | 3.16E+01 | 7.42E-02 | 1.05E-05 | 5.06E+03 | 2.30E-01 | 5.61E-03 | 25 | 330.55 | 523.00 | 6,895 | 1.6E-06 | 7.0E-01 | 9.90E+01 | | X | 3.7E-04 | 5.0E-01 | | | | |
| 75354 | 1,1-Dichloroethylene | 5.89E+01 | 9.00E-02 | 1.04E-05 | 2.25E+03 | 1.07E+00 | 2.60E-02 | 25 | 304.75 | 576.05 | 6,247 | 0.0E+00 | 7.0E-02 | 9.69E+01 | | | 3.7E-04 | 2.0E-01 | | | | |
| 75650 | tertiary-Butyl Alcohol | 2.11E+00 | 9.85E-02 | 1.14E-05 | 1.00E+06 | 3.70E-04 | 9.02E-06 | 25 | 355.55 | 508.00 | 9.338 | 0.0E+00 | 6.9E-02 | 7.41E+01 | | | | | | | | |
| 76131 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 1.11E+04 | 7.80E-02 | 8.20E-06 | 1.70E+02 | 1.97E+01 | 4.80E-01 | 25 | 320.70 | 487.30 | 6,463 | 0.0E+00 | 3.0E+01 | 1.87E+02 | | | 3.7E-04 | 3.0E+01 | | | | |
| 78875 | 1,2-Dichloropropane | 4.37E+01 | 7.82E-02 | 8.73E-06 | 2.80E+03 | 1.15E-01 | 2.79E-03 | 25 | 369.52 | 572.00 | 7,590 | 1.0E-05 | 4.0E-03 | 1.13E+02 | ? | | 3.7E-04 | 4.0E-03 | X | | | |
| 78933 | Methylethylketone (2-butanone) | 2.30E+00 | 8.08E-02 | 9.80E-06 | 2.23E+05 | 2.29E-03 | 5.58E-05 | 25 | 352.50 | 536.78 | 7,481 | 0.0E+00 | 5.0E+00 | 7.21E+01 | | | 3.7E-04 | 1.0E+00 | | | | |
| 79005 | 1,1,2-Trichloroethane | 5.01E+01 | 7.80E-02 | 8.80E-06 | 4.42E+03 | 3.73E-02 | 9.11E-04 | 25 | 386.15 | 602.00 | 8,322 | 1.6E-05 | 2.0E-04 | 1.33E+02 | | X | 3.7E-04 | 1.4E-02 | | X | | 1.4E-02 |
| 79016 | Trichloroethylene | 1.66E+02 | 7.90E-02 | 9.10E-06 | 1.47E+03 | 4.21E-01 | 1.03E-02 | 25 | 360.36 | 544.20 | 7,505 | 4.1E-06 | 2.0E-03 | 1.31E+02 | | | 3.7E-04 | 4.0E-02 | X | | | |
| 91203 | Naphthalene | 2.00E+03 | 5.90E-02 | 7.50E-06 | 3.10E+01 | 1.98E-02 | 4.82E-04 | 25 | 491.14 | 748.40 | 10,373 | 3.4E-05 | 3.0E-03 | 1.28E+02 | | | 3.7E-04 | 3.0E-03 | | | | |
| 95476 | o-Xylene | 3.63E+02 | 8.70E-02 | 1.00E-05 | 1.78E+02 | 2.12E-01 | 5.18E-03 | 25 | 417.60 | 630.30 | 8,661 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | | 3.7E-04 | 1.0E-01 | | | | |
| 95501 | 1,2-Dichlorobenzene | 6.17E+02 | 6.90E-02 | 7.90E-06 | 1.56E+02 | 7.77E-02 | 1.90E-03 | 25 | 453.57 | 705.00 | 9,700 | 0.0E+00 | 2.0E-01 | 1.47E+02 | | | 3.7E-04 | 2.0E-01 | | | | |
| 95636 | 1,2,4-Trimethylbenzene | 1.35E+03 | 6.06E-02 | 7.92E-06 | 5.70E+01 | 2.52E-01 | 6.14E-03 | 25 | 442.30 | 649.17 | 9,369 | 0.0E+00 | 7.0E-03 | 1.20E+02 | | | 3.7E-04 | 6.0E-03 | | | | |
| 96184 | 1,2,3-Trichloropropane | 2.20E+01 | 7.10E-02 | 7.90E-06 | 1.75E+03 | 1.67E-02 | 4.08E-04 | 25 | 430.00 | 652.00 | 9,171 | 8.6E-03 | 3.0E-04 | 1.47E+02 | X | | 3.7E-04 | 4.9E-03 | X | | | |
| 98828 | Cumene | 4.89E+02 | 6.50E-02 | 7.10E-06 | 6.13E+01 | 4.74E+01 | 1.16E+00 | 25 | 425.56 | 631.10 | 10,335 | 0.0E+00 | 4.0E-01 | 1.20E+02 | | | 3.7E-04 | 4.0E-01 | | | | |
| 100414 | Ethylbenzene | 3.63E+02 | 7.50E-02 | 7.80E-06 | 1.69E+02 | 3.22E-01 | 7.86E-03 | 25 | 409.34 | 617.20 | 8,501 | 2.5E-06 | 1.0E+00 | 1.06E+02 | | | 3.7E-04 | 1.0E+00 | | | | |
| 103651 | n-Propylbenzene | 5.62E+02 | 6.01E-02 | 7.83E-06 | 6.00E+01 | 4.37E-01 | 1.07E-02 | 25 | 432.20 | 630.00 | 9,123 | 0.0E+00 | 1.4E-01 | 1.20E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 104518 | n-Butylbenzene | 1.11E+03 | 5.70E-02 | 8.12E-06 | 2.00E+00 | 5.38E-01 | 1.31E-02 | 25 | 456.46 | 660.50 | 9,290 | 0.0E+00 | 1.4E-01 | 1.34E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 106423 | p-Xylene | 3.89E+02 | 7.69E-02 | 8.44E-06 | 1.85E+02 | 3.13E-01 | 7.64E-03 | 25 | 411.52 | 616.20 | 8,525 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | ? | 3.7E-04 | 1.0E-01 | | | | |
| 106467 | 1,4-Dichlorobenzene | 6.17E+02 | 6.90E-02 | 7.90E-06 | 7.90E+01 | 9.82E-02 | 2.39E-03 | 25 | 447.21 | 684.75 | 9,271 | 1.1E-05 | 8.0E-01 | 1.47E+02 | | | 3.7E-04 | 8.0E-01 | | | | |
| 107062 | 1,2-Dichloroethane | 1.74E+01 | 1.04E-01 | 9.90E-06 | 8.52E+03 | 4.00E-02 | 9.77E-04 | 25 | 356.65 | 561.00 | 7,643 | 2.6E-05 | 7.0E-03 | 9.90E+01 | | | 3.7E-04 | 0.0E+00 | | | 2.1E-05 | 4.0E-01 |
| 108203 | Diisopropyl ether | 2.28E+01 | 6.54E-02 | 7.76E-06 | 8.80E+03 | 1.05E-01 | 2.56E-03 | 25 | 341.50 | 500.00 | 6,960 | 0.0E+00 | 7.0E-01 | 1.02E+02 | | | | | | | | |
| 108383 | m-Xylene | 4.07E+02 | 7.00E-02 | 7.80E-06 | 1.61E+02 | 3.00E-01 | 7.32E-03 | 25 | 412.27 | 617.05 | 8,523 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | ? | 3.7E-04 | 1.0E-01 | | | | |
| 108883 | Toluene | 1.82E+02 | 8.70E-02 | 8.60E-06 | 5.26E+02 | 2.72E-01 | 6.62E-03 | 25 | 383.78 | 591.79 | 7,930 | 0.0E+00 | 3.0E-01 | 9.21E+01 | | | 3.7E-04 | 4.0E-01 | | | | |
| 108907 | Chlorobenzene | 2.19E+02 | 7.30E-02 | 8.70E-06 | 4.72E+02 | 1.51E-01 | 3.69E-03 | 25 | 404.87 | 632.40 | 8,410 | 0.0E+00 | 5.0E-02 | 1.13E+02 | | | 3.7E-04 | 6.0E-02 | | | | 1.0E+00 |
| 110827 | Cyclohexane | 9.63E+02 | 7.40E-02 | 8.50E-06 | 5.50E+01 | 7.84E+00 | 1.00E-01 | 25 | 353.90 | 572.20 | 7,474 | 0.0E+00 | 6.0E+00 | 8.42E+01 | | | | | | | | |
| 120821 | 1,2,4-Trichlorobenzene | 1.78E+03 | 3.00E-02 | 8.23E-06 | 4.88E+01 | 5.81E-02 | 1.42E-03 | 25 | 486.15 | 725.00 | 10,471 | 0.0E+00 | 2.0E-03 | 1.81E+02 | | | 3.7E-04 | 2.0E-01 | | | | 4.0E-03 |
| 127184 | Tetrachloroethylene | 1.55E+02 | 7.20E-02 | 8.20E-06 | 2.00E+02 | 7.53E-01 | 1.84E-02 | 25 | 394.40 | 620.20 | 8,288 | 5.9E-06 | 3.5E-02 | 1.66E+02 | | | 3.7E-04 | 0.0E+00 | | | | |
| 135988 | sec-Butylbenzene | 9.66E+02 | 5.70E-02 | 8.12E-06 | 3.94E+00 | 5.68E-01 | 1.39E-02 | 25 | 446.5 | 679 | 88730 | 0.0E+00 | 1.4E-01 | 1.34E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 156592 | cis-1,2-Dichloroethylene | 3.55E+01 | 7.36E-02 | 1.13E-05 | 3.50E+03 | 1.67E-01 | 4.07E-03 | 25 | 333.65 | 544 | 7192 | 0.0E+00 | 3.5E-02 | 9.69E+01 | | X | 3.7E-04 | 3.5E-02 | | X | | |
| 156605 | trans-1,2-Dichloroethylene | 5.25E+01 | 7.07E-02 | 1.19E-05 | 6.30E+03 | 3.84E-01 | 9.36E-03 | 25 | 320.85 | 516.5 | 6717 | 0.0E+00 | 6.0E-02 | 9.69E+01 | | X | 3.7E-04 | 7.0E-02 | | X | | |
| 541731 | 1,3-Dichlorobenzene | 1.98E+03 | 6.92E-02 | 7.86E-06 | 1.34E+02 | 1.27E-01 | 3.09E-03 | 25 | 446 | 684 | 9230 | 0.0E+00 | 1.1E-01 | 1.47E+02 | | X | 3.7E-04 | 1.1E-01 | | X | | |
| 630206 | 1,1,1,2-Tetrachloroethane | 1.16E+02 | 7.10E-02 | 7.90E-06 | 1.10E+03 | 9.90E-02 | 2.41E-03 | 25 | 403.5 | 624 | 9768 | 7.4E-06 | 1.1E-01 | 1.68E+02 | | X | 3.7E-04 | 1.1E-01 | | X | | |

Brown = 2009 updates
Blue = Evaluated as a carcinogen.
Bold = CalEPA OEHHA Values
Red = OEHHA URF < USEPA URF
Green = IRIS RfC < OEHHA REL
new data for VLOOKUP based on June 2013 VISL Chem Props tab obtained from *www.epa.gov/oswer/vaporintrusion/documents/VISL-Calculator.xlsm*
indicates replaced with the 2013 EPA Region 9 RSL value which is more stringent than 2011 DTSC-HERO value.

## General Notes to Tables

% denotes percent.

% v/v denotes percent by volume.

$\mu g/m^3$ denotes microgram(s) per cubic meter.

1,1-DFA denotes 1,1-Difluoroethane.

ASTM denotes American Society for Testing and Materials.

C/I denotes commercial/industrial.

Cal/EPA denotes California Environmental Protection Agency.

cm denotes centimeter.

$cm^3$ denotes cubic centimeters.

DTSC denotes California Department of Toxic Substances Control.

ELCR denotes excess lifetime cancer risk.

EPA denotes U.S. Environmental Protection Agency.

ft denotes feet.

ft bgs denotes feet below ground surface.

HHRA denotes Human Health Risk Assessment.

HI denotes hazard index.

HQ denotes hazard quotient.

ID denotes identification.

in denotes inches.

IR denotes installation restoration.

IUR denotes inhalation unit risk.

J denotes estimated value below the analysis reporting limit.

Max denotes maximum.

MDL denotes method detection limit.

Min denotes minimum.

n/a denotes not applicable.

na denotes not analyzed.

NA denotes none available.

ND denotes not detected.

No. denotes number.

PCE denotes tetrachloroethene.

ppmv denotes parts per million by volume.

RBSL denotes risk-based screening level.

$RfC_i$ denotes inhalation reference concentration.

RL denotes analysis reporting limit.

TCE denotes trichloroethene.

U denotes not detected at or above the analysis reporting limit.

VC denotes vinyl chloride.

VOCs denotes volatile organic compounds.

y/n denotes yes/no.

TBD denotes spreadsheet cell to be loaded with data

# Appendix E
# Area 3, BioVapor and Enhanced Johnson and Ettinger Model Spreadsheet Input and Output Sheets for Petroleum Hydrocarbons in Groundwater

(provided on electronic copy only)

Site Name: Area 3, Well SWL0008
Address: OU-3, Montrose and Del Amo Dual Groundwater Site

# BioVapor Input

Date: 1/22/2014
Completed By: Larry R. Froebe
Job ID: EP-S9-13-02

Model Input Screens

1 Environmental Factors | 2 Chemicals | 3 Chemical Concentrations | Chemical Database

## 1. Oxygen Surface Boundary Condition

?

Slab or Basement Foundation (e.g., Specify Airflow)

## 2. Indoor Target Criteria

?

- (●) Do not perform backward Calculation
- ( ) Based on Indoor Risk / Hazard Target
- ( ) Specified Indoor Air Concentration Target

Note: Target indoor air concentrations can be edited on the "Chemical Database" screen

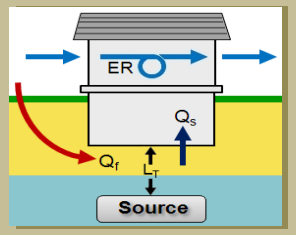
## 3. Exposure and Risk Factors

?

| | | | |
|---|---|---|---|
| Target Hazard Quotient For Individual Chemicals | THQ | 1.00 | (-) |
| Target Excess Individual Lifetime Cancer Risk | TR | 1.00E-06 | (-) |
| Carcinogen Averaging Time | $AT_C$ | 70.00 | yrs |
| Non-carcinogenic Averaging Time | $AT_{NC}$ | 30.00 | yrs |
| Body Weight - Adult | BW | 70.00 | kg |
| Exposure Duration | ED | 30.00 | yrs |
| Exposure Frequency | EF | 350.00 | days/yr |
| Indoor Inhalation Rate Exposure Adjustment | CF | 1.00 | (-) |

## Legend

| | |
|---|---|
| 80.00 | Calculated Value |
| 80.00 | User Input Value |
| 80.00 | Value Outside Normal Range |




## 4. Building Parameters

?

| | | | |
|---|---|---|---|
| Indoor Mixing Height | $L_{mix}$ | 244.00 | cm |
| Air Exchange Rate | ER | 12.00 | 1/day |
| Foundation Thickness | $L_{crack}$ | 15.00 | cm |
| Foundation Area | $A_b$ | 1000000.00 | $cm^2$ |
| Foundation Crack Fraction | $\eta$ | 5.00E-03 | $cm^2$-cracks/$cm^2$-total |
| Total Porosity (Soil-filled Cracks) | $\theta_{T\text{-}crack}$ | 1.00 | $cm^3$-void/$cm^3$-soil |
| Water Filled Porosity (Soil-filled Cracks) | $\theta_{w\text{-}crack}$ | 0.00 | $cm^3$-void/$cm^3$-soil |
| Airflow Through Basement Foundation | $Q_s$ | 83.00 | $cm^3$-air/sec |
| Building Envelope Resistance | $L_{mix}$ * ER | 0.03 | cm/sec |

## 5. Vadose Zone Parameters

?

| | | | |
|---|---|---|---|
| Soil Porosity | $\theta_{T\text{-}soil}$ | 0.38 | $cm^3$-void/$cm^3$-soil |
| Soil Water Content | $\theta_{w\text{-}soil}$ | 0.05 | $cm^3$-water/$cm^3$-soil |
| Soil Organic Carbon Fraction | $f_{oc}$ | 5.00E-03 | $cm^3$-void/$cm^3$-soil |
| Soil Density - Bulk | $\rho s$ | 1.70 | g-soil/$cm^3$-soil |
| Airflow Under Foundation | $Q_f$ | 83.00 | $cm^3$-air/sec |
| Depth of Aerobic Zone Under Foundation | $L_A$ | - | cm |
| $O_2$ Concentration Under Foundation | $Co_2$-e | - | % |
| Annual Median Soil Temperature | T | 24.00 | °C |
| Baseline Soil Oxygen Respiration Rate (Calculated from Foc) | $\Lambda_{base}$ | 9.780E-08 | mg-$O_2$ / g-soil - sec |
| Depth to Source (from bottom of foundation) | LT | 1238.00 | cm |
| Minimum $O_2$ Conc. For Aerobic Biodegradation | | 4.00 | % |

## 6. Commands and Options

?

Default Values

- (●) Residential
- ( ) Commercial / Industrial

Paste

Home | Print | Reset | Next

Site Name: Area 3, Well SWL0008
Address: OU-3, Montrose and Del Amo Dual Groundwater Site

# BioVapor Inputs

Date: 1/22/2014
Completed By: Larry R. Froebe
Job ID: EP-S9-13-02

Model Input Screens

1 Environmental Factors | 2 Chemicals | 3 Chemical Concentrations

Chemical Database

## 1. Source Type

- ○ Soil Gas
- ◉ Groundwater

## 2. Chemical Selection

**Potential Risk Drivers**

naphthalene
toluene
trimethylbenzene, 1,2,4-
trimethylbenzene, 1,3,5-
xylenes (mixed isomers)

add

**Other Hydrocarbons**

methane
n-butane
isopentane
n-pentane

add

**Hydrocarbon Surrogates**

Other hydrocarbons (aliphatic)
Other hydrocarbons (aromatic)
Other hydrocarbons (labile)
TPH-GRO (C6-C10)

add

**Selected Chemicals**

benzene
ethylbenzene
naphthalene
toluene
xylenes (mixed isomers)
Other hydrocarbons (aromatic)

Remove | Reset List

## Note:

User must account for all hydrocarbons present in source. Use "other aromatic hydrocarbons" and "other aliphatic hydrocarbons" to account for unidentified hydrocarbons.

## 3. Commands and Options

?

Home | Print
Previous | Next | Edit Chemicals

Site Name: Area 3, Well SWL0008
Address: OU-3, Montrose and Del Amo Dual Groundwater Site

# BioVapor Inputs

Date: 1/22/2014
Completed By: Larry R. Froebe
Job ID: EP-S9-13-02

Model Input Screens

1 Environmental Factors | 2 Chemicals | 3 Chemical Concentrations | Chemical Database

## 2. Commands and Options

?

Home | Print | Previous | Next :: Results

## 1. Ground Water Source Chemical Concentrations

| Chemical | ug/L |
|---|---|
| benzene | 5.20E+01 |
| ethylbenzene | 1.00E+01 |
| naphthalene | 1.50E+01 |
| toluene | 2.90E+00 |
| xylenes (mixed isomers) | 1.60E+00 |
| Other hydrocarbons (aromatic) | 1.48E+02 |

2.30E+02 Total Entered Hydrocarbon Concentration (ug/L)

**Note:** The total hydrocarbon concentration should equal the total concentration of all hydrocarbons in the source area

## 3. Attenuation Factor

1 Groundwater to Deep Soil Gas Attenuation Factor

Site Name: Area 3, Well SWL0008
Address: OU-3, Montrose and Del Amo Dual Groundwater Site

# BioVapor Results

Date: 1/22/2014
Completed By: Larry R. Froebe
Job ID: EP-S9-13-02

Model Output Screens

VI Risk | Subsurface Profile | Detailed Results

**Commands and Options** ?

Home | Print | Previous | Next | Unprotect

| Target Hazard Quotient | Target Risk Level |
|---|---|
| 1 | 1.00E-06 |

**Forward Risk Calculation**

| Chemical Name | Groundwater Source Concentration | Soil Gas Source Concentration | Soil Gas to Indoor Air Attenuation Factor | Target Indoor Air Concentration | Predicted Indoor Air Concentration | Hazard Quotient | Risk Level |
|---|---|---|---|---|---|---|---|
| | ug/L | ug/m$^3$ | (-) | ug/m$^3$-air | ug/m$^3$-air | (-) | (-) |
| **benzene** | 5.20E+01 | 1.13E+04 | 6.85E-08 | 3.10E-01 | 7.76E-04 | 2.48E-05 | 1.82E-09 |
| **ethylbenzene** | 1.00E+01 | 3.10E+03 | 1.36E-07 | 9.70E-01 | 4.21E-04 | 4.04E-07 | - |
| **naphthalene** | 1.50E+01 | 2.80E+02 | 6.37E-15 | 7.00E-02 | 1.78E-12 | 5.70E-13 | - |
| **toluene** | 2.90E+00 | 7.63E+02 | 1.32E-07 | 5.20E+03 | 1.01E-04 | 2.42E-07 | - |
| **xylenes (mixed isomers)** | 1.60E+00 | 3.31E+02 | 2.22E-08 | 7.30E+02 | 7.33E-06 | 7.03E-08 | - |

**NOTE A:** "< 1E-100" means calculated attentuation factor is less than IE-100

**Backward Risk Calculation**

**Critical Chemical for Backward Risk Calculation:** Not Selected

| Chemical Name | Target Hazard Quotent | Target Cancer Risk | Target Indoor Air Concentration | Soil Gas Source Concentration | Effective Saturated Vapor Concentration | Groundwater Source Concentration | Effective Solubility |
|---|---|---|---|---|---|---|---|
| | (-) | (-) | ug/m$^3$-air | ug/m$^3$ | ug/m$^3$ | ug/L | ug/L |
| **benzene** | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected |
| **ethylbenzene** | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected |
| **naphthalene** | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected |
| **toluene** | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected |
| **xylenes (mixed isomers)** | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected | Not Selected |

**NOTE B:** Target indoor air concentrations can be edited on the "Chemical Database" screen

**NOTE C:** Red value indicates source concentration greater than saturation limit

**NOTE D:** Backward Risk Calculation not applicable when aerobic depth directly specified

**NOTE E:** Backward Calculation not completed due to Excel calculation error

Site Name: Area 3, Well SWL0008
Address: OU-3, Montrose and Del Amo Dual Groundwater Site

**BioVapor Results**

Date: 1/22/2014
Completed By: Larry R. Froebe
Job ID: EP-S9-13-02

Model Output Screens

VI Risk | Subsurface Profile | Detailed Results

Commands and Options

Home | Print | Previous | Next

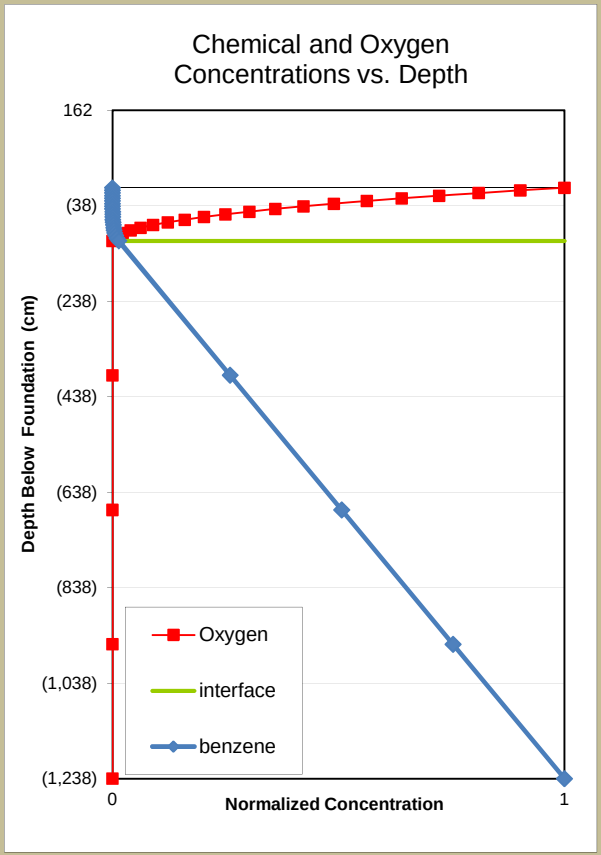
**Select Chemical to View**

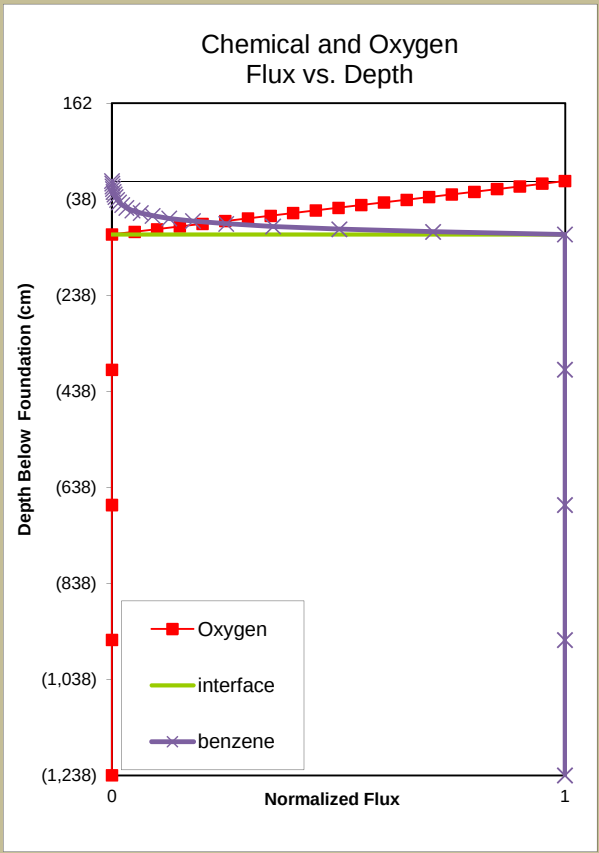
benzene

Update Charts

**Results Charts (Forward Calculation)**

Predicted concentration profile below building foundation



Site Name: Area 3, Well SWL0008
Address: OU-3, Montrose and Del Amo Dual Groundwater Site

# BioVapor Results

Date: 1/22/2014
Completed By: Larry R. Froebe
Job ID: EP-S9-13-02

Model Output Screens

VI Risk | Subsurface Profile | Detailed Results

Commands and Options

Home | Print | Previous | Unprotect | ?

## General Results - Forward Calculations

| Depth from building foundation to aerobic/anaerobic interface | Depth from aerobic/anaerobic interface to source | Total Depth |
|---|---|---|
| cm | cm | cm |
| 111.37 | 1126.63 | 1238.00 |

## Chemical Specific Results - Forward Calculations

| Chemical | Foundation Mass Transfer Resistance | Soil Resistance | Sub-slab to indoor air attenuation factor | Aerobic/anaerobic interface to sub-slab attenuation factor | Source to aerobic/anaerobic interface attenuation factor | Source to indoor air attenuation factor | Source to indoor air attenuation factor (if no biodegradation) |
|---|---|---|---|---|---|---|---|
| | cm/sec | cm/sec | (-) | (-) | (-) | (-) | (-) |
| **benzene** | 8.84E-05 | 1.15E-05 | 2.60E-03 | 1.86E-03 | 1.42E-02 | 6.85E-08 | 3.00E-04 |
| **ethylbenzene** | 8.63E-05 | 9.79E-06 | 2.54E-03 | 3.43E-03 | 1.56E-02 | 1.36E-07 | 2.59E-04 |
| **naphthalene** | 8.44E-05 | 7.70E-06 | 2.49E-03 | 5.71E-10 | 4.49E-03 | 6.37E-15 | 2.08E-04 |
| **toluene** | 8.82E-05 | 1.14E-05 | 2.60E-03 | 3.30E-03 | 1.54E-02 | 1.32E-07 | 2.97E-04 |
| **xylenes (mixed isomers)** | 8.58E-05 | 9.32E-06 | 2.53E-03 | 7.06E-04 | 1.24E-02 | 2.22E-08 | 2.48E-04 |
| **Other hydrocarbons (aromatic)** | 8.56E-05 | 9.14E-06 | 2.52E-03 | 2.16E-03 | 1.45E-02 | 7.90E-08 | 2.44E-04 |

Site Name: Area 3, Well SWL0008
Address: OU-3, Montrose and Del Amo Dual Groundwater Site

# BioVapor Results

Date: 1/22/2014
Completed By: Larry R. Froebe
Job ID: EP-S9-13-02

| Chemical | Concentration in indoor air | Concentration in sub-slab gas | Concentration at aerobic/anaerobic interface | Concentration at source | Concentration in indoor air (if no biodegradation) | Flux into enclosure | Flux from source |
|---|---|---|---|---|---|---|---|
| | ug/m$^3$-air | ug/m$^3$-air | ug/m$^3$-air | ug/m$^3$-air | ug/m$^3$-air | ug/sec | ug/sec |
| **benzene** | 7.76E-04 | 2.98E-01 | 1.60E+02 | 1.13E+04 | 3.40E+00 | 2.63E-05 | 1.4E-01 |
| **ethylbenzene** | 4.21E-04 | 1.66E-01 | 4.83E+01 | 3.10E+03 | 8.05E-01 | 1.43E-05 | 3.3E-02 |
| **naphthalene** | 1.78E-12 | 7.17E-10 | 1.26E+00 | 2.80E+02 | 5.83E-02 | 6.04E-14 | 2.4E-03 |
| **toluene** | 1.01E-04 | 3.88E-02 | 1.18E+01 | 7.63E+02 | 2.26E-01 | 3.42E-06 | 9.4E-03 |
| **xylenes (mixed isomers)** | 7.33E-06 | 2.90E-03 | 4.11E+00 | 3.31E+02 | 8.20E-02 | 2.48E-07 | 3.3E-03 |
| **Other hydrocarbons (aromatic)** | 3.37E-03 | 1.34E+00 | 6.19E+02 | 4.27E+04 | 1.04E+01 | 1.14E-04 | 4.2E-01 |
| **Totals** | 4.68E-03 | 1.84E+00 | 8.45E+02 | 5.85E+04 | 1.50E+01 | 1.58E-04 | 6.11E-01 |

| Chemical | Oxygen Demand in Vadose Zone | Minimum $O_2$ Concentration at top of aerobic zone (i.e., below building foundation) | Oxygen mass flow at the top of aerobic zone |
|---|---|---|---|
| | % of total demand | % | ug/sec |
| **benzene** | 0.00% | | |
| **ethylbenzene** | 0.00% | | |
| **naphthalene** | 0.00% | | |
| **toluene** | 0.00% | | |
| **xylenes (mixed isomers)** | 0.00% | | |
| **Other hydrocarbons (aromatic)** | 0.00% | | |
| **Baseline Soil Oxygen Demand** | 99.99% | | |
| **Totals** | 100.00% | 6.78% | 1.85E+04 |

Input Parameters to the J&E Algorithm for Groundwater-to-Indoor Air Vapor
Residential Exposure Scenario, Area 3
Dual Site Groundwater, Montrose and Del Amo Superfund Sites

| Input Parameters to J&E Model GW-ADV Version 3.0 | | Units | J&E Spreadsheet Defaults | Site-Specific Evaluation Groundwater Samples | Basis for Parameter |
|---|---|---|---|---|---|
| $L_{WT}$ | Depth below grade to water table | cm (feet) | - (-) | 1,253 (41) | Site-specific, based on evaluation of historical water levels in CH2M HILL database. |
| Vadose Zone Properties (Without Engineered Fill) | | | | | |
| $T_s$ | Average groundwater temperature | °C | 22 | 24 | 75°F, California average shallow groundwater temperature (p. 48, EPA, 2004); DTSC, 2011, page D-6 |
| $h_A$ | Thickness of soil stratum A | cm (feet) | TBD | 107 (3.5) | Boring log for well SWL0008 |
| $h_B$ | Thickness of soil stratum B | cm (feet) | TBD | 701 (23) | Boring log for well SWL0008 |
| $h_C$ | Thickness of soil stratum C | cm (feet) | TBD | 445 (14.61) | Boring log for well SWL0008 |
| - | Stratum A soil type | -- | TBD | Sand | Boring log for well SWL0008 |
| $\rho_B^A$ | Stratum A soil dry bulk density | $g/cm^3$ | TBD | 1.66 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^A$ | Stratum A soil total porosity | unitless | TBD | 0.375 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^A$ | Stratum A soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.054 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum B soil type | -- | TBD | Loam | Boring log for well SWL0008 |
| $\rho_B^B$ | Stratum B soil dry bulk density | $g/cm^3$ | TBD | 1.59 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^B$ | Stratum B soil total porosity | unitless | TBD | 0.399 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^B$ | Stratum B soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.148 | The default value for sand in the 'Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| - | Stratum C soil type | -- | TBD | Sandy Loam | SCS Soil Name equivalent to Silty Sand with 20-50% fines; Boring log for well SWL0008 |
| $\rho_B^C$ | Stratum C soil dry bulk density | $g/cm^3$ | TBD | 1.62 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $n^C$ | Stratum C soil total porosity | unitless | TBD | 0.387 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| $\Theta_W^C$ | Stratum C soil water-filled porosity | $cm^3/cm^3$ | TBD | 0.103 | Soil Properties Lookup Table' of the EPA J&E spreadsheet, VLOOKUP table, herein |
| Building Parameters | | | | | |
| $L_F$ | Depth below grade to bottom of enclosed space floor - slab on grade (building with no basement) | cm | 15 | 15 | default, EPA, 2004, page 47 |
| $L_{crack}$ | Enclosed space floor thickness | cm | 10 | 9 | DTSC, 2011, Table 3; EPA, 2004 uses 10 cm, but California value of 9 cm is more conservative |
| $\Delta P$ | Soil-building pressure differential | $g/cm\text{-}s^2$ | 40 | 40 | OEHHA, 2005, page B-13; DTSC accepts EPA default in absence of California-specific measurements |
| $L_B$ | Enclosed space floor length | cm | 1,000 | 1,000 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $W_B$ | Enclosed space floor width | cm | 1,000 | 1,000 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| $H_B$ | Enclosed space height | cm | 244 | 244 | OEHHA, 2005, page B-13; DTSC accepts EPA default, EPA, 2004 |
| w | Floor-wall seam crack width | cm | 0.1 | 0.1 | OEHHA, 2005, page B-13; EPA, 2004, page 55. |
| $\eta$ | Crack-to-total area ratio | unitless | model calculated | 0.005 | California default, DTSC, 2011, Table 3. |
| ER | Indoor air exchange rate | 1/hour | 0.25 | 0.5 | Original EPA default 0.5 adopted for California residential building (DTSC, 2011) and retained after EPA adopted value of 0.25/hour, EPA, 1997 |
| $Q_{soil}$ | Average vapor flow rate into building | L/min | 5 | 5 | OEHHA, 2005, page B-13; California accepts EPA default, EPA, 2004, except when site-specific permeability is used. |
| $\alpha$ | Infinite Source - Indoor Attenuation Coefficient | unitless | model calculated | model calculated | Product of Johnson-Ettinger algorithm on INTERCALCS page incorporating site-specific information, EPA, 2004. |
| Physical-Chemical & Toxicity Parameters | | | | | |
| | The values were derived from the 'Chemical Properties Look Up Table' spreadsheet of *HERD_Groundwater_Screening_Model.xls* (updated December 2, 2011), *<http://www.dtsc.ca.gov/AssessingRisk/JE_Models.cfm>*. | | | | |
| Exposure Parameters - Residential Scenario | | | | | |
| $AT_c$ | Averaging time for carcinogens | years | 70 | 70 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| $AT_{NC}$ | Averaging time for noncarcinogens | years | 30 | 30 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ED | Exposure duration | years | 30 | 30 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| EF | Exposure frequency | days/year | 350 | 350 | OEHHA, 2005, page B-14; EPA, 1997; EPA, 2002, Exhibit 1-2 |
| ET | Exposure time | hours/day | 24 | 24 | U.S. EPA, 1991; DTSC, 2011, Appendix C |

General notes follow on next page.

References:


DTSC, 2011, *Final Guidance for the Evaluation and Mitigation of Subsurface Vapor Intrusion to Indoor Air (Vapor Intrusion Guidance*, October.
OEHHA, 2005, *Human-Exposure-Based Screening Numbers Developed to Aid Estimation of Cleanup Costs for Contaminated Soi*, January.
U.S. EPA Office of Emergency and Remedial Response, 1991, *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part B), Interim Fina*, EPA/540/R-92/003, December.
U.S. EPA Office of Research and Development, National Center for Environmental Assessment, 1997, Exposure Factors Handbook, EPA/600/P-95/002Fa, Augus
U.S. EPA Region IX, 1999, EPA Superfund Record of Decision for Dual Site Groundwater Operable Unit, Montrose Chemical and Del Amo Superfund Sites, EPA/ROD/R09-99/035, March
U.S. EPA Office of Solid Waste and Emergency Response, 2002, Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites, OSWER 9355.4-24, Decembe

DATA ENTRY SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

GW-ADV
Version 3.0; 02/03

Reset to

CALCULATE RISK-BASED GROUNDWATER CONCENTRATION (enter "X" in "YES" box)

YES [ ]

**ASSUMED PETROLEUM HYDROCARBON BIODEGRADATION**

**OR**

CALCULATE INCREMENTAL RISKS FROM ACTUAL GROUNDWATER CONCENTRATION (enter "X" in "YES" box and initial groundwater conc. below)

YES [X]

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | ENTER Chemical CAS No. (numbers only, no dashes) | ENTER Initial groundwater conc., $C_W$ (µg/L) | Qualifier | Chemicals Evaluated (COPCs and Surrogates) | Surrogate? | Chemical Detected in Groundwater: COPC Detected | Chemical Detected in Groundwater: CAS No. |
|---|---|---|---|---|---|---|---|
| 1 | 107062 | 4.0 | | 1,2-Dichloroethane | NO | | |
| 2 | 71432 | 52 | | Benzene | NO | | |
| 3 | 100414 | 10 | | Ethylbenzene | NO | | |
| 4 | 98828 | 35 | | Cumene | NO | | |
| 5 | 91203 | 15 | | Naphthalene | NO | | |
| 6 | 108883 | 2.9 | | Toluene | NO | | |
| 7 | 79016 | 5.3 | | Trichloroethylene | NO | | |
| 8 | 108383 | 1.6 | | m-Xylene | YES | Xylenes, total | 1330207 |
| 9 | 156592 | 1.1 | | cis-1,2-Dichloroethylene | NO | | |
| 10 | 104518 | 13 | | n-Butylbenzene | NO | | |
| 11 | 103651 | 82 | | n-Propylbenzene | NO | | |
| 12 | 135988 | 18 | | sec-Butylbenzene | NO | | |
| 13 | 75650 | 68 | | tertiary-Butyl Alcohol | NO | | |

MORE ↓

| ENTER Average soil/ groundwater temperature, $T_S$ (°C) | ENTER Depth below grade to bottom of enclosed space floor, $L_F$ (cm) | ENTER Depth below grade to water table, $L_{WT}$ (cm) | ENTER Thickness of soil stratum A, $h_A$ (cm) | ENTER Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm) | ENTER Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm) | ENTER Soil stratum directly above water table, (Enter A, B, or C) | ENTER SCS soil type directly above water table | ENTER Soil stratum A SCS soil type (used to estimate soil vapor permeability) | OR | ENTER User-defined stratum A soil vapor permeability, $k_v$ ($cm^2$) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Totals must add up to value of $L_{WT}$ (cell G28) | | | | | | | |
| 24.0 | 15.0 | 1,253 | 107 | 701 | 445 | C | SL | S | | |
| Southern Cal. | slab-on-grade | 41.11 feet | 3.5 feet | 23 feet | 14.61 feet | | | | | |

MORE ↓

| ENTER Stratum A SCS soil type (Lookup Soil Parameters) | ENTER Stratum A soil dry bulk density, $\rho_b^A$ ($g/cm^3$) | ENTER Stratum A soil total porosity, $n^A$ (unitless) | ENTER Stratum A soil water-filled porosity, $\theta_w^A$ ($cm^3/cm^3$) | ENTER Stratum B SCS soil type (Lookup Soil Parameters) | ENTER Stratum B soil dry bulk density, $\rho_b^B$ ($g/cm^3$) | ENTER Stratum B soil total porosity, $n^B$ (unitless) | ENTER Stratum B soil water-filled porosity, $\theta_w^B$ ($cm^3/cm^3$) | ENTER Stratum C SCS soil type (Lookup Soil Parameters) | ENTER Stratum C soil dry bulk density, $\rho_b^C$ ($g/cm^3$) | ENTER Stratum C soil total porosity, $n^C$ (unitless) | ENTER Stratum C soil water-filled porosity, $\theta_w^C$ ($cm^3/cm^3$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| S | 1.66 | 0.375 | 0.054 | L | 1.59 | 0.399 | 0.148 | SL | 1.62 | 0.387 | 0.103 |

MORE ↓

| ENTER Enclosed space floor thickness, $L_{crack}$ (cm) | ENTER Soil-bldg. pressure differential, ΔP ($g/cm\text{-}s^2$) | ENTER Enclosed space floor length, $L_B$ (cm) | ENTER Enclosed space floor width, $W_B$ (cm) | ENTER Enclosed space height, $H_B$ (cm) | ENTER Floor-wall seam crack width, w (cm) | ENTER Indoor air exchange rate, ER (1/h) | ENTER Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m) |
|---|---|---|---|---|---|---|---|
| 9.0 | 40.0 | 1000 | 1000 | 244 | 0.10 | 0.5 | 5 |
| 3.5 inches | 4 Pa | 33 feet | 33 feet | 8 feet | default | Residential | default |

MORE ↓

| ENTER Averaging time for carcinogens, $AT_C$ (yrs) | ENTER Averaging time for noncarcinogens, $AT_{NC}$ (yrs) | ENTER Exposure duration, ED (yrs) | ENTER Exposure frequency, EF (days/yr) | ENTER Exposure Time, ET (hrs/day) | Target risk for carcinogens, TR (unitless) | Target hazard quotient for noncarcinogens, THQ (unitless) |
|---|---|---|---|---|---|---|
| 70 | 30 | 30 | 350 | 24 | 1.0E-06 | 1 |
| Residential Exposure Scenario | | | | | Used to calculate risk-based groundwater concentration. | |

END

CHEMICAL PROPERTIES SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER AREA 3

| Diffusivity in air, $D_a$ ($cm^2/s$) | Diffusivity in water, $D_w$ ($cm^2/s$) | Henry's law constant at reference temperature, H (atm-$m^3$/mol) | Henry's law constant reference temperature, $T_R$ ($^oC$) | Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol) | Normal boiling point, $T_B$ ($^oK$) | Critical temperature, $T_C$ ($^oK$) | Organic carbon partition coefficient, $K_{oc}$ ($cm^3/g$) | Pure component water solubility, S (mg/L) | Unit risk factor, URF ($\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.04E-01 | 9.90E-06 | 9.77E-04 | 25 | 7,643 | 356.65 | 561.00 | 1.74E+01 | 8.52E+03 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 1 |
| 8.80E-02 | 9.80E-06 | 5.54E-03 | 25 | 7,342 | 353.24 | 562.16 | 5.89E+01 | 1.79E+03 | 2.9E-05 | 3.0E-02 | Benzene | 2 |
| 7.50E-02 | 7.80E-06 | 7.86E-03 | 25 | 8,501 | 409.34 | 617.20 | 3.63E+02 | 1.69E+02 | 2.5E-06 | 1.0E+00 | Ethylbenzene | 3 |
| 6.50E-02 | 7.10E-06 | 1.16E+00 | 25 | 10,335 | 425.56 | 631.10 | 4.89E+02 | 6.13E+01 | 0.0E+00 | 4.0E-01 | Cumene | 4 |
| 5.90E-02 | 7.50E-06 | 4.82E-04 | 25 | 10,373 | 491.14 | 748.40 | 2.00E+03 | 3.10E+01 | 3.4E-05 | 3.0E-03 | Naphthalene | 5 |
| 8.70E-02 | 8.60E-06 | 6.62E-03 | 25 | 7,930 | 383.78 | 591.79 | 1.82E+02 | 5.26E+02 | 0.0E+00 | 3.0E-01 | Toluene | 6 |
| 7.90E-02 | 9.10E-06 | 1.03E-02 | 25 | 7,505 | 360.36 | 544.20 | 1.66E+02 | 1.47E+03 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 7 |
| 7.00E-02 | 7.80E-06 | 7.32E-03 | 25 | 8,523 | 412.27 | 617.05 | 4.07E+02 | 1.61E+02 | 0.0E+00 | 1.0E-01 | m-Xylene | 8 |
| 7.36E-02 | 1.13E-05 | 4.07E-03 | 25 | 7,192 | 333.65 | 544.00 | 3.55E+01 | 3.50E+03 | 0.0E+00 | 3.5E-02 | cis-1,2-Dichloroethylene | 9 |
| 5.70E-02 | 8.12E-06 | 1.31E-02 | 25 | 9,290 | 456.46 | 660.50 | 1.11E+03 | 2.00E+00 | 0.0E+00 | 1.4E-01 | n-Butylbenzene | 10 |
| 6.01E-02 | 7.83E-06 | 1.07E-02 | 25 | 9,123 | 432.20 | 630.00 | 5.62E+02 | 6.00E+01 | 0.0E+00 | 1.4E-01 | n-Propylbenzene | 11 |
| 5.70E-02 | 8.12E-06 | 1.39E-02 | 25 | 88,730 | 446.50 | 679.00 | 9.66E+02 | 3.94E+00 | 0.0E+00 | 1.4E-01 | sec-Butylbenzene | 12 |
| 9.85E-02 | 1.14E-05 | 9.02E-06 | 25 | 9 | 355.55 | 508.00 | 2.11E+00 | 1.00E+06 | 0.0E+00 | 6.9E-02 | tertiary-Butyl Alcoho | 13 |

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

**END**

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

| Exposure duration, $\tau$ (sec) | Source-building separation, $L_T$ (cm) | Stratum A soil air-filled porosity, $\theta_a^A$ ($cm^3/cm^3$) | Stratum B soil air-filled porosity, $\theta_a^B$ ($cm^3/cm^3$) | Stratum C soil air-filled porosity, $\theta_a^C$ ($cm^3/cm^3$) | Stratum A effective total fluid saturation, $S_{te}$ ($cm^3/cm^3$) | Stratum A soil intrinsic permeability, $k_i$ ($cm^2$) | Stratum A soil relative air permeability, $k_{rg}$ ($cm^2$) | Stratum A soil effective vapor permeability, $k_v$ ($cm^2$) | Thickness of capillary zone, $L_{cz}$ (cm) | Total porosity in capillary zone, $n_{cz}$ ($cm^3/cm^3$) | Air-filled porosity in capillary zone, $\theta_{a,cz}$ ($cm^3/cm^3$) | Water-filled porosity in capillary zone, $\theta_{w,cz}$ ($cm^3/cm^3$) | Floor-wall seam perimeter, $X_{crack}$ (cm) | **Area 3: Residential Exposure Scenario** / **Preparation Date: 1/21/2014** / **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | 1,2-Dichloroethane | 1 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Benzene | 2 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Ethylbenzene | 3 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Cumene | 4 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Naphthalene | 5 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Toluene | 6 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | Trichloroethylene | 7 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | m-Xylene | 8 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | cis-1,2-Dichloroethylene | 9 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | n-Butylbenzene | 10 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | n-Propylbenzene | 11 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | sec-Butylbenzene | 12 |
| 9.46E+08 | 1238.0328 | 0.321 | 0.251 | 0.284 | 0.003 | 1.02E-07 | 0.998 | 1.01E-07 | 25.00 | 0.387 | 0.067 | 0.320 | 4,000 | tertiary-Butyl Alcohol | 13 |

| Bldg. ventilation rate, $Q_{building}$ ($cm^3/s$) | Area of enclosed space below grade, $A_B$ ($cm^2$) | Crack-to-total area ratio, $\eta$ (unitless) | Crack depth below grade, $Z_{crack}$ (cm) | Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol) | Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-$m^3$/mol) | Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless) | Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s) | Stratum A effective diffusion coefficient, $D^{eff}_A$ ($cm^2/s$) | Stratum B effective diffusion coefficient, $D^{eff}_B$ ($cm^2/s$) | Stratum C effective diffusion coefficient, $D^{eff}_C$ ($cm^2/s$) | Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ($cm^2/s$) | Total overall effective diffusion coefficient, $D^{eff}_T$ ($cm^2/s$) | Diffusion path length, $L_d$ (cm) | **Area 3: Residential Exposure Scenario** / **Preparation Date: 1/21/2014** / **Chemicals Evaluated (including Surrogates)** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,368 | 9.31E-04 | 3.82E-02 | 1.80E-04 | 1.68E-02 | 6.55E-03 | 1.05E-02 | 1.26E-04 | 3.52E-03 | 1238.0328 | 1,2-Dichloroethane | 1 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,977 | 5.29E-03 | 2.17E-01 | 1.80E-04 | 1.42E-02 | 5.54E-03 | 8.88E-03 | 8.02E-05 | 2.52E-03 | 1238.0328 | Benzene | 2 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,994 | 7.43E-03 | 3.05E-01 | 1.80E-04 | 1.21E-02 | 4.72E-03 | 7.57E-03 | 6.64E-05 | 2.11E-03 | 1238.0328 | Ethylbenzene | 3 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 12,447 | 1.08E+00 | 4.42E+01 | 1.80E-04 | 1.05E-02 | 4.09E-03 | 6.56E-03 | 5.42E-05 | 1.76E-03 | 1238.0328 | Cumene | 4 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 12,768 | 4.48E-04 | 1.84E-02 | 1.80E-04 | 9.54E-03 | 3.72E-03 | 5.96E-03 | 1.10E-04 | 2.50E-03 | 1238.0328 | Naphthalene | 5 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 9,001 | 6.29E-03 | 2.58E-01 | 1.80E-04 | 1.41E-02 | 5.48E-03 | 8.78E-03 | 7.76E-05 | 2.45E-03 | 1238.0328 | Toluene | 6 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 8,382 | 9.80E-03 | 4.02E-01 | 1.80E-04 | 1.28E-02 | 4.97E-03 | 7.98E-03 | 6.93E-05 | 2.20E-03 | 1238.0328 | Trichloroethylene | 7 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 10,090 | 6.91E-03 | 2.84E-01 | 1.80E-04 | 1.13E-02 | 4.41E-03 | 7.07E-03 | 6.25E-05 | 1.98E-03 | 1238.0328 | m-Xylene | 8 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 7,592 | 3.90E-03 | 1.60E-01 | 1.80E-04 | 1.19E-02 | 4.63E-03 | 7.43E-03 | 7.20E-05 | 2.20E-03 | 1238.0328 | cis-1,2-Dichloroethylene | 9 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,671 | 1.23E-02 | 5.04E-01 | 1.80E-04 | 9.21E-03 | 3.59E-03 | 5.75E-03 | 5.00E-05 | 1.59E-03 | 1238.0328 | n-Butylbenzene | 10 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11,186 | 1.00E-02 | 4.10E-01 | 1.80E-04 | 9.72E-03 | 3.78E-03 | 6.07E-03 | 5.30E-05 | 1.68E-03 | 1238.0328 | n-Propylbenzene | 11 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 106,642 | 7.56E-03 | 3.10E-01 | 1.80E-04 | 9.21E-03 | 3.59E-03 | 5.75E-03 | 5.15E-05 | 1.62E-03 | 1238.0328 | sec-Butylbenzene | 12 |
| 3.39E+04 | 1.06E+06 | **5.00E-03** | 15 | 11 | 9.02E-06 | 3.70E-04 | 1.80E-04 | 1.59E-02 | 6.53E-03 | 1.01E-02 | 4.70E-03 | 7.73E-03 | 1238.0328 | tertiary-Butyl Alcohol | 13 |

Cal default

INTERMEDIATE CALCULATIONS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

| Convection path length, $L_p$ (cm) | Source vapor conc., $C_{source}$ ($\mu g/m^3$) | Crack radius, $r_{crack}$ (cm) | Average vapor flow rate into bldg., $Q_{soil}$ ($cm^3/s$) | Crack effective diffusion coefficient, $D^{crack}$ ($cm^2/s$) | Area of crack, $A_{crack}$ ($cm^2$) | Exponent of equivalent foundation Peclet number, exp($Pe^f$) (unitless) | Infinite source indoor attenuation coefficient, $\alpha$ (unitless) | Infinite source bldg. conc., $C_{building}$ ($\mu g/m^3$) | Unit risk factor, URF $(\mu g/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Chemicals Evaluated (including Surrogates) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 1.53E+02 | 1.33 | 8.33E+01 | 1.68E-02 | 5.30E+03 | 4.52E+03 | 8.59E-05 | 1.31E-02 | 2.6E-05 | 7.0E-03 | 1,2-Dichloroethane | 1 |
| 15 | 1.13E+04 | 1.33 | 8.33E+01 | 1.42E-02 | 5.30E+03 | 2.09E+04 | **6.85E-08** | 7.73E-04 | 2.9E-05 | 3.0E-02 | **Benzene** | 2 |
| 15 | 3.05E+03 | 1.33 | 8.33E+01 | 1.21E-02 | 5.30E+03 | 1.17E+05 | **1.36E-07** | 4.14E-04 | 2.5E-06 | 1.0E+00 | **Ethylbenzene** | 3 |
| 15 | 1.55E+06 | 1.33 | 8.33E+01 | 1.05E-02 | 5.30E+03 | 7.06E+05 | **2.22E-08** | 3.44E-02 | NA | 4.0E-01 | **Cumene** | 4 |
| 15 | 2.76E+02 | 1.33 | 8.33E+01 | 9.54E-03 | 5.30E+03 | 2.78E+06 | **6.37E-15** | 1.76E-12 | 3.4E-05 | 3.0E-03 | **Naphthalene** | 5 |
| 15 | 7.48E+02 | 1.33 | 8.33E+01 | 1.41E-02 | 5.30E+03 | 2.34E+04 | **1.32E-07** | 9.88E-05 | NA | 3.0E-01 | **Toluene** | 6 |
| 15 | 2.13E+03 | 1.33 | 8.33E+01 | 1.28E-02 | 5.30E+03 | 6.49E+04 | 5.45E-05 | 1.16E-01 | 4.1E-06 | 2.0E-03 | Trichloroethylene | 7 |
| 15 | 4.54E+02 | 1.33 | 8.33E+01 | 1.13E-02 | 5.30E+03 | 2.70E+05 | **2.22E-08** | 1.01E-05 | NA | 1.0E-01 | **m-Xylene** | 8 |
| 15 | 1.76E+02 | 1.33 | 8.33E+01 | 1.19E-02 | 5.30E+03 | 1.46E+05 | 5.44E-05 | 9.56E-03 | NA | 3.5E-02 | cis-1,2-Dichloroethylene | 9 |
| 15 | 6.55E+03 | 1.33 | 8.33E+01 | 9.21E-03 | 5.30E+03 | 4.67E+06 | **2.22E-08** | 1.45E-04 | NA | 1.4E-01 | **n-Butylbenzene** | 10 |
| 15 | 3.36E+04 | 1.33 | 8.33E+01 | 9.72E-03 | 5.30E+03 | 2.12E+06 | **2.22E-08** | 7.47E-04 | NA | 1.4E-01 | **n-Propylbenzene** | 11 |
| 15 | 5.58E+03 | 1.33 | 8.33E+01 | 9.21E-03 | 5.30E+03 | 4.67E+06 | **2.22E-08** | 1.24E-04 | NA | 1.4E-01 | **sec-Butylbenzene** | 12 |
| 15 | 2.52E+01 | 1.33 | 8.33E+01 | 1.59E-02 | 5.30E+03 | 7.18E+03 | 1.81E-04 | 4.55E-03 | NA | 6.9E-02 | tertiary-Butyl Alcohol | 13 |

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

**END**

**ASSUMED PETROLEUM HYDROCARBON BIODEGRADATION**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

**RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:**

**Area 3: Residential Exposure Scenario**

| | Indoor exposure groundwater conc., carcinogen (µg/L) | Indoor exposure groundwater conc., noncarcinogen (µg/L) | Risk-based indoor exposure groundwater conc., (µg/L) | Pure component water solubility, S (µg/L) | Final indoor exposure groundwater conc., (µg/L) |
|---|---|---|---|---|---|
| 1 | NA | NA | NA | 8.52E+06 | NA |
| 2 | NA | NA | NA | 1.79E+06 | NA |
| 3 | NA | NA | NA | 1.69E+05 | NA |
| 4 | NA | NA | NA | 6.13E+04 | NA |
| 5 | NA | NA | NA | 3.10E+04 | NA |
| 6 | NA | NA | NA | 5.26E+05 | NA |
| 7 | NA | NA | NA | 1.47E+06 | NA |
| 8 | NA | NA | NA | 1.61E+05 | NA |
| 9 | NA | NA | NA | 3.50E+06 | NA |
| 10 | NA | NA | NA | 2.00E+03 | NA |
| 11 | NA | NA | NA | 6.00E+04 | NA |
| 12 | NA | NA | NA | 3.94E+03 | NA |
| 13 | NA | NA | NA | 1.00E+09 | NA |

**Area 3: Residential Exposure Scenario**

**INCREMENTAL RISK CALCULATIONS:**

**Preparation Date: 1/21/2014**

| | Incremental risk from vapor intrusion to indoor air, carcinogen (unitless) | Percent of Total Risk (%) | Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless) | Percent of Total Health Hazard (%) |
|---|---|---|---|---|
| 1 | 1E-7 | 41% | 2E-3 | 3% |
| 2 | 9E-9 | 3% | 2E-5 | 0.04% |
| 3 | 4E-10 | 0.1% | 4E-7 | 0.0007% |
| 4 | NA | 0% | 8E-5 | 0.1% |
| 5 | 2E-17 | 0.00000001% | 6E-13 | 0.000000001% |
| 6 | NA | 0% | 3E-7 | 0.0005% |
| 7 | 2E-7 | 57% | 6E-2 | 96% |
| 8 | NA | 0% | 1E-7 | 0.0002% |
| 9 | NA | 0% | 3E-4 | 0.5% |
| 10 | NA | 0% | 1E-6 | 0.002% |
| 11 | NA | 0% | 5E-6 | 0.009% |
| 12 | NA | 0% | 8E-7 | 0.001% |
| 13 | NA | 0% | 6E-5 | 0.1% |
| Total | 3E-7 | 100.0% | 0.1 | 100.0% |

**Preparation Date: 1/21/2014**

**ASSUMED PETROLEUM HYDROCARBON BIODEGRADATION**

| | Risk-Based Screening Level (RBSL) Cancer µg/L TR = 1E-6 | Risk-Based Screening Level (RBSL) Non-cancer µg/L THQ = 1 | COPCs Evaluated | CAS No. |
|---|---|---|---|---|
| 1 | 29 | 2.23.E+03 | 1,2-Dichloroethane | 107062 |
| 2 | 5,645 | 1.79.E+06 | Benzene | 71432 |
| 3 | 23,499 | 1.69.E+05 | Ethylbenzene | 100414 |
| 4 | NA | 6.13.E+04 | Cumene | 98828 |
| 5 | 31,000 | 3.10.E+04 | Naphthalene | 91203 |
| 6 | NA | 5.26.E+05 | Toluene | 108883 |
| 7 | 27 | 9.53.E+01 | Trichloroethylene | 79016 |
| 8 | NA | 1.61.E+05 | m-Xylene | 108383 |
| 9 | NA | 4.20.E+03 | cis-1,2-Dichloroethylene | 156592 |
| 10 | NA | 2.00.E+03 | n-Butylbenzene | 104518 |
| 11 | NA | 6.00.E+04 | n-Propylbenzene | 103651 |
| 12 | NA | 3.94.E+03 | sec-Butylbenzene | 135988 |
| 13 | NA | 1.07.E+06 | tertiary-Butyl Alcohol | 75650 |

**SCROLL TO "END"** **MESSAGE AND ERROR SUMMARY BELOW: (DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

**SOIL AND GROUNDWATER-BASED ERROR STATEMENTS (DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

**CHEMICAL-BASED ERROR STATEMENTS (DO NOT USE RESULTS IF ERRORS ARE PRESENT)**

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
| 12 | sec-Butylbenzene | 135988 |
| 13 | tertiary-Butyl Alcohol | 75650 |

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
| 12 | sec-Butylbenzene | 135988 |
| 13 | tertiary-Butyl Alcohol | 75650 |

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
| 12 | sec-Butylbenzene | 135988 |
| 13 | tertiary-Butyl Alcohol | 75650 |

RESULTS SHEET
ENHANCED GW-ADV JOHNSON-ETTINGER MODEL VAPOR INTRUSION SPREADSHEET - RESIDENTIAL VERSION
MONTROSE AND DEL AMO SUPERFUND SITES OU-3 DUAL SITE GROUNDWATER, AREA 3

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
| 12 | sec-Butylbenzene | 135988 |
| 13 | tertiary-Butyl Alcohol | 75650 |

**Area 3: Residential Exposure Scenario**

**Preparation Date: 1/21/2014**

| | COPCs Evaluated | CAS No. |
|---|---|---|
| 1 | 1,2-Dichloroethane | 107062 |
| 2 | Benzene | 71432 |
| 3 | Ethylbenzene | 100414 |
| 4 | Cumene | 98828 |
| 5 | Naphthalene | 91203 |
| 6 | Toluene | 108883 |
| 7 | Trichloroethylene | 79016 |
| 8 | m-Xylene | 108383 |
| 9 | cis-1,2-Dichloroethylene | 156592 |
| 10 | n-Butylbenzene | 104518 |
| 11 | n-Propylbenzene | 103651 |
| 12 | sec-Butylbenzene | 135988 |
| 13 | tertiary-Butyl Alcohol | 75650 |

**END**

**VLOOKUP TABLES**

| Soil Properties Lookup Table | | | | | | | | Bulk Density | | |
|---|---|---|---|---|---|---|---|---|---|---|
| SCS Soil Type | $K_s$ (cm/h) | $a_1$ (1/cm) | N (unitless) | M (unitless) | n ($cm^3/cm^3$) | $q_r$ ($cm^3/cm^3$) | Mean Grain Diameter (cm) | ($g/cm^3$) | $q_w$ ($cm^3/cm^3$) | SCS Soil Name |
| C | 0.61 | 0.01496 | 1.253 | 0.2019 | 0.459 | 0.098 | 0.0092 | 1.43 | 0.215 | Clay |
| CL | 0.34 | 0.01581 | 1.416 | 0.2938 | 0.442 | 0.079 | 0.016 | 1.48 | 0.168 | Clay Loam |
| L | 0.50 | 0.01112 | 1.472 | 0.3207 | 0.399 | 0.061 | 0.020 | 1.59 | 0.148 | Loam |
| LS | 4.38 | 0.03475 | 1.746 | 0.4273 | 0.390 | 0.049 | 0.040 | 1.62 | 0.076 | Loamy Sand |
| S | 26.78 | 0.03524 | 3.177 | 0.6852 | 0.375 | 0.053 | 0.044 | 1.66 | 0.054 | Sand |
| SC | 0.47 | 0.03342 | 1.208 | 0.1722 | 0.385 | 0.117 | 0.025 | 1.63 | 0.197 | Sandy Clay |
| SCL | 0.55 | 0.02109 | 1.330 | 0.2481 | 0.384 | 0.063 | 0.029 | 1.63 | 0.146 | Sandy Clay Loam |
| SI | 1.82 | 0.00658 | 1.679 | 0.4044 | 0.489 | 0.050 | 0.0046 | 1.35 | 0.167 | Silt |
| SIC | 0.40 | 0.01622 | 1.321 | 0.2430 | 0.481 | 0.111 | 0.0039 | 1.38 | 0.216 | Silty Clay |
| SICL | 0.46 | 0.00839 | 1.521 | 0.3425 | 0.482 | 0.090 | 0.0056 | 1.37 | 0.198 | Silty Clay Loam |
| SIL | 0.76 | 0.00506 | 1.663 | 0.3987 | 0.439 | 0.065 | 0.011 | 1.49 | 0.180 | Silt Loam |
| SL | 1.60 | 0.02667 | 1.449 | 0.3099 | 0.387 | 0.039 | 0.030 | 1.62 | 0.103 | Sandy Loam |

| Chemical Properties Lookup Table | | | | | | | | | | | | CalEPA Toxicity Criteria in bold (last updated 12/2/11 DTSC/HERO) | | | | | Original EPA Values | | | | Original 2011 DTSC-HERO Values | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CAS No. | Chemical | Organic carbon partition coefficient, $K_{oc}$ ($cm^3/g$) | Diffusivity in air, $D_a$ ($cm^2/s$) | Diffusivity in water, $D_w$ ($cm^2/s$) | Pure component water solubility, S (mg/L) | Henry's law constant H' (unitless) | Henry's law constant at reference temperature, H (atm-$m^3$/mol) | Henry's law constant reference temperature, $T_R$ (°C) | Normal boiling point, $T_B$ (°K) | Critical temperature, $T_C$ (°K) | Enthalpy of vaporization at the normal boiling point, $DH_{v,b}$ (cal/mol) | Unit risk factor, URF $(mg/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | Molecular weight, MW (g/mol) | URF extrapolated (X) | RfC extrapolated (X) | Unit risk factor, URF $(mg/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) | URF extrapolated (X) | RfC extrapolated (X) | Unit risk factor, URF $(mg/m^3)^{-1}$ | Reference conc., RfC ($mg/m^3$) |
| 56235 | Carbon tetrachloride | 1.74E+02 | 7.80E-02 | 8.80E-06 | 7.93E+02 | 1.24E+00 | 3.03E-02 | 25 | 349.90 | 556.60 | 7,127 | 4.2E-05 | 4.0E-02 | 1.54E+02 | | | 1.5E-05 | 0.0E+00 | | | | |
| 67641 | Acetone | 5.75E-01 | 1.24E-01 | 1.14E-05 | 1.00E+06 | 1.59E-03 | 3.87E-05 | 25 | 329.20 | 508.10 | 6,955 | 0.0E+00 | 3.1E+01 | 5.81E+01 | | X | 3.7E-04 | 3.5E-01 | | X | | |
| 67663 | Chloroform | 3.98E+01 | 1.04E-01 | 1.00E-05 | 7.92E+03 | 1.50E-01 | 3.66E-03 | 25 | 334.32 | 536.40 | 6,988 | 2.3E-05 | 9.8E-02 | 1.19E+02 | | | 3.7E-04 | 0.0E+00 | | | 5.3E-06 | 3.0E-01 |
| 71432 | Benzene | 5.89E+01 | 8.80E-02 | 9.80E-06 | 1.79E+03 | 2.27E-01 | 5.54E-03 | 25 | 353.24 | 562.16 | 7,342 | 2.9E-05 | 3.0E-02 | 7.81E+01 | | | 3.7E-04 | 0.0E+00 | | | | |
| 75092 | Methylene chloride | 1.17E+01 | 1.01E-01 | 1.17E-05 | 1.30E+04 | 8.96E-02 | 2.18E-03 | 25 | 313.00 | 510.00 | 6,706 | 1.0E-06 | 4.0E-01 | 8.49E+01 | | | 3.7E-04 | 3.0E+00 | | | | |
| 75274 | Bromodichloromethane | 5.50E+01 | 2.98E-02 | 1.06E-05 | 6.74E+03 | 6.54E-02 | 1.60E-03 | 25 | 363.15 | 585.85 | 7,800 | 3.7E-05 | 7.0E-02 | 1.64E+02 | ? | X | 3.7E-04 | 7.0E-02 | X | X | | |
| 75343 | 1,1-Dichloroethane | 3.16E+01 | 7.42E-02 | 1.05E-05 | 5.06E+03 | 2.30E-01 | 5.61E-03 | 25 | 330.55 | 523.00 | 6,895 | 1.6E-06 | 7.0E-01 | 9.90E+01 | | X | 3.7E-04 | 5.0E-01 | | | | |
| 75354 | 1,1-Dichloroethylene | 5.89E+01 | 9.00E-02 | 1.04E-05 | 2.25E+03 | 1.07E+00 | 2.60E-02 | 25 | 304.75 | 576.05 | 6,247 | 0.0E+00 | 7.0E-02 | 9.69E+01 | | | 3.7E-04 | 2.0E-01 | | | | |
| 75650 | tertiary-Butyl Alcohol | 2.11E+00 | 9.85E-02 | 1.14E-05 | 1.00E+06 | 3.70E-04 | 9.02E-06 | 25 | 355.55 | 508.00 | 9.338 | 0.0E+00 | 6.9E-02 | 7.41E+01 | | | | | | | | |
| 76131 | 1,1,2-Trichloro-1,2,2-trifluoroethane | 1.11E+04 | 7.80E-02 | 8.20E-06 | 1.70E+02 | 1.97E+01 | 4.80E-01 | 25 | 320.70 | 487.30 | 6,463 | 0.0E+00 | 3.0E+01 | 1.87E+02 | | | 3.7E-04 | 3.0E+01 | | | | |
| 78875 | 1,2-Dichloropropane | 4.37E+01 | 7.82E-02 | 8.73E-06 | 2.80E+03 | 1.15E-01 | 2.79E-03 | 25 | 369.52 | 572.00 | 7,590 | 1.0E-05 | 4.0E-03 | 1.13E+02 | ? | | 3.7E-04 | 4.0E-03 | X | | | |
| 78933 | Methylethylketone (2-butanone) | 2.30E+00 | 8.08E-02 | 9.80E-06 | 2.23E+05 | 2.29E-03 | 5.58E-05 | 25 | 352.50 | 536.78 | 7,481 | 0.0E+00 | 5.0E+00 | 7.21E+01 | | | 3.7E-04 | 1.0E+00 | | | | |
| 79005 | 1,1,2-Trichloroethane | 5.01E+01 | 7.80E-02 | 8.80E-06 | 4.42E+03 | 3.73E-02 | 9.11E-04 | 25 | 386.15 | 602.00 | 8,322 | 1.6E-05 | 2.0E-04 | 1.33E+02 | | X | 3.7E-04 | 1.4E-02 | | X | | 1.4E-02 |
| 79016 | Trichloroethylene | 1.66E+02 | 7.90E-02 | 9.10E-06 | 1.47E+03 | 4.21E-01 | 1.03E-02 | 25 | 360.36 | 544.20 | 7,505 | 4.1E-06 | 2.0E-03 | 1.31E+02 | | | 3.7E-04 | 4.0E-02 | X | | | |
| 91203 | Naphthalene | 2.00E+03 | 5.90E-02 | 7.50E-06 | 3.10E+01 | 1.98E-02 | 4.82E-04 | 25 | 491.14 | 748.40 | 10,373 | 3.4E-05 | 3.0E-03 | 1.28E+02 | | | 3.7E-04 | 3.0E-03 | | | | |
| 95476 | o-Xylene | 3.63E+02 | 8.70E-02 | 1.00E-05 | 1.78E+02 | 2.12E-01 | 5.18E-03 | 25 | 417.60 | 630.30 | 8,661 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | | 3.7E-04 | 1.0E-01 | | | | |
| 95501 | 1,2-Dichlorobenzene | 6.17E+02 | 6.90E-02 | 7.90E-06 | 1.56E+02 | 7.77E-02 | 1.90E-03 | 25 | 453.57 | 705.00 | 9,700 | 0.0E+00 | 2.0E-01 | 1.47E+02 | | | 3.7E-04 | 2.0E-01 | | | | |
| 95636 | 1,2,4-Trimethylbenzene | 1.35E+03 | 6.06E-02 | 7.92E-06 | 5.70E+01 | 2.52E-01 | 6.14E-03 | 25 | 442.30 | 649.17 | 9,369 | 0.0E+00 | 7.0E-03 | 1.20E+02 | | | 3.7E-04 | 6.0E-03 | | | | |
| 96184 | 1,2,3-Trichloropropane | 2.20E+01 | 7.10E-02 | 7.90E-06 | 1.75E+03 | 1.67E-02 | 4.08E-04 | 25 | 430.00 | 652.00 | 9,171 | 8.6E-03 | 3.0E-04 | 1.47E+02 | X | | 3.7E-04 | 4.9E-03 | X | | | |
| 98828 | Cumene | 4.89E+02 | 6.50E-02 | 7.10E-06 | 6.13E+01 | 4.74E+01 | 1.16E+00 | 25 | 425.56 | 631.10 | 10,335 | 0.0E+00 | 4.0E-01 | 1.20E+02 | | | 3.7E-04 | 4.0E-01 | | | | |
| 100414 | Ethylbenzene | 3.63E+02 | 7.50E-02 | 7.80E-06 | 1.69E+02 | 3.22E-01 | 7.86E-03 | 25 | 409.34 | 617.20 | 8,501 | 2.5E-06 | 1.0E+00 | 1.06E+02 | | | 3.7E-04 | 1.0E+00 | | | | |
| 103651 | n-Propylbenzene | 5.62E+02 | 6.01E-02 | 7.83E-06 | 6.00E+01 | 4.37E-01 | 1.07E-02 | 25 | 432.20 | 630.00 | 9,123 | 0.0E+00 | 1.4E-01 | 1.20E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 104518 | n-Butylbenzene | 1.11E+03 | 5.70E-02 | 8.12E-06 | 2.00E+00 | 5.38E-01 | 1.31E-02 | 25 | 456.46 | 660.50 | 9,290 | 0.0E+00 | 1.4E-01 | 1.34E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 106423 | p-Xylene | 3.89E+02 | 7.69E-02 | 8.44E-06 | 1.85E+02 | 3.13E-01 | 7.64E-03 | 25 | 411.52 | 616.20 | 8,525 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | ? | 3.7E-04 | 1.0E-01 | | | | |
| 106467 | 1,4-Dichlorobenzene | 6.17E+02 | 6.90E-02 | 7.90E-06 | 7.90E+01 | 9.82E-02 | 2.39E-03 | 25 | 447.21 | 684.75 | 9,271 | 1.1E-05 | 8.0E-01 | 1.47E+02 | | | 3.7E-04 | 8.0E-01 | | | | |
| 107062 | 1,2-Dichloroethane | 1.74E+01 | 1.04E-01 | 9.90E-06 | 8.52E+03 | 4.00E-02 | 9.77E-04 | 25 | 356.65 | 561.00 | 7,643 | 2.6E-05 | 7.0E-03 | 9.90E+01 | | | 3.7E-04 | 0.0E+00 | | | 2.1E-05 | 4.0E-01 |
| 108203 | Diisopropyl ether | 2.28E+01 | 6.54E-02 | 7.76E-06 | 8.80E+03 | 1.05E-01 | 2.56E-03 | 25 | 341.50 | 500.00 | 6,960 | 0.0E+00 | 7.0E-01 | 1.02E+02 | | | | | | | | |
| 108383 | m-Xylene | 4.07E+02 | 7.00E-02 | 7.80E-06 | 1.61E+02 | 3.00E-01 | 7.32E-03 | 25 | 412.27 | 617.05 | 8,523 | 0.0E+00 | 1.0E-01 | 1.06E+02 | | ? | 3.7E-04 | 1.0E-01 | | | | |
| 108883 | Toluene | 1.82E+02 | 8.70E-02 | 8.60E-06 | 5.26E+02 | 2.72E-01 | 6.62E-03 | 25 | 383.78 | 591.79 | 7,930 | 0.0E+00 | 3.0E-01 | 9.21E+01 | | | 3.7E-04 | 4.0E-01 | | | | |
| 108907 | Chlorobenzene | 2.19E+02 | 7.30E-02 | 8.70E-06 | 4.72E+02 | 1.51E-01 | 3.69E-03 | 25 | 404.87 | 632.40 | 8,410 | 0.0E+00 | 5.0E-02 | 1.13E+02 | | | 3.7E-04 | 6.0E-02 | | | | 1.0E+00 |
| 110827 | Cyclohexane | 9.63E+02 | 7.40E-02 | 8.50E-06 | 5.50E+01 | 7.84E+00 | 1.00E-01 | 25 | 353.90 | 572.20 | 7,474 | 0.0E+00 | 6.0E+00 | 8.42E+01 | | | | | | | | |
| 120821 | 1,2,4-Trichlorobenzene | 1.78E+03 | 3.00E-02 | 8.23E-06 | 4.88E+01 | 5.81E-02 | 1.42E-03 | 25 | 486.15 | 725.00 | 10,471 | 0.0E+00 | 2.0E-03 | 1.81E+02 | | | 3.7E-04 | 2.0E-01 | | | | 4.0E-03 |
| 127184 | Tetrachloroethylene | 1.55E+02 | 7.20E-02 | 8.20E-06 | 2.00E+02 | 7.53E-01 | 1.84E-02 | 25 | 394.40 | 620.20 | 8,288 | 5.9E-06 | 3.5E-02 | 1.66E+02 | | | 3.7E-04 | 0.0E+00 | | | | |
| 135988 | sec-Butylbenzene | 9.66E+02 | 5.70E-02 | 8.12E-06 | 3.94E+00 | 5.68E-01 | 1.39E-02 | 25 | 446.5 | 679 | 88730 | 0.0E+00 | 1.4E-01 | 1.34E+02 | | X | 3.7E-04 | 1.4E-01 | | X | | |
| 156592 | cis-1,2-Dichloroethylene | 3.55E+01 | 7.36E-02 | 1.13E-05 | 3.50E+03 | 1.67E-01 | 4.07E-03 | 25 | 333.65 | 544 | 7192 | 0.0E+00 | 3.5E-02 | 9.69E+01 | | X | 3.7E-04 | 3.5E-02 | | X | | |
| 156605 | trans-1,2-Dichloroethylene | 5.25E+01 | 7.07E-02 | 1.19E-05 | 6.30E+03 | 3.84E-01 | 9.36E-03 | 25 | 320.85 | 516.5 | 6717 | 0.0E+00 | 6.0E-02 | 9.69E+01 | | X | 3.7E-04 | 7.0E-02 | | X | | |
| 541731 | 1,3-Dichlorobenzene | 1.98E+03 | 6.92E-02 | 7.86E-06 | 1.34E+02 | 1.27E-01 | 3.09E-03 | 25 | 446 | 684 | 9230 | 0.0E+00 | 1.1E-01 | 1.47E+02 | | X | 3.7E-04 | 1.1E-01 | | X | | |
| 630206 | 1,1,1,2-Tetrachloroethane | 1.16E+02 | 7.10E-02 | 7.90E-06 | 1.10E+03 | 9.90E-02 | 2.41E-03 | 25 | 403.5 | 624 | 9768 | 7.4E-06 | 1.1E-01 | 1.68E+02 | | X | 3.7E-04 | 1.1E-01 | | X | | |

Brown = 2009 updates
Blue = Evaluated as a carcinogen.
Bold = CalEPA OEHHA Values
Red = OEHHA URF < USEPA URF
Green = IRIS RfC < OEHHA REL
new data for VLOOKUP based on June 2013 VISL Chem Props tab obtained from *www.epa.gov/oswer/vaporintrusion/documents/VISL-Calculator.xlsm*
indicates replaced with the 2013 EPA Region 9 RSL value which is more stringent than 2011 DTSC-HERO value.

## General Notes to Tables

% denotes percent.

% v/v denotes percent by volume.

$\mu g/m^3$ denotes microgram(s) per cubic meter.

1,1-DFA denotes 1,1-Difluoroethane.

ASTM denotes American Society for Testing and Materials.

C/I denotes commercial/industrial.

Cal/EPA denotes California Environmental Protection Agency.

cm denotes centimeter.

$cm^3$ denotes cubic centimeters.

DTSC denotes California Department of Toxic Substances Control.

ELCR denotes excess lifetime cancer risk.

EPA denotes U.S. Environmental Protection Agency.

ft denotes feet.

ft bgs denotes feet below ground surface.

HHRA denotes Human Health Risk Assessment.

HI denotes hazard index.

HQ denotes hazard quotient.

ID denotes identification.

in denotes inches.

IR denotes installation restoration.

IUR denotes inhalation unit risk.

J denotes estimated value below the analysis reporting limit.

Max denotes maximum.

MDL denotes method detection limit.

Min denotes minimum.

n/a denotes not applicable.

na denotes not analyzed.

NA denotes none available.

ND denotes not detected.

No. denotes number.

PCE denotes tetrachloroethene.

ppmv denotes parts per million by volume.

RBSL denotes risk-based screening level.

$RfC_i$ denotes inhalation reference concentration.

RL denotes analysis reporting limit.

TCE denotes trichloroethene.

U denotes not detected at or above the analysis reporting limit.

VC denotes vinyl chloride.

VOCs denotes volatile organic compounds.

y/n denotes yes/no.

TBD denotes spreadsheet cell to be loaded with data