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TECHNICAL MEMORANDUM OF RISK ASSESSMENT EVALUATION for SITE 5 - FIRE TRAINING AREA GROUNDWATER (OU 2)

NAVAL AIR STATION JOINT RESERVE BASE WILLOW GROVE, PENNSYLVANIA

Naval Facilities Engineering Command Mid-Atlantic

Contract Number N62472-03-D-0057

Contract Task Order 003

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TETRA TECH NUS, INC.

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NAVAL AIR STATION JOINT RESERVE BASE
WILLOW GROVE, PENNSYLVANIA

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ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

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TABLE OF CONTENTS

SECTION **PAGE**

EXECUTIVE SUMMARY ES-1

1.0 INTRODUCTION 1-1

2.0 REVIEW OF THE 1997 RISK ASSESSMENT 2-1
- 2.1 TOXICITY SCREENING CRITERIA AND SELECTION OF COPCS 2-1
- 2.2 EXPOSURE FACTOR ASSUMPTIONS 2-2
- 2.3 TOXICITY VALUES 2-3
- 2.4 METHODOLOGY USED TO ESTIMATE EXPOSURE POINT CONCENTRATIONS 2-5

3.0 UPDATED RISK CHARACTERIZATION 3-1
- 3.1 NONCARCINOGENIC RISKS 3-1
- 3.2 CARCINOGENIC RISKS 3-1
- 3.3 COMPARISON OF RESULTS 3-1
- 3.4 RISKS FROM LEAD 3-1
- 3.5 RISKS ASSOCIATED WITH VAPOR INTRUSION INTO BUILDINGS 3-1
- 3.6 UNCERTAINTY ASSOCIATED WITH TOXICITY CRITERIA FOR TRICHLOROETHENE 3-2

REFERENCES R-1

TABLES

FIGURES
- 2.1 SITE 5 GROUNDWATER MONITORING WELL LOCATIONS

ATTACHMENTS
- A RAGS PART D TABLES
- B SAMPLE CALCULATIONS
- C LEAD MODEL
- D VAPOR INTRUSION MODEL

EXECUTIVE SUMMARY

This technical memorandum presents a review and limited update of the human health risk assessment (HHRA) of groundwater originally prepared in 1997 as part of the Remedial Investigation Report for Site 5 – Fire Training Area (TtNUS, 2002). The review identifies changes in the risk assessment methodology since the 1997 HHRA was prepared and discusses, in general, the impact the changes would have on the risk estimates presented in the 1997 HHRA. The review concentrates on the changes in the methodology for evaluating risks to hypothetical residents since these receptors were identified as the critical receptors in the 1997 HHRA. Therefore, changes in risk assessment methodology and the impact of these changes on the risk estimates for hypothetical residents hypothetically exposed to groundwater are discussed in detail in the following subsections. In addition, the risk estimates for hypothetical residents exposed to groundwater are re-calculated following current risk assessment guidance.

Review of 1997 HHRA Methodology Versus Current HHRA Methodology

The following items summarize the major differences between the 1997 HHRA methodology and the methodology used to prepare the updated HHRA of groundwater:

- The protocol used to select chemicals of potential concern (COPC) for the updated HHRA is the same as the protocol used in the 1997 HHRA and it considered current Region 3 risk-based concentrations (RBCs) and USPEA Maximum Contaminant Levels (MCLs) in the toxicity screening used to select COPCs. The list of COPCs evaluated in the updated HHRA includes all COPCs identified in the 1997 HHRA except for aluminum and beryllium; however, 1,4-dichlorobenzene, benzene, chloroform, cis-1,2-dichloroethene, 1,4-dioxane, and vanadium were added to the list of COPCs.

- The most significant changes in the exposure assessment protocol (1997 versus current) are those associated with the calculation of the exposure point concentration (EPC). EPCs calculated per current methodology are higher for most COPCs than those calculated for the 1997 HHRA.

- Significant changes in toxicity criteria (i.e., reference doses, cancer slope factors) were noted for 1,1,1-trichloroethene, 1,1-dichloroethene, 1,2-dichloroethane, tetrachloroethene, barium, and beryllium between the 1997 HHRA and the updated HHRA. Beryllium and 1,1-dichloroethene were evaluated as carcinogens in the 1997 HHRA. USEPA withdrew the oral cancer slope factor for beryllium in 1998 and for 1,1-dichloroethene in 2002 and as a result beryllium and

1,1-dichloroethene are no longer evaluated as carcinogens for the ingestion and dermal contact exposure pathways. The reference doses for tetrachloroethene and 1,1,1-trichloroethane increased by an order of magnitude. The current reference dose for barium is approximately three times higher than the one used in the 1997 HHRA. In addition, the oral absorption efficiency for Dieldrin has changed from 0.5 to 1 and, as a result, Dieldrin is less toxic via the dermal contact exposure pathway. As a result of these changes, the risk estimates in this updated HHRA are lower than those presented in the 1997 HHRA.

Updated Risk Estimates for Hypothetical Future Residents Exposed to Groundwater

Risk estimates for the hypothetical future resident exposed to groundwater were recalculated and presented in this technical memorandum.

The cancer risk estimates for the hypothetical future lifelong resident under the RME scenario in this evaluation (3×10^{-4}) are lower than those estimated in the 1997 HHRA (8×10^{-4}) primarily because of the aforementioned changes in the toxicity criteria for 1,1-dichloroethene. 1,1-Dichloroethene was the major contributor to the risk estimates presented in the 1997 HHRA while tetrachloroethene was the major contributor to the risk estimates in this updated HHRA.

HIs for the child residents and adult residents estimated for the RME scenario were within acceptable levels and are similar to those presented in the 1997 HHRA.

Risks Associated With Vapor Intrusion Into Buildings

USEPA's Johnson and Ettinger volatilization model was used to evaluated exposures to COPCs that have volatilized from groundwater and migrated through building foundations into indoor air. Estimated caner risks and hazard indices for current industrial workers and hypothetical residents were within acceptable levels.

1.0 INTRODUCTION

This technical memorandum presents a review and limited update of the human health risk assessment (HHRA) of Site 5 groundwater originally prepared in 1997 as part of the Remedial Investigation Report for Site 5-Fire Training Area (TtNUS, 2002). The review identifies changes in the risk assessment methodology since the 1997 HHRA was prepared and discusses, in general, the impact the changes would have on the risk estimates presented in the 1997 HHRA. The review concentrates on the changes in the methodology for evaluating risks to hypothetical residents since these receptors were identified as the critical receptors in the 1997 HHRA. Therefore, changes in risk assessment methodology and the impact of these changes on the risk estimates for hypothetical residents hypothetically exposed to groundwater are discussed in detail in the following subsections. In addition, the risk estimates for hypothetical residents exposed to groundwater are re-calculated following current risk assessment guidance.

2.0 REVIEW OF THE 1997 RISK ASSESSMENT

The 1997 HHRA for groundwater at Site 5 was reviewed to evaluate if the use of current risk assessment methodology (versus the methodology available in 1997) would significantly impact the risk assessment results presented in the 1997 HHRA. For example, after the 1997 HHRA was prepared, the USEPA extensively revised the guidance for evaluating the dermal route of exposure (USEPA, 2004) and for calculating exposure point concentrations (EPCs) (USEPA, 2002; Singh et. al., 2004). In addition, USEPA updated some of the toxicity criteria (Reference Doses [RfDs] and cancer slope factors [CSFs]) used in quantitative risk assessment and the toxicity screening criteria used to select the chemicals of potential concern (COPCs). The impacts of these changes on the risk estimates presented in the 1997 HHRA are discussed below.

2.1 TOXICITY SCREENING CRITERIA AND SELECTION OF COPCS

USEPA Region 3 Risk-Based Concentrations (RBCs) available in 1997 were used as the basis of the COPC toxicity screening levels in the 1997 HHRA. USEPA Region 3 updates its RBC table twice a year; consequently the RBC table has undergone numerous revisions since the 1997 HHRA. An updated COPC selection table for groundwater is presented in Attachment A. Figure 2-1 shows the location of the monitoring wells evaluated in the technical memorandum. USEPA Region 3 RBCs (USEPA, 2006a) for tap water and USEPA MCLs (USEPA, 2006b) were used to select COPCs for groundwater. A chemical was retained as a COPC in groundwater if the maximum detected concentration exceeded the lesser of the toxicity screening levels based on the USEPA Region 3 RBC and USEPA MCL. No background groundwater samples were collected at Site 5; consequently chemicals were not eliminated as COPCs based on a comparison of site concentrations to background concentrations.

Benzene, 1,1,1-tetrachloroethane, 1,1,2-tetrachloroethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, tetrachloroethene, trichloroethene, Dieldrin, aluminum, arsenic, barium, beryllium, chromium, iron, lead, manganese, and nickel were retained as COPCs for groundwater in the 1997 HHRA for Site 5. Table 2.1 in Attachment A presents the updated COPC selection table for direct contact exposures to groundwater based on the most recent round of groundwater sampling. Results of the HHRA presented in the RI (TtNUS, 1997), noted that metals were not used at the site, while the maximum detected concentration of metals exceeded certain screening criteria, they were less than the EPA MCLs, concluded that risks from metals were not a concern at Site 5. Therefore, metals were determined not to be a concern, and the 2005 groundwater samples were only analyzed for VOCs and 1,4-dioxane. At the request of USEPA Region III the metal results from the 1997 groundwater sampling are included in Table 2.1 for the purposes of identifying all COPCs in groundwater at Site 5. The following chemicals were detected in groundwater at maximum concentrations exceeding toxicity screening levels based on the

current USEPA Region 3 RBCs for tap water and current USEPA MCLs and were selected as COPCs for groundwater at Site 5.

- VOCs [1,1,1-tetrachloroethane, 1,1,2-tetrachloroethane, 1,1-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, 1,4-dichlorobenzene, benzene, chloroform, cis-1,2-dichloroethene, tetrachloroethene, trichloroethene]

- SVOCs [1,4-dioxane]

- Inorganics [arsenic, barium, chromium, iron, lead, manganese, nickel, and vanadium]

1,2-Dichloroethene, 1,4-dichlorobenzene, chloroform, arsenic, chromium, and barium were detected at concentrations exceeding the USEPA Region 3 RBCs but were less than the USEPA MCLs. Concentrations of cis-1,2-dichloroethene exceeded the USEPA MCL in one sample only. Lead was only detected in one sample.

2.2 EXPOSURE FACTOR ASSUMPTIONS

Tables 1 through 4 present a comparison of the exposure assumptions for child residents and adult residents used in the 1997 HHRA versus those currently recommended by USEPA guidance. The most significant change in the exposure assumptions are those used to evaluate the dermal route of exposure. The exposure assumptions used in the 1997 HHRA were based on recommendations provided in USEPA's Dermal Exposure Assessment: Principles and Applications, January 1992 and USEPA Region 3's Assessing Dermal Contact with Soil, December 1995. The updated dermal exposure assumptions are based on recommendations in USEPA's Supplemental Guidance for Dermal Risk Assessment, July 2004 and USEPA Region 3's Updated Dermal Exposure Assessment Guidance, June 2003.

In the 1997 HHRA, the surface area (SA) for the child resident was a weighted value calculated for the exposure duration of the receptor (2,728 cm^2-yr/kg). The current guidance recommends a value of 6,600 cm^2 as the total body surface area of a child. For the adult resident, a SA of 18,150 cm^2 was used for the total body surface area in the 1997 HHRA. Current guidance recommends a value of 18,000 cm^2 for the total body surface area.

The old dermal guidance recommended exposure times of 0.33 hr/day and 0.25 hr/day for the child and adult resident, respectively. The new guidance recommends exposure times of 1 hr/day for the child resident and 0.5 hr/day for the adult resident.

The equations used to estimate the absorbed dose per event (DA_{event}) for organics have been updated since the 1997 HHRA was prepared. The most significant change to the equations is the addition of a fraction absorbed (FA) term to the equations. This term accounts for the slow absorption rates of high molecular weight chemicals. For the chemicals retained as COPCs in groundwater in the 1997 HHRA, all have a FA equal to 1. Consequently, the absorbed doses for dermal contact with groundwater calculated using the new dermal guidance would not be significantly different than those calculated using the old dermal guidance.

For evaluating exposures while showering, the old guidance recommended a shower duration of 15 minutes and 20 minutes for the total time in the bathroom. Current guidance recommends a shower duration of 30 minutes and 60 minutes for the total time in the bathroom.

2.3 TOXICITY VALUES

Tables 5 and 6 present a comparison of the RfDs and CSFs used in the 1997 HHRA versus current values. Significant changes in oral and/or inhalation toxicity values are noted for 1,1,1-trichloroethane, 1,1-dichloroethene, 1,2-dichloroethane, benzene, trichloroethene, tetrachloroethene, barium, and beryllium.

Toxicity criteria for trichloroethene are not currently published on the USEPA's Integrated Risk Information System (IRIS) database. The 1997 HHRA was prepared using a provisional oral RfD and inhalation CSF and a withdrawn oral CSF for trichloroethene. The USEPA has published draft toxicity values based on the USEPA's Trichloroethylene Health Risk Assessment: Synthesis and Characterization (USEPA, 2001a). However, these values are still undergoing peer review. The toxicity criteria developed by the California EPA (CA EPA, 2002) were used for trichloroethene in this updated HHRA because the draft USEPA criteria have not been finalized. The current CA EPA oral RfD for trichloroethene is 0.5 mg/kg/day; the oral RfD used in the 1997 HHRA was 0.006 mg/kg/day. Previously an inhalation RfD was not available for trichloroethene, however, the current CA EPA published value is 0.17 mg/kg/day. For noncarcinogenic exposures, these changes in toxicity values result in higher non-cancer risk estimates for trichloroethene exposure via inhalation and lower risk estimates for trichloroethene exposure via ingestion and dermal contact. The current oral and inhalation CA EPA CSFs for trichloroethene are 0.013 $(mg/kg/day)^{-1}$ and 0.007 $(mg/kg/day)^{-1}$, respectively. The oral and inhalation CSFs used in the 1997 HHRA were 0.011 $(mg/kg/day)^{-1}$ and 0.006 $(mg/kg/day)^{-1}$, respectively. Overall these changes do not significantly impact the risk estimates presented for trichloroethene in the 1997 HHRA. Section 3.6 discusses the uncertainty associated with the toxicity criteria for trichloroethene and presents a comparison of the risks calculated using the draft USEPA and CA EPA toxicity criteria.

Beryllium was evaluated as a carcinogen via the oral and dermal routes of exposure in the 1997 HHRA. However, in 1998, USEPA withdrew the oral cancer slope factor for beryllium, and as a result beryllium is no longer evaluated as a carcinogen for the ingestion and dermal contact exposure pathways. An inhalation RfD of 0.0000057mg/kg/day is also now available for beryllium (USEPA, 2006c). However, beryllium is not a volatile chemical; the availability of an inhalation RfD has no impact on the HHRA evaluation of beryllium concentrations in groundwater. Beryllium was determined not to be a concern in the 1997 HHRA and would not be a concern based on the revised toxicity criteria.

1,1-Dichloroethene was also evaluated as a carcinogen via the oral, dermal, and inhalation routes of exposure in the 1997 HHRA. However, in 2002 USEPA withdrew the oral and inhalation cancer slope factors for 1,1-dichloroethene, and as a result 1,1-dichloroethene is no longer evaluated as a carcinogen for the ingestion, dermal contact, and inhalation exposure pathways. In addition, the oral RfD was revised from 0.009 mg/kg/day to 0.05 mg/kg/day, and an inhalation RfD of 0.06 mg/kg/day is now available for 1,1-dichloroethene. These changes in the RfD indicate that 1,1-dichloroethene is less toxic for exposures via the ingestion and dermal exposure pathways than previously reported.

The oral CSF for tetrachloroethene was revised from 0.052 $(mg/kg/day)^{-1}$ to 0.54 $(mg/day/day)^{-1}$, and the inhalation CSF has changed from 0.002 $(mg/day/day)^{-1}$ to 0.02 $(mg/day/day)^{-1}$. Also an inhalation RfD of 0.08 mg/kg/day is now available for tetrachloroethene (USEPA, 2006a). As a result of these changes, cancer risk estimates for tetrachloroethene presented in this 1997 HHRA would be approximately an order of magnitude higher based on the updated toxicity criteria.

The oral CSF for benzene was revised from 0.029 $(mg/kg/day)^{-1}$ to 0.055 $(mg/day/day)^{-1}$, and the inhalation CSF has changed from 0.029 $(mg/day/day)^{-1}$ to 0.027 $(mg/day/day)^{-1}$ (USEPA, 2006c). These changes indicated the benzene is slightly more toxic for carcinogenic exposures via ingestion and dermal contact. In addition an oral RfD of 0.004 mg/kg/day is now available, and the inhalation RfD has changed from 0.0017 mg/kg/day to 0.0086 mg/kg/day.

The inhalation RfD for 1,2-dichloroethane was revised from 0.0029 mg/kg/day to 0.7 mg/kg/day (USEPA, 2006a). This change indicates 1,2-dichloroethane is less toxic via the inhalation route than previously determined.

The oral RfD for 1,1,1-trichloroethane was revised from 0.035 mg/kg/day to 0.28 mg/kg/day (USEPA, 2006a). Also an inhalation RfD is no longer available for 1,1,1-trichloroethane. These changes indicate that 1,1,1-trichloroethane is less toxic for exposures via the ingestion, dermal contact route, and inhalation routes of exposure than previously determined.

The oral RfD for barium was revised from 0.07 mg/kg/day to 0.2 mg/kg/day (USEPA, 2006c). This change indicates that barium is less toxic for exposures via the ingestion route than previously determined.

The oral RfD for hexavalent chromium was revised from 0.005 mg/kg/day to 0.003 mg/kg/day (USEPA, 2006c). In addition, the recommended oral absorption efficiency for hexavalent chromium was revised from 0.01 to 0.025 (USEPA, 2004) which results in the new dermal RfD of 0.000075 mg/kg/day. Also an inhalation RfD of 0.00003 mg/kg/day is now available for hexavalent chromium (USEPA, 2006c). These changes indicate that chromium is considered slightly more toxic for exposures via the incidental ingestion and inhalation routes of exposure and slightly less toxic via the dermal contact route of exposure than previously determined. Overall these changes do not significantly impact the risk estimates presented for chromium in the 1997 HHRA. Chromium is not a volatile chemical; the availability of an inhalation RfD has no impact on the HHRA evaluation of chromium concentrations in groundwater. Chromium was determined not to be a concern in the 1997 HHRA and would not be a concern based on the revised toxicity criteria.

The recommended oral absorption efficiency values for Dieldrin, arsenic, barium, and manganese have also been changed resulting in the revised dermal toxicity values presented in Tables 5 and 6. However, only the changes presented for the dermal values for manganese are significant. Although, the changes in the dermal toxicity values for manganese do not significantly impact the risks because dermal exposures to manganese in groundwater are insignificant in comparison to exposures from ingestion of manganese in groundwater.

2.4 METHODOLOGY USED TO ESTIMATE EXPOSURE POINT CONCENTRATIONS

Exposure point concentrations (EPCs) in the 1997 HHRA were calculated following USEPA's Supplemental Guidance to Risk Assessment Guidance for Superfund (RAGS): Calculating the Concentration Term (USEPA, 1992b). In accordance with this guidance the Student-t upper confidence limit (UCL) was used as the EPC if the data was normally distributed and the H-statistic based UCL (H-UCL) was used as the EPC if the data was lognormally distributed. If the distribution of the data could not be determined then the data was assumed to be lognormally distributed and the H-UCL was selected as the EPC. USEPA has updated the guidance for calculating EPCs (USEPA, 2002; Singh et. al., 2004). The updated guidance continues to recommend the Student-t UCL for normally distributed data and the H-UCL for lognormally distributed data but also includes EPC recommendations for data that follow a gamma distribution and for cases where the data distribution can not be determined (i.e., the non parametric case). EPCs in the 1997 HHRA were calculated using all the monitoring wells. Current guidance recommends only using the monitoring wells located in the center of the plume or most

concentrated area of the plume. The EPCs calculated in this technical memorandum were also calculated using all the monitoring wells in order to facilitate the comparison of the results. If only the sampling results from the monitoring wells located in the center of the plume had been used to calculate the EPCs then the EPCs and corresponding risks would likely be higher than those calculated using all the monitoring wells.

Table 7 presents a comparison of the EPCs presented in the 1997 HHRA, calculated in accordance with the old EPC guidance, and the EPCs calculated following the new EPC guidance. The EPCs for all VOC COPCs calculated according to the new EPC guidance and the most recent round of sampling results are higher than the values calculated using the old guidance and the RI sampling results with the exception of 1,2-dichloroethane and benzene. For inorganics the EPCs calculated according to the new EPC guidance and the 1997 sampling results are higher than the values calculated using the old guidance for aluminum, chromium, and iron and lower for lead and manganese.

3.0 UPDATED RISK CHARACTERIZATION

The cancer risks and hazard indices were recalculated for child residents and adult residents exposed to groundwater incorporating the changes in risk assessment methodology and exposure assumptions discussed in Section 2 and using the results from the most recent round of groundwater sampling. Incremental lifetime cancer risks (ILCRs) and hazard indices (HIs) under the RME and CTE scenarios are summarized in Tables 8 and 9. The results of the risk assessment in RAGS Part D format (USEPA, 2001b) are included in Attachment A and sample calculations are included in Attachment B.

3.1 NONCARCINOGENIC RISKS

HIs for the child residents (HI = 4) and adult residents (HI = 2) under the RME scenario exceed unity although the HQs for the individual target organs are less than or equal to unity, indicating that adverse non-carcinogenic effects are not anticipated for these receptors under the defined exposure conditions.

HIs for the child resident (HI =2) under the CTE scenario exceed unity although the HQs for the individual target organs are less than or equal to unity, and the HI for adult residents was equal to 1, indicating that adverse non-carcinogenic effects are not anticipated for this receptor under the defined exposure conditions.

3.2 CARCINOGENIC RISKS

The ILCR under the RME for child residents (ILCR = 1×10^{-4}) is equal to the upper bound of USEPA's target risk range of 10^{-4} to 10^{-6}, while the ILCR for adult residents (ILCR = 2×10^{-4}) and lifelong residents (ILCR = 3×10^{-4}) exceeds the target risk range. Tetrachloroethene is the major contributor to the ILCRs for the adult (ILCR = 1×10^{-4}) and lifelong residents (ILCR = 2×10^{-4}).

ILCRs for the child resident (ILCR = 2×10^{-5}), adult resident (ILCR = 4×10^{-5}), and lifelong resident (6×10^{-5}) under the CTE scenario are within the USEPA's target risk range of 10^{-4} to 10^{-6}.

3.3 COMPARISON OF RESULTS

Table 10 presents a comparison of the cancer risks and hazard indices from the 1997 HHRA and those calculated in this evaluation. ILCRs for lifelong residents are lower in this evaluation (ILCR = 3×10^{-4}) as compared to those estimated in the 1997 HHRA (ILCR = 8×10^{-4}). The main reason for the decrease in the ILCR is the changes in the toxicity criteria for 1,1-dichloroethene. 1,1-Dichloroethene was the major contributor to the ILCR in the 1997 HHRA. In 2002 USEPA withdrew the oral cancer slope factor for

1,1-dichloroethene, and as a result 1,1-dichloroethene is no longer evaluated as a carcinogen for the ingestion and dermal contact exposure pathways. Tetrachloroethene was the major contributor to the ILCR in this evaluation. The ILCR for tetrachloroethene (2×10^{-4}) is higher in this evaluation as compared to the value estimated in the 1997 HHRA (1×10^{-5}), mainly due to the increase in the oral cancer slope factor for tetrachloroethene.

HIs for child and adult residents estimated in this evaluation are similar to those presented in the 1997 HHRA. The main reason for the decrease in the HIs are that the toxicity criteria for 1,1,1-trichloroethane, 1,1-dichloroethene, and trichloroethene have changed. The HIs presented in the 1997 RI included risks from inorganics which were not analyzed for in the most recent groundwater sampling since the 1997 RI concluded that metals were not a concern in groundwater.

3.4 RISKS FROM LEAD

Lead was identified as a COPC in groundwater at Site 5. Lead was detected in 1 of 21 groundwater samples and the detected concentration of 18.1 µg/L exceeded the Safe Water Drinking Act action level of 15 µg/L.

Hypothetical future residential exposures to lead in groundwater were evaluated using the IEUBK lead model, Version 1, Build 263 (USEPA, 1994). As recommended by the IEUBK model, the average lead concentration of 89.7 mg/kg in surface soil and 2.24 µg/L in groundwater were used as the EPCs. Default values were used for the rest of the model input parameters. IEUBK model outputs are included in Attachment C. The lead concentrations of 89.7 mg/kg in surface soil and 2.24 µg/L in groundwater results in 0.08 percent of future on-site child residents having a blood lead level greater than 10 µg/dL and results in a geometric mean blood lead level of 2.3 µg/dL. This value is within the USEPA goal as described in the 1994 OSWER Directive of no more than 5 percent of children exceeding a 10 µg/dL blood lead level.

3.5 RISKS ASSOCIATED WITH VAPOR INTRUSION INTO BUILDINGS

Exposures to COPCs that have migrated from groundwater into indoor air were evaluated using the USEPA's Johnson and Ettinger volatilization model (USEPA, 2003). Two scenarios were evaluated: a current industrial use scenario and a hypothetical residential scenario. Table 11 presents the input parameters that were used in the analysis. Site specific values were used when available for evaluating current industrial exposures. Model default values were used for hypothetical residential exposures. The depth to groundwater is approximately 20 feet. In the vicinity of the building, the plume has migrated to a deeper portion of the aquifer, and occurs at a depth of approximately 50 - 70 feet (estimated), but is

overlain by the shallower, clean water. Based on the closest monitoring wells (7I and 10I), the plume at depth is projected to consist of about 10 - 50 µg/L total VOCs, comprised of 1,1,1-trichloroethane (25%), 1,1-dichloroethene (25%), trichloroethene (20%), 1,1-dichloroethane (20%), and tetrachloroethene, benzene, cis-1,2-dichloroethene, and 1,1,2-1,1,1-trichloroethane (10% all together). The modeling analysis assumed that the plume was located at the top of the water table (20 feet bgs) with a concentration of 50 µg/L total VOCs. Results of the evaluation are presented in Tables 12 and 13 for industrial and hypothetical residential exposures, respectively. Spreadsheet calculations/printouts for the Johnson and Ettinger volatilization model are presented in Attachment D.

HIs for industrial workers (HI = 0.001) and hypothetical residents (HI = 0.01) residents exposed to COPCs that have migrated from groundwater through building foundations into indoor air are less than unity, indicating that adverse non-carcinogenic effects are not anticipated for these receptors under the defined exposure conditions. The ILCRs for the industrial workers (ILCR = 7×10^{-7}) and hypothetical residents (ILCR = 1×10^{-6}) exposed to COPCs that have migrated from groundwater through building foundations into indoor air are within EPA's target risk range of 10^{-4} to 10^{-6}.

3.6 UNCERTAINTY ASSOCIATED WITH TOXICITY CRITERIA FOR TRICHLOROETHENE

As noted in Section 2.3, toxicity criteria (i.e., RfDs, CSFs) for trichloroethene are not currently published on the USEPA's IRIS database or in USEPA's Health Effects Assessment Summary Tables (HEAST). The toxicity criteria developed by the California EPA (CA EPA, 2002) were used to evaluate trichloroethene in this risk assessment because the USEPA ***draft*** toxicity values published in a recent technical document (USEPA, 2001a) are currently undergoing peer review. A range of CSFs [0.02–0.4 $(mg/kg/day)^{-1}$], as opposed to a single recommended value, is presented in this recent draft guidance. The draft CSFs are 2 to 30 times higher than the CA EPA CSF [0.013 $(mg/kg/day)^{-1}$]. The draft oral RfD is 0.0003 mg/kg/day as compared to the CA EPA RfD of 0.5 mg/kg/day. Table 14 presents a comparison of the risks calculated using the draft USEPA toxicity values and the California EPA values. ILCRs calculated using the lower bound of the draft USEPA CSFs are slightly higher than those calculated using the CA EPA CSF while ILCRs calculated using the upper bound of the USEPA CSFs are approximately 30 times higher than those calculated using the CA EPA CSF. HIs based on the USEPA draft RfDs are approximately 1,700 times higher than those calculated using the CA EPA RfD.

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TABLES

TABLE 1
COMPARISON OF EXPOSURE ASSUMPTIONS
CHILD RESIDENTS EXPOSED TO GROUNDWATER - REASONABLE MAXIMUM EXPOSURES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW GROVE, PENNSYLVANIA

Parameter Code	Parameter Definition	Old Value[1]	Rationale/ Reference	New Value	Rationale/ Reference
Ingestion					
IR-GW	Ingestion Rate of Groundwater (L/day)	1	USEPA, 1991	1	USEPA, 1991
EF	Exposure Frequency (days/year)	350	USEPA, 1991	350	USEPA, 1991
ED	Exposure Duration (years)	6	USEPA, 1989 USEPA, 1991	6	USEPA, 1989 USEPA, 1991
BW	Body Weight (kg)	15	USEPA, 1989 USEPA, 1991	15	USEPA, 1989 USEPA, 1991
AT-C	Averaging Time (Cancer) (days)	25550	USEPA, 1989	25550	USEPA, 1989
AT-N	Averaging Time (Non-Cancer) (days)	2190	USEPA, 1989	2190	USEPA, 1989
Dermal Contract					
DAevent	Dermally Absorbed Dose per Event (mg/cm^2-event)	Chemical Specific	USEPA, 1992	Chemical Specific	USEPA, 2004
SA	Skin Surface Available for Contact	**2728 cm^2-yr/kg**	USEPA, 1989	**6600 cm^2**	USEPA, 2004
EV	Event Frequency (events/day)	1	USEPA, 1992	1	USEPA, 2004
ET	Exposure Time (hours/day)	**0.33**	USEPA, 1992	**1**	USEPA, 2004
EF	Exposure Frequency (days/year)	350	USEPA, 1991	350	USEPA, 1991
ED	Exposure Duration (years)	6	USEPA, 1989 USEPA, 1991	6	USEPA, 1989 USEPA, 1991
BW	Body Weight (kg)	15	USEPA, 1989 USEPA, 1991	15	USEPA, 1989 USEPA, 1991
AT-C	Averaging Time (Cancer) (days)	25550	USEPA, 1989	25550	USEPA, 1989
AT-N	Averaging Time (Non-Cancer) (days)	2190	USEPA, 1989	2190	USEPA, 1989
Inhalation					
IR	Inhalation Rate (m^3/hr)	Not Evaluated		Not Evaluated	
Ra	Air Exchange Rate (1/min)				
Ds	Shower Duration (min)				
Dt	Total Time in Bathroom (min)				
EF	Exposure Frequency (days/year)				
ED	Exposure Duration (years)				
BW	Body Weight (kg)				
AT-C	Averaging Time (Cancer) (days)				
AT-N	Averaging Time (Non-Cancer) (days)				

Notes:
1 - Old values are from the Remedial Investigation Report for Site 5 Fire Training Area, February 2002, Table 3-24.
USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.
USEPA, 1991: Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03.
USEPA, 1992: Dermal Exposure Assessment: Principles and Applications. EPA/600/8-91/011B.
USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Values that have changed from the previous HHRA are shaded.

TABLE 2
COMPARISON OF EXPOSURE ASSUMPTIONS
CHILD RESIDENTS EXPOSED TO GROUNDWATER - CENTRAL TENDENCY EXPOSURES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW GROVE, PENNSYLVANIA

Parameter Code	Parameter Definition	Old Value[1]	Rationale/ Reference	New Value	Rationale/ Reference
Ingestion					
IR-GW	Ingestion Rate of Groundwater (L/day)	0.7	USEPA, 1991	0.7	USEPA, 1997
EF	Exposure Frequency (days/year)	350	USEPA, 1991	350	USEPA, 1991
ED	Exposure Duration (years)	2	USEPA, 1989 USEPA, 1991	2	USEPA, 1989 USEPA, 1991
BW	Body Weight (kg)	15	USEPA, 1989 USEPA, 1991	15	USEPA, 1989 USEPA, 1991
AT-C	Averaging Time (Cancer) (days)	25550	USEPA, 1989	25550	USEPA, 1989
AT-N	Averaging Time (Non-Cancer) (days)	730	USEPA, 1989	730	USEPA, 1989
Dermal Contract					
DAevent	Dermally Absorbed Dose per Event (mg/cm^2-event)	Chemical Specific	USEPA, 1992	Chemical Specific	USEPA, 2004
SA	Skin Surface Available for Contact	**850 cm^2-yr/kg**	USEPA, 1989	**6600 cm^2**	USEPA, 2004
EV	Event Frequency (events/day)	1	USEPA, 1992	1	USEPA, 2004
ET	Exposure Time (hours/day)	0.33	USEPA, 1992	0.33	USEPA, 2004
EF	Exposure Frequency (days/year)	350	USEPA, 1991	350	USEPA, 1991
ED	Exposure Duration (years)	2	USEPA, 1989 USEPA, 1991	2	USEPA, 1989 USEPA, 1991
BW	Body Weight (kg)	15	USEPA, 1989 USEPA, 1991	15	USEPA, 1989 USEPA, 1991
AT-C	Averaging Time (Cancer) (days)	25550	USEPA, 1989	25550	USEPA, 1989
AT-N	Averaging Time (Non-Cancer) (days)	730	USEPA, 1989	730	USEPA, 1989
Inhalation					
IR	Inhalation Rate (m^3/hr)	Not Evaluated		Not Evaluated	
Ra	Air Exchange Rate (1/min)				
Ds	Shower Duration (min)				
Dt	Total Time in Bathroom (min)				
EF	Exposure Frequency (days/year)				
ED	Exposure Duration (years)				
BW	Body Weight (kg)				
AT-C	Averaging Time (Cancer) (days)				
AT-N	Averaging Time (Non-Cancer) (days)				

Notes:
1 - Old values are from the Remedial Investigation Report for Site 5 Fire Training Area, February 2002, Table 3-25.
Foster, S.A. and P.C. Chrostowski, 1987. Inhalation Exposure to Volatile Organic Contaminants in the Shower.
USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.
USEPA, 1991: Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03.
USEPA, 1992: Dermal Exposure Assessment: Principles and Applications. EPA/600/8-91/011B.
USEPA, 1997: Exposure Factors Handbook. EPA/600/8-95/002FA.
USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Values that have changed from the previous HHRA are shaded.

TABLE 3
COMPARISON OF EXPOSURE ASSUMPTIONS
ADULT RESIDENTS EXPOSED TO GROUNDWATER - REASONABLE MAXIMUM EXPOSURES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW GROVE, PENNSYLVANIA

Parameter Code	Parameter Definition	Old Value[1]	Rationale/ Reference	New Value	Rationale/ Reference
Ingestion					
IR-GW	Ingestion Rate of Groundwater (L/day)	2	USEPA, 1991	2	USEPA, 1991
EF	Exposure Frequency (days/year)	350	USEPA, 1991	350	USEPA, 1991
ED	Exposure Duration (years)	24	USEPA, 1989 USEPA, 1991	24	USEPA, 1989 USEPA, 1991
BW	Body Weight (kg)	70	USEPA, 1989 USEPA, 1991	70	USEPA, 1989 USEPA, 1991
AT-C	Averaging Time (Cancer) (days)	25550	USEPA, 1989	25550	USEPA, 1989
AT-N	Averaging Time (Non-Cancer) (days)	8760	USEPA, 1989	8760	USEPA, 1989
Dermal Contract					
DAevent	Dermally Absorbed Dose per Event (mg/cm^2-event)	Chemical Specific	USEPA, 1992	Chemical Specific	USEPA, 2004
SA	Skin Surface Available for Contact (cm^2)	**18150**	USEPA, 1989	**18000**	USEPA, 2004
EV	Event Frequency (events/day)	1	USEPA, 1992	1	USEPA, 2004
ET	Exposure Time (hours/day)	**0.25**	USEPA, 1992	**0.5**	USEPA, 2004
EF	Exposure Frequency (days/year)	350	USEPA, 1991	350	USEPA, 1991
ED	Exposure Duration (years)	24	USEPA, 1989 USEPA, 1991	24	USEPA, 1989 USEPA, 1991
BW	Body Weight (kg)	70	USEPA, 1989 USEPA, 1991	70	USEPA, 1989 USEPA, 1991
AT-C	Averaging Time (Cancer) (days)	25550	USEPA, 1989	25550	USEPA, 1989
AT-N	Averaging Time (Non-Cancer) (days)	8760	USEPA, 1989	8760	USEPA, 1989
Inhalation					
IR	Inhalation Rate (m^3/hr)	**0.83**	USEPA, 1989	**0.6**	USEPA, 1989
Ra	Air Exchange Rate (1/min)	**0.017**	Foster & Chrostowski 1987	**0.0167**	Foster & Chrostowski 1987
Ds	Shower Duration (min)	**15**	Professional Judgment	**30**	USEPA, 2004, USEPA Region III, 2005
Dt	Total Time in Bathroom (min)	**20**	Professional Judgment	**60**	USEPA, 2004, USEPA Region III, 2005
SV	Shower Room Volume (m^3)	12	Foster & Chrostowski 1987	12	Foster & Chrostowski 1987
ts	Shower Dropled Droplet Time (seconds)	**2**	Foster & Chrostowski 1987	**0.5**	Foster & Chrostowski 2003
FR	Shower Flow Rate (L/min)	10	Foster & Chrostowski 1987	10	Foster & Chrostowski 1987
EF	Exposure Frequency (days/year)	350	USEPA, 1991	350	USEPA, 1991
ED	Exposure Duration (years)	24	USEPA, 1989 USEPA, 1991	24	USEPA, 1989 USEPA, 1991
BW	Body Weight (kg)	70	USEPA, 1989 USEPA, 1991	70	USEPA, 1989 USEPA, 1991
AT-C	Averaging Time (Cancer) (days)	25550	USEPA, 1989	25550	USEPA, 1989
AT-N	Averaging Time (Non-Cancer) (days)	8760	USEPA, 1989	8760	USEPA, 1989

Notes:
1 - Old values are from the Remedial Investigation Report for Site 5 Fire Training Area, February 2002, Table 3-24.
Foster, S.A. and P.C. Chrostowski, 1987. Inhalation Exposure to Volatile Organic Contaminants in the Shower.
USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.
USEPA, 1991: Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03.
USEPA, 1992: Supplemental Guidance to RAGS: Calculating the Concentration Term. PB92-963373.
USEPA, 2002: Supplement Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.
USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.
USEPA Region III, 2005, Note on the Use of Dermal Guidance in Region III, April 7.

Values that have changed from the previous HHRA are shaded.

TABLE 4
COMPARISON OF EXPOSURE ASSUMPTIONS
ADULT RESIDENTS EXPOSED TO GROUNDWATER - CENTRAL TENDENCY EXPOSURES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW GROVE, PENNSYLVANIA

Parameter Code	Parameter Definition	Old Value[1]	Rationale/ Reference	New Value	Rationale/ Reference
Ingestion					
IR-GW	Ingestion Rate of Groundwater (L/day)	1.4	USEPA, 1991	1.4	USEPA, 1991
EF	Exposure Frequency (days/year)	350	USEPA, 1991	350	USEPA, 1991
ED	Exposure Duration (years)	7	USEPA, 1989 USEPA, 1991	7	USEPA, 1989 USEPA, 1991
BW	Body Weight (kg)	70	USEPA, 1989 USEPA, 1991	70	USEPA, 1989 USEPA, 1991
AT-C	Averaging Time (Cancer) (days)	25550	USEPA, 1989	25550	USEPA, 1989
AT-N	Averaging Time (Non-Cancer) (days)	2555	USEPA, 1989	2555	USEPA, 1989
Dermal Contract					
DAevent	Dermally Absorbed Dose per Event (mg/cm^2-event)	Chemical Specific	USEPA, 1992	Chemical Specific	USEPA, 2004
SA	Skin Surface Available for Contact (cm^2)	**18150**	USEPA, 1989	**18000**	USEPA, 2004
EV	Event Frequency (events/day)	1	USEPA, 1992	1	USEPA, 2004
ET	Exposure Time (hours/day)	0.25	USEPA, 1992	0.25	USEPA, 2004
EF	Exposure Frequency (days/year)	350	USEPA, 1991	350	USEPA, 1991
ED	Exposure Duration (years)	7	USEPA, 1989 USEPA, 1991	7	USEPA, 1989 USEPA, 1991
BW	Body Weight (kg)	70	USEPA, 1989 USEPA, 1991	70	USEPA, 1989 USEPA, 1991
AT-C	Averaging Time (Cancer) (days)	25550	USEPA, 1989	25550	USEPA, 1989
AT-N	Averaging Time (Non-Cancer) (days)	2555	USEPA, 1989	2555	USEPA, 1989
Inhalation					
IR	Inhalation Rate (m^3/hr)	**0.83**	USEPA, 1989	**0.6**	USEPA, 1989
Ra	Air Exchange Rate (1/min)	0.017	Foster & Chrostowski 1987	0.017	Foster & Chrostowski 1987
Ds	Shower Duration (min)	15	Professional Judgment	15	USEPA, 2004
Dt	Total Time in Bathroom (min)	**20**	Professional Judgment	**30**	Professional Judgment
SV	Shower Room Volume (m^3)	12	Foster & Chrostowski 1987	12	Foster & Chrostowski 1987
ts	Shower Dropled Droplet Time (seconds)	**2**	Foster & Chrostowski 1987	**0.5**	Foster & Chrostowski 2003
FR	Shower Flow Rate (L/min)	10	Foster & Chrostowski 1987	10	Foster & Chrostowski 1987
EF	Exposure Frequency (days/year)	350	USEPA, 1991	350	USEPA, 1991
ED	Exposure Duration (years)	7	USEPA, 1989 USEPA, 1991	7	USEPA, 1989 USEPA, 1991
BW	Body Weight (kg)	70	USEPA, 1989 USEPA, 1991	70	USEPA, 1989 USEPA, 1991
AT-C	Averaging Time (Cancer) (days)	25550	USEPA, 1989	25550	USEPA, 1989
AT-N	Averaging Time (Non-Cancer) (days)	2555	USEPA, 1989	2555	USEPA, 1989

Notes:
1 - Old values are from the Remedial Investigation Report for Site 5 Fire Training Area, February 2002, Table 3-25.
Foster, S.A. and P.C. Chrostowski, 1987. Inhalation Exposure to Volatile Organic Contaminants in the Shower.
USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.
USEPA, 1991: Human Health Evaluation Manual, Supplemental Guidance: Standard Default Exposure Factors. OSWER Directive 9285.6-03.
USEPA, 1992: Supplemental Guidance to RAGS: Calculating the Concentration Term. PB92-963373.
USEPA, 2002: Supplement Guidance for Developing Soil Screening Levels for Superfund Sites. OSWER 9355.4-24.
USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.
USEPA Region III, 2005, Note on the Use of Dermal Guidance in Region III, April 7.

Values that have changed from the previous HHRA are shaded.

TABLE 5
COMPARISON OF REFERENCE DOSES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW, GROVE PENNSYLVANIA

Chemical of Potential Concern	Oral Absorption Efficiency for Dermal		Oral RfD		Dermal RfD[2]		Inhalation RfD	
	Old	New[1]	Old mg/kg/day	New mg/kg/day	Old mg/kg/day	New mg/kg/day	Old mg/kg/day	New mg/kg/day
Volatiles Organic Compounds								
1,1,1-Trichloroethane	1	1	3.5E-02 E	**2.8E-01** E	3.5E-02	**2.8E-01**	2.9E-01 W	**NA**
1,1,2-Trichloroethane	1	1	4.0E-03 I	4.0E-03 I	4.0E-03	4.0E-03	NA	NA
1,1-Dichloroethane	1	1	1.0E-01 I	**2.0E-01 P**	1.0E-01	**2.0E-01**	1.4E-01 A	1.4E-01 A
1,1-Dichloroethene	1	1	9.0E-03 I	**5.0E-02** I	9.0E-03	**5.0E-02**	NA	**6.0E-02 I**
1,2-Dichloroethane	1	1	NA	NA	NA	NA	2.9E-03 E	**7.0E-01 M**
Benzene	1	1	NA	**4.0E-03 I**	NA	**4.0E-03**	1.7E-03 E	**8.6E-03 I**
Tetrachloroethene	1	1	1.0E-02 I	1.0E-02 I	1.0E-02	1.0E-02	NA	**8.0E-02 M**
Trichloroethene	1	1	6.0E-03 E	**5.0E-01 CA**	6.0E-03	**5.0E-01**	NA	**1.7E-01 CA**
Pesticides/PCBs								
Dieldrin	0.5	**1**	5.0E-05 I	5.0E-05 I	1.0E-04 I	**5.0E-05** I	NA	NA
Inorganics								
Aluminum	0.27	**1**	1.0E+00 E	**NA**	3.70E+00	**NA**	NA	NA
Arsenic	0.95	**1**	3.0E-04 I	3.0E-04 I	3.16E-04	**3.0E-04**	NA	NA
Barium	1	**0.07**	7.0E-02 I	**2.0E-01** I	7.0E-02	**1.4E-02**	1.43E-04 A	1.4E-04 A
Beryllium	0.01	**0.007**	5.0E-03 I	**2.0E-03** I	5.0E-01	**1.4E-05**	NA	**5.7E-06 I**
Chromium	0.01	**0.025**	5.0E-03 I	**3.0E-03** I	5.0E-01	**7.5E-05**	NA	**3.0E-05 I**
Iron	1	1	3.0E-01 E	3.0E-01 E	3.0E-01	3.0E-01	NA	NA
Lead	1	1	NA	NA	NA	NA	NA	NA
Manganese (Water)	1	**0.04**	2.3E-02 I	**2.4E-02** I	2.3E-02	**9.6E-04**	NA	NA
Manganese (Food)	1	**0.04**	1.4E-01 I	1.4E-01 I	1.4E-01	**5.6E-03**	1.43E-05 I	1.4E-05 I

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.
2 - Adjusted dermal RfD = Oral RfD x Oral Absorption Efficiency for Dermal.
A= HEAST Alternative value.
CA = California EPA, Technical Support Document for Describing Available Cancer Potency Factors, December 2002.
E = EPA-NCEA Provisional value.
I = Integrated Risk Information System (IRIS), December 2006.
M = ATSDR MRL.
P = EPA Provisional Peer-Reviewed Value.
W = Withdrawn
Values that have changed from the previous HHRA are shaded.

TABLE 6
COMPARISON OF CANCER SLOPE FACTORS
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW, GROVE PENNSYLVANIA

Chemical of Potential Concern	Oral Absorption Efficiency for Dermal		Oral CSF		Dermal CSF[2]		Inhalation CSF	
	Old	New[1]	Old (mg/kg/day)$^{-1}$	New (mg/kg/day)$^{-1}$	Old (mg/kg/day)$^{-1}$	New (mg/kg/day)$^{-1}$	Old (mg/kg/day)$^{-1}$	New (mg/kg/day)$^{-1}$
Volatiles Organic Compounds								
1,1,1-Trichloroethane	1	1	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	1	1	5.7E-02 I	5.7E-02 I	5.7E-02	5.7E-02	5.6E-02 I	5.6E-02 I
1,1-Dichloroethane	1	1	NA	NA	NA	NA	NA	NA
1,1-Dichloroethene	1	1	**6.0E-01 I**	**NA**	**6.0E-01**	**NA**	**1.8E-01 I**	**NA**
1,2-Dichloroethane	1	1	9.1E-02 I	9.1E-02 I	9.1E-02	9.1E-02	9.1E-02 I	9.1E-02 I
Benzene	1	1	**2.9E-02 I**	**5.5E-02 I**	**2.9E-02**	**5.5E-02 I**	**2.9E-02 I**	**2.7E-02 I**
Tetrachloroethene	1	1	**5.2E-02 E**	**5.4E-01 O**	**5.2E-02**	**5.4E-01**	**2.0E-03 E**	**2.0E-02 O**
Trichloroethene	1	1	**1.1E-02 W**	**1.3E-02 CA**	**1.1E-02**	**1.3E-02**	**6.0E-03 E**	**7.0E-03 CA**
Pesticides/PCBs								
Dieldrin	**0.5**	**1**	1.6E+01 I	1.6E+01 I	**8.00E+00**	**1.6E+01**	1.6E+01 I	1.6E+01 I
Inorganics								
Aluminum	1	1	NA	NA	NA	NA	NA	NA
Arsenic	**0.95**	**1**	1.5E+00 I	1.5E+00 I	**1.43E+00**	**1.5E+00**	1.5E+01 I	1.5E+01 I
Barium	**1**	**0.7**	NA	NA	NA	NA	NA	NA
Beryllium	**0.01**	**0.007**	**4.3E+00 I**	**NA**	**4.3E-02**	**NA**	8.4E+00 I	8.4E+00 I
Chromium	**0.01**	**0.025**	NA	NA	NA	NA	4.2E+01 I	4.2E+01 I
Lead	1	1	NA	NA	NA	NA	NA	NA
Iron	1	1	NA	NA	NA	NA	NA	NA
Manganese (Water)	**1**	**0.04**	NA	NA	NA	NA	NA	NA
Manganese (Food)	**1**	**0.04**	NA	NA	NA	NA	NA	NA

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.
2 - Adjusted cancer slope factor for dermal = Oral cancer slope factor / Oral Absorption Efficiency for Dermal.
CA = California EPA, Technical Support Document for Describing Available Cancer Potency Factors, December 2002.
E = NCEA Provisional value.
I = Integrated Risk Information System (IRIS), December 2006.
O = Other, EPA Region 3 RBC Table, October 2006.
W = Withdrawn from IRIS or HEAST.
Values that have changed from the previous HHRA are shaded.

TABLE 7
COMPARISON OF EXPOSURE POINT CONCENTRATIONS
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW, GROVE PENNSYLVANIA

Chemical	Exposure Point Concentrations	
	Old Value(1)	New Value(2)
1,1,1-Trichloroethane	114(3)	319(5)
1,1,2-Trichloroethane	5.55(3)	7.66(5)
1,1-Dichloroethane	45.9(3)	169(5)
1,1-Dichloroethene	52.9(3)	72.8(5)
1,2-Dichloroethane	4(4)	1.96(5)
1,4-Dichlorobenzene	NA	2.66(5)
Benzene	6.79(3)	2.99(5)
Chloroform	NA	0.33(4)
cis-1,2-Dichloroethene	NA	90.8(5)
Tetrachloroethene	9.14(3)	17(5)
Trichloroethene	33.9(3)	163(5)
1,4-Dioxane	NA	4.96(5)
Aluminum	1300(3)	3700(5)
Arsenic	0.633(3)	0.695(6)
Barium	574(3)	454(7)
Beryllium	0.683(3)	0.798(6)
Chromium	7.32(3)	13.3(8)
Iron	853(3)	3990(5)
Lead	12.6(3)	2.24(9)
Manganese	356(3)	144(7)
Nickel	14.6(3)	18.3(6)

Notes:
All concentrations are in ug/L.
NA - This chemical was not identified as a COPC in the previous risk assessment.
1 - Old values are from the Remedial Investigation Report for Site 5 - Fire Training Area, February 2002, Appendix J.
2 - Calculated according to USEPA, 2002: Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites.
3 - Land's H-UCL.
4 - Maximum detected concentration.
5 - 99% Chebyshev(Mean, Std) UCL.
6 - Student's-t UCL
7 - Approximate Gamma 95% UCL
8 - 95% Chebyshev(Mean, Std) UCL.
9 - Arithmetic mean
UCL = Upper Confidence Limit.
COPC = Chemical of Potential Concern.

TABLE 8

SUMMARY OF CANCER RISKS AND HAZARD INDICES
REASONABLE MAXIMUM EXPOSURES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW GROVE, PENNSYLVANIA

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks > 10-4	Chemicals with Cancer Risks > 10-5 and £ 10-4	Chemicals with Cancer Risks > 10–6 αvδ ≤ 10–5	Hazard Index	Chemicals Contributing to an HI > 1
Child Residents	Groundwater	Ingestion	7E-05	- -	Tetrachloroethane	1,1,2-Trichloroethane, Trichloroethene, Arsenic	3	- -
		Dermal Contact	3E-05	- -	Tetrachloroethane	Trichloroethene	0.5	- -
		Total	1E-04	- -	Tetrachloroethane	1,1,2-Trichloroethane, Trichloroethene, Arsenic	4	- -
Adult Residents	Groundwater	Ingestion	1E-04	- -	Tetrachloroethane, Trichloroethene	1,1,2-Trichloroethane, 1,2-Dichloroethane, Benzene,Arsenic	1	- -
		Dermal Contact	5E-05	- -	Tetrachloroethane	Trichloroethene	0.2	- -
		Inhalation	9E-06	- -	- -	Trichloroethene	0.00003	- -
		Total	2E-04	- -	Tetrachloroethane, Trichloroethene	1,1,2-Trichloroethane, 1,2-Dichloroethane, Benzene,Arsenic	2	- -
Lifelong Residents (Child and Adult)	Groundwater	Ingestion	2E-04	- -	Tetrachloroethane, Trichloroethene, Arsenic	1,1,2-Trichloroethane, 1,2-Dichloroethane, Benzene	NA	- -
		Dermal Contact	8E-05	- -	Tetrachloroethane	Trichloroethene	NA	- -
		Inhalation	9E-06	- -	- -	Trichloroethene	NA	- -
		Total	3E-04	Tetrachloroethane	Trichloroethene, Arsenic	1,1,2-Trichloroethane, 1,2-Dichloroethane, 1,4-Dichlorobenzene, Benzene	NA	- -

TABLE 9

SUMMARY OF CANCER RISKS AND HAZARD INDICES
CENTRAL TENDENCY EXPOSURES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW GROVE, PENNSYLVANIA

Receptor	Media	Exposure Route	Cancer Risk	Chemicals with Cancer Risks > 10-4	Chemicals with Cancer Risks > 10-5 and £ 10-4	Chemicals with Cancer Risks > 10–6 αvδ ≤ 10–5	Hazard Index	Chemicals Contributing to an HI > 1
Child Residents	Groundwater	Ingestion	2E-05	- -	- -	Tetrachloroethane, Trichloroethene	2	- -
		Dermal Contact	6E-06	- -	- -	Tetrachloroethane	0.2	- -
		Total	2E-05	- -	Tetrachloroethane	Tetrachloroethane, Arsenic	2	- -
Adult Residents	Groundwater	Ingestion	3E-05	- -	Tetrachloroethane	Tetrachloroethane, Arsenic	0.9	- -
		Dermal Contact	1E-05	- -	- -	Tetrachloroethane	0.10	- -
		Inhalation	8E-07	- -	- -	- -	0.00001	- -
		Total	4E-05	- -	Tetrachloroethane	Tetrachloroethane, Arsenic	1	- -
Lifelong Residents (Child and Adult)	Groundwater	Ingestion	4E-05	- -	Tetrachloroethane	Trichloroethene, Arsenic	NA	- -
		Dermal Contact	2E-05	- -	Tetrachloroethane	- -	NA	- -
		Inhalation	8E-07	- -	- -	- -	NA	- -
		Total	6E-05	- -	Tetrachloroethane	1,1,2-Trichloroethane, Trichloroethene, Arsenic	NA	- -

TABLE 10
COMPARISON OF CANCER RISKS AND HAZARD INDICES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW GROVE

Receptor Group	Cancer Risk		Hazard Index	
	Old Value[1]	New Value	Old Value[1]	New Value
Child Resident	NR	1E-04	3.4	3.6
Adult Resident	NR	2E-04	1.9	1.6
Lifelong Resident	8E-04	3E-04	NA	NA

Notes:
NR - Not reported, only results for the lifelong resident were presented in the RI report.
NA - Not applicable for this receptor.
1 - Old values are from the Remedial Investigation Report for Site 5 Fire Training Area, February 2002, Table 4-23 & 4-25.

TABLE 11
INPUT PARAMETERS FOR THE VAPOR INTRUSION MODEL
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW, GROVE PENNSYLVANIA

Parameter	Definition	Industrial		Residential	
		Value	Reference	Value	Reference
Ts	Average soil/groundwater temperature (^{o}C)	13	USEPA, 2003	13	USEPA, 2003
L_F	Depth below grade to bottom of enclosed space floor (cm)	30(1)	site-specific	200(2)	default
L_{WT}	Depth below grade to water table (cm)	610	site-specific	610	site-specific
	Soil Conservation Service (SCS) soil type	SIL(3)	site-specific	SIL	site-specific
L_{crack}	Enclosed space floor thickness (cm)	20	site-specific	10	default
L_B	Enclosed floor space length (cm)	4600	site-specific	1000	default
W_B	Enclosed floor space width (cm)	1565	site-specific	1000	default
H_B	Enclosed space height (cm)	730	site-specific	366	default
ER	Indoor air exchange rate (1/hr)	0.72	ASTM, 1995	0.25	default

Notes:
ASTM, 1995: American Society for Testing and Materials (ASTM).
USEPA, 2003: User's Guide for Evaluating Subsurface Vapor Intrusion Into Buildings.
1 - Slab on grade construction.
2 - House with a basement
3 - Silty loam

TABLE 12
SUMMARY OF CANCER RISKS AND HAZARD INDICES
VAPOR INTRUSION MODELING - INDUSTRIAL EXPOSURES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW GROVE

Chemical	Cancer Risk	Hazard Index
1,1-Dichloroethane	NA	0.00002
1,1-Dichloroethene	NA	0.0004
cis-1,2-Dichloroethene	NA	NA
1,1,1-Trichloroethane	NA	0.00002
1,1,2-Trichloroethane	5.2E-09	NA
Benzene	1.5E-08	0.0002
Tetrachloroethene	2.7E-09	0.00002
Trichloroethene	6.8E-07	0.0004
Total	**7E-07**	**0.001**

NA - No toxicity criteria available.

TABLE 13
SUMMARY OF CANCER RISKS AND HAZARD INDICES
VAPOR INTRUSION MODELING - RESIDENTIAL EXPOSURES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW GROVE

Chemical	Cancer Risk	Hazard Index
1,1-Dichloroethane	NA	0.0003
1,1-Dichloroethene	NA	0.006
cis-1,2-Dichloroethene	NA	NA
1,1,1-Trichloroethane	NA	0.0003
1,1,2-Trichloroethane	1.1E-07	NA
Benzene	3.0E-07	0.003
Tetrachloroethene	5.3E-08	0.0004
Trichloroethene	1.0E-06	0.0005
Total	**1E-06**	**0.01**

NA - No toxicity criteria available.

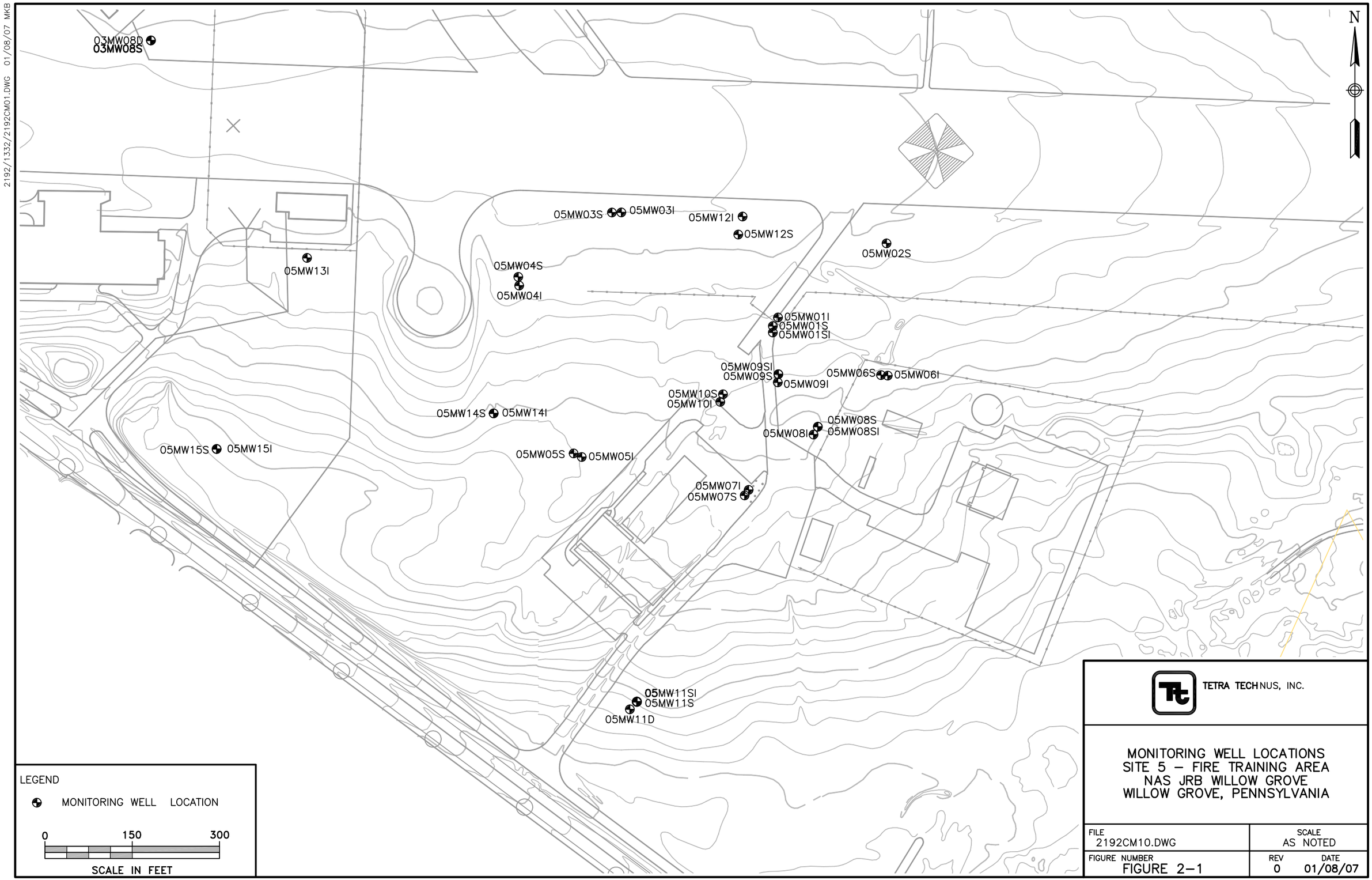
TABLE 14
COMPARISON OF TCE RISKS BASED ON DRAFT EPA AND CAL EPA TOXICITY VALUES
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW, GROVE PENNSYLVANIA

Cancer Risk							
TCE CSF	**Child Resident**		**Adult Resident**			**Lifelong Resident**	
	Ingestion	**Dermal Contact**	**Ingestion**	**Dermal Contact**	**Inhalation**	**Ingestion**	**Dermal Contact**
EPA Draft Lower Bound 0.02 $(mg/kg/day)^{-1}$	1.8E-05	1.7E-06	3.1E-05	3.5E-06	8.5E-06	4.9E-05	5.2E-06
EPA Draft Upper Bound 0.40 $(mg/kg/day)^{-1}$	3.6E-04	3.4E-05	6.1E-04	7.0E-05	1.7E-04	9.7E-04	1.0E-04
Cal EPA Oral CSF 0.013 $(mg/kg/day)^{-1}$	1.2E-05	1.1E-06	2.0E-05	2.2E-06		3.2E-05	3.3E-06
Cal EPA Inhalation CSF 0.007 $(mg/kg/day)^{-1}$					2.9E-06		

HAZARD INDEX					
TCE RfD	**Child Resident**		**Adult Resident**		
	Ingestion	**Dermal Contact**	**Ingestion**	**Dermal Contact**	**Inhalation**
EPA Draft Oral RfD 0.0003 (mg/kg/day)	3.5E+01	3.3E+00	1.5E+01	1.7E+00	
EPA Draft Inhalation RfD 0.01 (mg/kg/day)					1.2E-01
Cal EPA Oral RfD 0.5 $(mg/kg/day)^{-1}$	2.1E-02	1.9E-03	8.9E-03	9.9E-04	
Cal EPA Inhalation RfD 0.17 $(mg/kg/day)^{-1}$					7.2E-03

FIGURES

2192/1332/2192CM01.DWG 01/08/07 MKB



TETRA TECHNUS, INC.

MONITORING WELL LOCATIONS
SITE 5 – FIRE TRAINING AREA
NAS JRB WILLOW GROVE
WILLOW GROVE, PENNSYLVANIA

FILE	SCALE
2192CM10.DWG	AS NOTED

FIGURE NUMBER	REV	DATE
FIGURE 2–1	0	01/08/07

ATTACHMENT A

RAGS PART D TABLES

LIST OF TABLES
RAGS PART D TABLE 2
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN

Table No.

2.1 Groundwater

TABLE 2.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GROUNDWATER
SITE 5 - FIRE TRAINING AREA
NASJGB WILLOW GROVE, PENNSYLVANIA

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration[1]	Maximum Concentration[1]	Units	Sample with Maximum Concentration	Frequency of Detection	Range of Nondects[2]	Concentration Used for Screening[3]	Above Background Concentration[4]	EPA Region 3 RBCs for Tap Water[5]	Potential ARAR/TBC[6]	Potential ARAR/TBC Source[6]	COPC Flag	Rationale for Contaminant Deletion or Selection[7]
Site 5	**Volatile Organic Compounds**														
	71-55-6	**1,1,1-Trichloroethane**	0.45 J	960	ug/L	05MW01S-032-20050818-D	15/33	0.16	960	NA	**170 N**	**200**	MCL	**Yes**	ASL
	79-00-5	**1,1,2-Trichloroethane**	0.64 J	23	ug/L	05MW01S-032-20050818	6/33	0.11	23	NA	**0.19 C**	**5**	MCL	**Yes**	ASL
	75-34-3	**1,1-Dichloroethane**	0.79 J	500	ug/L	05MW01S-032-20050818-D	15/33	0.17	500	NA	**90 N**	NA	NA	**Yes**	ASL
	75-35-4	**1,1-Dichloroethene**	0.41 J	190	ug/L	05MW01S-032-20050818-D	17/33	0.19	190	NA	**35 N**	**7**	MCL	**Yes**	ASL
	95-50-1	1,2-Dichlorobenzene	1.7	1.8	ug/L	05MW01S-032-20050818-D	1/33	0.08	1.8	NA	27 N	600	MCL	No	BSL
	107-06-2	**1,2-Dichloroethane**	0.4 J	4.1	ug/L	05MW01S-032-20050818, 05MW01S-032-20050818-D	6/33	0.13	4.1	NA	**0.12 C**	5	MCL	**Yes**	ASL
	106-46-7	**1,4-Dichlorobenzene**	7.6	8.2	ug/L	05MW01S-032-20050818-D	1/33	0.12	8.2	NA	**0.47 C**	75	MCL	**Yes**	ASL
	67-64-1	Acetone	3.3 J	3.3 J	ug/L	05MW14S-066-20050824	1/10	1.6	3.3	NA	550 N	NA	NA	No	BSL
	71-43-2	**Benzene**	0.39 J	8.8	ug/L	05MW01S-032-20050818-D	4/33	0.15	8.8	NA	**0.34 C**	**5**	MCL	**Yes**	ASL
	75-00-3	Chloroethane	0.62 J	0.63 J	ug/L	05MW01S-032-20050818	1/33	0.46	0.63	NA	3.6 C	NA	NA	No	BSL
	67-66-3	**Chloroform**	0.33 J	0.33 J	ug/L	05MW01S-032-20050818, 05MW01S-032-20050818-D	1/33	0.16	0.33	NA	**0.15 C**	80	MCL	**Yes**	ASL
	156-59-2	**cis-1,2-Dichloroethene**	0.51 J	270	ug/L	05MW01S-032-20050818, 05MW01S-032-20050818-D	15/33	0.09	270	NA	**6.1 N**	**70**	MCL	**Yes**	ASL
		M+P-Xylenes	0.61 J	0.61 J	ug/L	05MW12S-070-20050825	1/33	0.24	0.61	NA	21 N[8]	10000	MCL[8]	No	BSL
	108-87-2	Methyl Cyclohexane	2	2.3	ug/L	05MW01S-032-20050818	1/33	0.14	2.3	NA	630 N	NA	NA	No	BSL
	75-09-2	Methylene Chloride	0.65 J	1	ug/L	05MW09SI-074-20050817, 05MW09I-106-20050817	4/33	0.42 - 1.2	1	NA	4.1 C	5	MCL	No	BSL
	127-18-4	**Tetrachloroethene**	0.77 J	50 J	ug/L	05MW01S-032-20050818	14/33	0.12	50	NA	**0.1 C**	**5**	MCL	**Yes**	ASL
	108-88-3	Toluene	0.65 J	0.65 J	ug/L	05MW12S-070-20050825	1/33	0.11	0.65	NA	230 N	1000	MCL	No	BSL
	1330-20-7	Total Xylenes	0.61 J	0.61 J	ug/L	05MW12S-070-20050825	1/33	0.37	0.61	NA	21 N	10000	MCL	No	BSL
	156-60-5	Trans-1,2-Dichloroethene	0.89 J	0.93 J	ug/L	05MW01S-032-20050818-D	1/33	0.1	0.93	NA	12 N	100	MCL	No	BSL
	79-01-6	**Trichloroethene**	0.36 J	490	ug/L	05MW01S-032-20050818-D	17/33	0.12	490	NA	**0.026 C**	**5**	MCL	**Yes**	ASL
	Semi-Volatile Organic Compounds														
	123-91-1	**1,4-Dioxane**	12	13	ug/L	05MW01S-032-20050818	1/32	2 - 2.1	13	NA	**6.1 C**	NA	NA	**Yes**	ASL
	Inorganics														
	7429-90-5	Aluminum	59.9	6970	ug/L	05MW10S_19970624	7/21	50 - 173	6970	Yes	NA	NA	MCL	No	NTX
	7440-38-2	**Arsenic**	2 L	2 L	ug/L	05MW10S_19970624	1/21	1	2	Yes	**0.045 C**	10	MCL	**Yes**	ASL
	7440-39-3	**Barium**	43.8	1430	ug/L	05MW10S_19970624	21/21	- - -	1430	Yes	**730 N**	2000	MCL	**Yes**	ASL
	7440-41-7	Beryllium	2.8	2.8	ug/L	05MW10S_19970624	1/21	1	2.8	Yes	7.3 N	4	MCL	No	BSL
	7440-70-2	Calcium	5740	39000	ug/L	05MW08SI_19970623	21/21	- - -	39000	Yes	NA	NA	MCL	No	NUT
	7440-47-3	**Chromium**	6 K	40.8	ug/L	05MW10S_19970624	6/21	5	40.8	Yes	**11 N[9]**	100	MCL[10]	**Yes**	ASL
	7440-48-4	Cobalt	5.1	18.8 K	ug/L	05MW09SI_19970623	3/21	5	18.8	Yes	NA	NA	MCL	No	NTX
	7439-89-6	**Iron**	61.4	7440	ug/L	05MW10S_19970624	18/21	50	7440	Yes	**1100 N**	NA	MCL	**Yes**	ASL
	7439-92-1	**Lead**	18.1	18.1	ug/L	05MW07I_19970623	1/21	1 - 19.9	18.1	Yes	**15**	**15**	MCL	**Yes**	ASL
	7439-95-4	Magnesium	1820	12000	ug/L	05MW08SI_19970623	21/21	- - -	12000	Yes	NA	NA	MCL	No	NUT
	7439-96-5	**Manganese**	5 K	397	ug/L	05MW01S_19970623	19/21	5	397	Yes	**73 N**	NA	MCL	**Yes**	ASL
	7440-02-0	**Nickel**	74.3	74.3	ug/L	05MW10S_19970624	1/21	20	74.3	Yes	**73 N**	NA	MCL	**Yes**	ASL
	7440-09-7	Potassium	1630	26000	ug/L	05MW06I_19970625	9/21	1500	26000	Yes	NA	NA	MCL	No	NUT
	7440-23-5	Sodium	7680	29100	ug/L	05MW10S_19970624	21/21	- - -	29100	Yes	NA	NA	MCL	No	NUT
	7440-62-2	**Vanadium**	5	5	ug/L	05MW10S_19970624	1/21	5	5	Yes	**3.7 N**	NA	MCL	**Yes**	ASL
	7440-66-6	Zinc	27.7 K	457	ug/L	05MW10S_19970624	5/21	5 - 39.2	457	Yes	1100 N	NA	MCL	No	BSL

TABLE 2.1
OCCURRENCE, DISTRIBUTION AND SELECTION OF CHEMICALS OF POTENTIAL CONCERN - GROUNDWATER
SITE 5 - FIRE TRAINING AREA
NASJGB WILLOW GROVE, PENNSYLVANIA

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	CAS Number	Chemical	Minimum Concentration(1)	Maximum Concentration(1)	Units	Sample with Maximum Concentration	Frequency of Detection	Range of Nondects(2)	Concentration Used for Screening(3)	Above Background Concentration(4)	EPA Region 3 RBCs for Tap Water(5)	Potential ARAR/TBC(6)	Potential ARAR/TBC Source(6)	COPC Flag	Rationale for Contaminant Deletion or Selection(7)

Footnotes
1 - Sample and duplicate are considered as two separate samples when determining the minimum and maximum concentrations.
2 - Values presented are sample-specific quantitation limits.
3 - The maximum detected concentration is used for screening purposes.
4 - No background data are available for groundwater.
5 - The EPA Region 3 tap water screening level is presented. Value represents the risk based tap water screening level divided by 10 to correspond to a target hazard quotient of 0.1 for noncarcinogens (denoted with a "N" flag), or an incremental cancer risk of 1.0E-6 for carcinogens (denoted with a "C" flag) (USEPA Region III, October 31, 2006).
6 - USEPA Primary Drinking Water Standard (USEPA,Summer 2006).
7 - The chemical is selected as a COPC if the maximum detected concentration exceeds the risk-based COPC screening level. Chemicals selected as COPCs are indicated by shaded chemical names.
8 - Value is for total xylenes.
9 - Value is for hexavalent chromium.
10 - Value is for total chromium.

Definitions:
ARAR/TBC = Applicable or Relevant and Appropriate Requirements To Be Considered
C = Carcinogen
COPC = Chemical Of Potential Concern
J = Estimated value
MCL = Maximum Contaminant Level
N = Noncarcinogen
NA = Not Applicable/Not Available
RBC = Risk Based Concentration

Associated Samples - Organics

05MW01I-135-20050817	05MW05I-210-20050810	05MW08SI-065-20050812-D	05MW11S-025-20050811
05MW01S-032-20050818	05MW05S-040-20050810	05MW09I-106-20050817	05MW12I-114-20050817
05MW01S-032-20050818-D	05MW06I-084-20050812	05MW09S-032-20050817	05MW12S-070-20050825
05MW01SI-085-20050818	05MW06S-038-20050812	05MW09SI-074-20050817	05MW13I-142-20050824
05MW02S-030-20050817	05MW07I-084-20050809	05MW10I-126-20050809	05MW14I-150-20050825
05MW03I-128-20050816	05MW07S-026-20050809	05MW10S-032-20050809	05MW14I-150-20050825-D
05MW03I-128-20050816-D	05MW08I-099-20050818	05MW10SI-094-20050809	05MW14S-066-20050824
05MW03S-031-20050816	05MW08S-036-20050812	05MW11D-149-20050811	05MW15I-150-20050824
05MW04I-085-20050816	05MW08SI-065-20050812	05MW11I-050-20050811	05MW15S-045-20050824
05MW04S-030-20050816			

Associated Samples - Inorganics

05MW01D_19970707	05MW03S_19970624	05MW07S_19970623	05MW09S_19970624
05MW01I_19970623	05MW04S_19970625	05MW08I_19970623	05MW09SI_19970623
05MW01S_19970623	05MW05S_19970624	05MW08I_19970623-D	05MW10I_19970624
05MW02S_19970624	05MW06I_19970625	05MW08S_19970625	05MW10S_19970624
05MW02S_19970624-D	05MW06S_19970625	05MW08SI_19970623	05MW10SI_19970624
05MW03I_19970624	05MW07I_19970623	05MW09I_19970623	

Rationale Codes:
For selection as a COPC:
ASL = Above Screening Level and site background.

For elimination as a COPC:
BSL = Below Screening Level
NTX = No toxicity criteria available

LIST OF TABLES
RAGS PART D TABLE 3
MEDIUM-SPECIFIC EXPOSURE POINT CONCENTRATION SUMMARY

Table No.

Reasonable Maximum/Central Tendency Exposures

3.1.RME Groundwater

TABLE 3.1.RME
EXPOSURE POINT CONCENTRATION SUMMARY
REASONABLE MAXIMUM EXPOSURE
NASJRB WILLOW GROVE

Scenario Timeframe: Current/Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean	95% UCL (Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
						Value	Units	Statistic	Rationale
Site 5	1,1,1-Trichloroethane	ug/L	35.5	319 (NP)	960	319	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	1,1,2-Trichloroethane	ug/L	0.890	7.66 (NP)	23	7.66	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	1,1-Dichloroethane	ug/L	22.3	169 (NP)	500	169	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	1,1-Dichloroethene	ug/L	13.1	72.8 (NP)	190	72.8	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	1,2-Dichloroethane	ug/L	0.361	1.96 (NP)	4.1	1.96	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	1,4-Dichlorobenzene	ug/L	0.298	1.33 (NP)	8.2	2.66	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (2)
	Benzene	ug/L	0.398	2.99 (NP)	8.8	2.99	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	Chloroform	ug/L	0.088	0.100 (NP)	0.33 J	0.33	ug/L	Maximum Concentration	W-, A-D, & K-S Test (3)
	cis-1,2-Dichloroethene	ug/L	9.68	90.8 (NP)	270	90.8	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	Tetrachloroethene	ug/L	2.15	17.0 (NP)	50 J	17.0	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	Trichloroethene	ug/L	18.8	163 (NP)	490	163	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	1,4-Dioxane	ug/L	1.4	2.00 (NP)	13	5	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	Arsenic	ug/L	0.6	0.695 (NP)	2 L	0.695	ug/L	Student-t UCL	W-, A-D, & K-S Test (4)
	Barium	ug/L	316.7	454 (G)	1430	454	ug/L	Approximate Gamma 95% UCL	A-D & K-S Test (5)
	Chromium	ug/L	5.3	13.3 (NP)	40.8	13.3	ug/L	95% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (6)
	Iron	ug/L	532.1	3990 (NP)	7440	3990	ug/L	99% Chebyshev(Mean, Std) UCL	W-, A-D, & K-S Test (1)
	Lead	ug/L	2.24	6.22 (NP)	18.1	2.24	ug/L	Arithmetic Mean	(7)
	Manganese	ug/L	81.5	144 (G)	397	144	ug/L	Approximate Gamma 95% UCL	A-D & K-S Test (5)
	Nickel	ug/L	13.1	18.3 (NP)	74.3	18.3	ug/L	Student-t UCL	W-, A-D, & K-S Test (4)
	Vanadium	ug/L	2.62	2.82 (NP)	5	2.82	ug/L	Student-t UCL	W-, A-D, & K-S Test (4)

For non-detects, 1/2 sample quantitation limit was used as a proxy concentration; for duplicate sample results, the average value was used in the calculation.
G = Gamma
L = Lognormal
NP = Non-parametric
1 - The Shapiro-Wilks, Anderson-Darling, and Kolmogorov-Smirnov tests indicate that the data is non-parametric. The ProUCL guidance recommends that the 99% Chebyshev(Mean, Std) UCL be used as the exposure point concentration.
2 - The Shapiro-Wilks, Anderson-Darling, and Kolmogorov-Smirnov tests indicate that the data is non-parametric. The ProUCL guidance recommends that the 95% Chebyshev(Mean, Std) UCL be used as the exposure point concentration. The 99% Chebyshev(Mean, Std) UCL was used as the exposure point concentration due to the low frequency of detection.
3 - The Shapiro-Wilks, Anderson-Darling, and Kolmogorov-Smirnov tests indicate that the data is non-parametric. The ProUCL guidance recommends that the Student-t UCL be used as the exposure point concentration. The maximum detected concentration was used as the exposure point concentration due to the low frequency of detection.
4 - The Shapiro-Wilks, Anderson-Darling, and Kolmogorov-Smirnov tests indicate that the data is non-parametric. The ProUCL guidance recommends that the Student-t or Modified-t UCL be used as the exposure point concentration. The Student-t UCL is presented.
5 - Anderson-Darling (A-D) and Kolmogorov Smirnov (K-S) test indicates that the data follows a gamma distribution, the approximate gamma 95% UCL is used as the exposure point concentration.
6 - The Shapiro-Wilks, Anderson-Darling, and Kolmogorov-Smirnov tests indicate that the data is non-parametric. The ProUCL guidance recommends that the 99% Chebyshev(Mean, Std) UCL be used as the exposure point concentration.
7 - Mean concentration is used as exposure point concentration for evaluating exposures to lead.
USEPA, 1994:Guidance Manual for the Integrated Exposure Uptake Biokinetic Model for lead in Children

Exposure point concentrations for the RME scenarios are also the exposure point concentrations for the CTE scenarios.

LIST OF TABLES
RAGS PART D TABLE 4
VALUES USED FOR DAILY INTAKE CALCULATIONS

Table No.

Reasonable Maximum Exposures

4.1.RME Child Residents Exposed to Groundwater
4.2.RME Adult Residents Exposed to Groundwater
4.3.RME Adult Residents Exposed to Volatile Emissions from Groundwater

Central Tendency Exposures

4.1.CTE Child Residents Exposed to Groundwater
4.2.CTE Adult Residents Exposed to Groundwater
4.3.CTE Adult Residents Exposed to Volatile Emissions from Groundwater

4.4 Intermediate Variables For Calculating DA(Event)

TABLE 4.1.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Residents	Child	Site 5	CGW	Chemical Concentration in Groundwater	Max or 95% UCL	mg/kg	USEPA, 2002	Chronic Daily Intake (CDI) (mg/kg/day) =
				CF	Conversion Factor	0.001	mg/ug	--	
				IR-GW	Ingestion Rate of Groundwater	1	L/day	USEPA, 1991	CGW x CF x IR-GW x EF x ED
				EF	Exposure Frequency	350	days/year	USEPA, 1991	BW x AT
				ED	Exposure Duration	6	years	USEPA, 1989, 1991	
				BW	Body Weight	15	kg	USEPA, 1989, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	USEPA, 1989	
Dermal	Residents	Child	Site 5	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	USEPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	6,600	cm2	USEPA, 2004	
				EV	Event Frequency	1	events/day	USEPA, 2004	DAevent x EV x EF x ED x SA
				ET	Exposure Time	1	hours/day	USEPA, 2004	BW x AT
				EF	Exposure Frequency	350	days/year	USEPA, 1991	
				ED	Exposure Duration	6	years	USEPA, 1989, 1991	See text for calculation of DAevent.
				BW	Body Weight	15	kg	USEPA, 1989, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,190	days	USEPA, 1989	

Sources:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

USEPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

USEPA, 2002: Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.

USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake = 5.48E-06 Cancer Dermal Intake = 3.62E+01

Noncancer Ingestion Intake = 6.39E-05 Noncancer Dermal Intake = 4.22E+02

TABLE 4.2.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Residents	Adult	Site 5	CGW	Chemical Concentration in Groundwater	95% UCL or Max	ug/L	USEPA, 2002	Chronic Daily Intake (CDI) (mg/kg/day) =
				CF	Conversion Factor	0.001	mg/ug	--	
				IR-GW	Ingestion Rate of Groundwater	2	L/day	USEPA, 1991	CGW x CF x IR-GW x EF x ED
				EF	Exposure Frequency	350	days/year	USEPA, 1991	BW x AT
				ED	Exposure Duration	24	years	USEPA, 1989, 1991	
				BW	Body Weight	70	kg	USEPA, 1989, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	USEPA, 1989	
Dermal	Residents	Adult	Site 5	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	USEPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	18,000	cm2	USEPA, 2004	
				EV	Event Frequency	1	events/day	USEPA, 2004	DAevent x EV x EF x ED x SA
				ET	Exposure Time	0.5	hours/day	USEPA, 2004	BW x AT
				EF	Exposure Frequency	350	days/year	USEPA, 1991	
				ED	Exposure Duration	24	years	USEPA, 1989, 1991	See text for calculation of DAevent.
				BW	Body Weight	70	kg	USEPA, 1989, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	8,760	days	USEPA, 1989	

Sources:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

USEPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

USEPA, 2002: Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.

USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake = 9.39E-06 Cancer Dermal Intake = 8.45E+01

Noncancer Ingestion Intake = 2.74E-05 Noncancer Dermal Intake = 2.47E+02

TABLE 4.3.RME

VALUES USED FOR DAILY INTAKE CALCULATIONS

REASONABLE MAXIMUM EXPOSURE

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Residents	Adult	Site 5	S	Volatile Chemical Generation Rate	Derived	mg/m3-min shower	Foster&Chrostowski 1987	Chronic Daily Intake (CDI) (mg/kg-day)=
				IRsh	Inhalation Rate of volatiles in shower	0.6	m3/hr	USEPA, 1989	
				EF	Exposure Frequency	350	days/year	USEPA, 1991	S x IRsh x K x EF x ED
				K	Masss Transfer Coefficient	Derived	min	Foster&Chrostowski 1987	BW x AT x Ra x CF
				ED	Exposure Duration	24	years	USEPA, 1989, 1991	
				BW	Body Weight	70	kg	USEPA, 1989, 1991	
				Ra	Air Exchange Rate	0.017	min-1	Foster&Chrostowski 1987	
				CF	Conversion Factor	60	min/hr		
				Ds	Shower Duration	30	min	USEPA, 2004	
				Dt	Total Time in Bathroom	60	min	USEPA, 2004	
				AT-C	Averaging Time (Cancer)	25550	days	USEPA, 1989	
				AT-N	Averaging Time (Noncancer)	8760	days	USEPA ,1989	

Sources

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

USEPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

Foster, S.A. and P.C. Chrostowski, 1987. Inhalation Exposure to Volatile Organic Contaminants in the Shower.

TABLE 4.1.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Residents	Child	Site 5	CGW	Chemical Concentration in Groundwater	Max or 95% UCL	mg/kg	USEPA, 2002	Chronic Daily Intake (CDI) (mg/kg/day) =
				CF	Conversion Factor	0.001	mg/ug	--	
				IR-GW	Ingestion Rate of Groundwater	0.7	L/day	USEPA, 1997	CGW x CF x IR-GW x EF x ED
				EF	Exposure Frequency	350	days/year	USEPA, 1991	BW x AT
				ED	Exposure Duration	2	years	USEPA, 1993	
				BW	Body Weight	15	kg	USEPA, 1989, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	730	days	USEPA, 1989	
Dermal	Residents	Child	Site 5	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	USEPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	6,600	cm2	USEPA, 2004	
				EV	Event Frequency	1	events/day	USEPA, 2004	DAevent x EV x EF x ED x SA
				ET	Exposure Time	0.33	hours/day	USEPA, 2004	BW x AT
				EF	Exposure Frequency	350	days/year	USEPA, 1991	
				ED	Exposure Duration	2	years	USEPA, 1993	See text for calculation of DAevent.
				BW	Body Weight	15	kg	USEPA, 1989, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	730	days	USEPA, 1989	

Sources:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

USEPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

USEPA, 2002: Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.

USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake = 1.28E-06 Cancer Dermal Intake = 1.21E+01

Noncancer Ingestion Intake = 4.47E-05 Noncancer Dermal Intake = 4.22E+02

TABLE 4.2.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Ingestion	Residents	Adult	Site 5	CGW	Chemical Concentration in Groundwater	95% UCL or Max	ug/L	USEPA, 2002	Chronic Daily Intake (CDI) (mg/kg/day) =
				CF	Conversion Factor	0.001	mg/ug	--	
				IR-GW	Ingestion Rate of Groundwater	1.4	L/day	USEPA, 1991	CGW x CF x IR-GW x EF x ED
				EF	Exposure Frequency	350	days/year	USEPA, 1991	BW x AT
				ED	Exposure Duration	7	years	USEPA, 1993	
				BW	Body Weight	70	kg	USEPA, 1989, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	USEPA, 1989	
Dermal	Residents	Adult	Site 5	Daevent	Dermally Absorbed Dose per Event	Calculated	mg/cm2-event	USEPA, 2004	Dermally Absorbed Dose (mg/kg/day) =
				SA	Skin Surface Available for Contact	18,000	cm2	USEPA, 2004	
				EV	Event Frequency	1	events/day	USEPA, 2004	DAevent x EV x EF x ED x SA
				ET	Exposure Time	0.25	hours/day	USEPA, 2004	BW x AT
				EF	Exposure Frequency	350	days/year	USEPA, 1991	
				ED	Exposure Duration	7	years	USEPA, 1989, 1991	See text for calculation of DAevent.
				BW	Body Weight	70	kg	USEPA, 1989, 1991	
				AT-C	Averaging Time (Cancer)	25,550	days	USEPA, 1989	
				AT-N	Averaging Time (Non-Cancer)	2,555	days	USEPA, 1989	

Sources:

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

USEPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

USEPA, 1993: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

USEPA, 2002: Calculating Upper Confidence Limits for Exposure Point Concentrations at Hazardous Waste Sites. OSWER 9285.6-10.

USEPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Final. EPA/540/R/99/005.

Unit Intake Calculations

Ingestion Intake = (IR-GW x EF x ED)/(BW x AT)

Dermal Intake = (SA x EV x EF x ED)/(BW x AT)

Cancer Ingestion Intake = 1.92E-06 Cancer Dermal Intake = 2.47E+01

Noncancer Ingestion Intake = 1.92E-05 Noncancer Dermal Intake = 2.47E+02

TABLE 4.3.CTE

VALUES USED FOR DAILY INTAKE CALCULATIONS

CENTRAL TENDENCY EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Air

Exposure Route	Receptor Population	Receptor Age	Exposure Point	Parameter Code	Parameter Definition	Value	Units	Rationale/ Reference	Intake Equation/ Model Name
Inhalation	Residents	Adult	Site 5	S	Volatile Chemical Generation Rate	Derived	mg/m3-min shower	Foster&Chrostowski 1987	Chronic Daily Intake (CDI) (mg/kg-day)=
				IRsh	Inhalation Rate of volatiles in shower	0.6	m3/hr	USEPA, 1989	
				EF	Exposure Frequency	350	days/year	USEPA, 1991	S x IRsh x K x EF x ED
				K	Masss Transfer Coefficient	Derived	min	Foster&Chrostowski 1987	BW x AT x Ra x CF
				ED	Exposure Duration	7	years	USEPA, 1993	
				BW	Body Weight	70	kg	USEPA, 1989, 1991	
				Ra	Air Exchange Rate	0.017	min-1	Foster&Chrostowski 1987	
				CF	Conversion Factor	60	min/hr		
				Ds	Shower Duration	15	min	USEPA, 1997	
				Dt	Total Time in Bathroom	30	min	USEPA, 1997	
				AT-C	Averaging Time (Cancer)	25550	days	USEPA, 1989	
				AT-N	Averaging Time (Noncancer)	2555	days	USEPA ,1989	

Sources

USEPA, 1989: Risk Assessment Guidance for Superfund. Vol 1: Human Health Evaluation Manual, Part A. EPA/540/1-86/060.

USEPA, 1991: Risk Assessment Guidance for Superfund - Supplemental Guidance- Standard Default Exposure Factors Interim Final.

USEPA, 1993: Superfund Standard Default Exposure Factors for the Central Tendency and Reasonable Maximum Exposure.

USEPA, 1997: Exposure Factors Handbook.

Foster, S.A. and P.C. Chrostowski, 1987. Inhalation Exposure to Volatile Organic Contaminants in the Shower.

TABLE 4.4
INTERMEDIATE VARIABLES FOR CALCULATING DA(EVENT)
SITE 5 - FIRE TRAINING AREA
NASJRB WILLOW, GROVE PENNSYLVANIA

Chemical of Potential Concern	Media	Dermal Absorption Fraction (soil)	FA	Kp		T(event)		Tau		T*		B
			Value	Value	Units	Value	Units	Value	Units	Value	Units	Value
Volatile Organic Compounds												
1,1,1-Trichloroethane	Groundwater	NA	1	1.3E-02	cm/hr	(1)	hr	6.0E-01	hr	1.4E+00	hr	5.6E-02
1,1,2-Trichloroethane	Groundwater	NA	1	6.4E-03	cm/hr	(1)	hr	6.0E-01	hr	1.4E+00	hr	2.9E-02
1,1-Dichloroethane	Groundwater	NA	1	6.7E-03	cm/hr	(1)	hr	3.8E-01	hr	9.2E-01	hr	2.6E-02
1,1-Dichloroethene	Groundwater	NA	1	1.2E-02	cm/hr	(1)	hr	3.7E-01	hr	8.9E-01	hr	4.4E-02
1,2-Dichloroethane	Groundwater	NA	1	4.2E-03	cm/hr	(1)	hr	3.8E-01	hr	9.2E-01	hr	1.6E-02
1,4-Dichlorobenzene	Groundwater	NA	1	4.2E-02	cm/hr	(1)	hr	7.1E-01	hr	1.7E+00	hr	2.0E-01
Benzene	Groundwater	NA	1	1.5E-02	cm/hr	(1)	hr	2.9E-01	hr	7.0E-01	hr	5.1E-02
Chloroform	Groundwater	NA	1	6.8E-03	cm/hr	(1)	hr	5.0E-01	hr	1.2E+00	hr	2.9E-02
cis-1,2-Dichloroethene	Groundwater	NA	1	1.1E-02	cm/hr	(1)	hr	3.7E-01	hr	8.8E-01	hr	4.1E-02
Tetrachloroethene	Groundwater	NA	1	3.3E-02	cm/hr	(1)	hr	9.1E-01	hr	2.2E+00	hr	1.7E-01
Trichloroethene	Groundwater	NA	1	1.2E-02	cm/hr	(1)	hr	5.8E-01	hr	1.4E+00	hr	5.1E-02
Semivolatile Organic Compounds												
1,4-Dioxane	Groundwater	NA	1	3.3E-04	cm/hr	(1)	hr	3.3E-01	hr	8.0E-01	hr	1.2E-03
Inorganics												
Arsenic	Groundwater	NA	NA	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Barium	Groundwater	NA	NA	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Chromium	Groundwater	NA	NA	2.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Iron	Groundwater	NA	NA	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Lead	Groundwater	NA	NA	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Manganese	Groundwater	NA	NA	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Nickel	Groundwater	NA	NA	2.0E-04	cm/hr	(1)	hr	NA	NA	NA	NA	NA
Vanadium	Groundwater	NA	NA	1.0E-03	cm/hr	(1)	hr	NA	NA	NA	NA	NA

Notes:
All values from EPA's Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final, July 2004.
1 - T(event) is 1 hr for the child resident and 0.50 hr for the adult resident for exposures to groundwater under the RME scenario.
FA = Fraction Absorbed Water
Kp = Dermal Permeability Coefficient of Compound in Water
T(event) = Event Duration
Tau = Lag Time
T* = Time to Reach Steady-State
B = Dimensionless Ratio of the Permeability Coefficient of a Compound Through the Stratum Corneum Relative to its Permeability Coefficient Across the Viable Epidermis
NA = Not applicable.

LIST OF TABLES
RAGS PART D TABLE 5
NON-CANCER TOXICITY DATA

Table No.

5-1 Non-Cancer Toxicity Data - Oral/Dermal
5-2 Non-Cancer Toxicity Data - Inhalation

TABLE 5.1
NON-CANCER TOXICITY DATA -- ORAL/DERMAL
NASJRB WILLOW GROVE, PENNSYLVANIA

Chemical of Potential Concern	Chronic/ Subchronic	Oral RfD		Oral Absorption Efficiency for Dermal[1]	Absorbed RfD for Dermal[2]		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfD:Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds										
1,1,1-Trichloroethane	Chronic	2.8E-01	mg/kg/day	1	2.8E-01	mg/kg/day	None Reported	NA	EPA 3	10/31/2006
1,1,2-Trichloroethane	Chronic	4.0E-03	mg/kg/day	1	4.0E-03	mg/kg/day	Blood	1000/1	IRIS	12/11/2006
1,1-Dichloroethane	Chronic	2.0E-01	mg/kg/day	1	2.0E-01	mg/kg/day	Kidney	NA	EPA 3	10/31/2006
1,1-Dichloroethene	Chronic	5.0E-02	mg/kg/day	1	5.0E-02	mg/kg/day	Liver	100/1	IRIS	12/11/2006
1,2-Dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,4-Dichlorobenzene	Chronic	3.0E-02	mg/kg/day	1	3.0E-02	mg/kg/day	Liver	NA	EPA 3	10/31/2006
Benzene	Chronic	4.0E-03	mg/kg/day	1	4.0E-03	mg/kg/day	Blood	300/1	IRIS	12/11/2006
Chloroform	Chronic	1.0E-02	mg/kg/day	1	1.0E-02	mg/kg/day	Liver	1000/1	IRIS	12/11/2006
cis-1,2-Dichloroethene	Chronic	1.0E-02	mg/kg/day	1	1.0E-02	mg/kg/day	Blood	NA	EPA 3	10/31/2006
Tetrachloroethene	Chronic	1.0E-02	mg/kg/day	1	1.0E-02	mg/kg/day	Liver	1000/1	IRIS	12/11/2006
Trichloroethene	Chronic	5.0E-01	mg/kg/day	1	5.0E-01	mg/kg/day	Liver	NA	CA EPA	12/2002
Semivolatile Organic Compounds										
1,4-Dioxane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Inorganics										
Arsenic	Chronic	3.0E-04	mg/kg/day	1	3.0E-04	mg/kg/day	CVS, Skin	3/1	IRIS	12/11/2006
Barium	Chronic	2.0E-01	mg/kg/day	0.07	1.4E-02	mg/kg/day	Blood	300/1	IRIS	12/11/2006
Chromium	Chronic	3.0E-03	mg/kg/day	0.025	7.5E-05	mg/kg/day	Fetotoxicity, GS, Bone	300/3	IRIS	12/11/2006
Iron	Chronic	3.0E-01	mg/kg/day	1	3.0E-01	mg/kg/day	None Reported	1	EPA 3	10/31/2006
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	Chronic	2.4E-02	mg/kg/day	0.04	9.6E-04	mg/kg/day	CNS	6	IRIS	12/11/2006
Nickel	Chronic	2.0E-02	mg/kg/day	0.04	8.0E-04	mg/kg/day	Body Weight	300/1	IRIS	12/11/2006
Vanadium	Chronic	1.0E-03	mg/kg/day	0.026	2.6E-05	mg/kg/day	Kidney	300	EPA 3	10/31/2006

Notes:
1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.
2 - Adjusted dermal RfD = Oral RfD x Oral Absorption Efficiency for Dermal.

Definitions:
EPA 3 = U.S. EPA Region 3 Risk-Based Concentration Table, October 31, 2006.
IRIS = Integrated Risk Information System
NA = Not Applicable
CA EPA = California EPA, Technical Support Document for Describing Available Cancer Potency Factors, December 2002.
GS = Gastrointestinal sysyem
CNS = Central nervous system
CVS = Cardiovascular system

TABLE 5.2
NON-CANCER TOXICITY DATA -- INHALATION
NASJRB WILLOW GROVE, PENNSYLVANIA

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC		Extrapolated RfD[1]		Primary Target Organ(s)	Combined Uncertainty/Modifying Factors	RfC : Target Organ(s)	
		Value	Units	Value	Units			Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds									
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1,2-Trichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	Chronic	4.9E-01	mg/m^3	1.4E-01	(mg/kg/day)	Kidney	NA	EPA 3	10/26/2006
1,1-Dichloroethene	Chronic	2.0E-01	mg/m^3	6.0E-02	(mg/kg/day)	Liver	30/1	IRIS	12/11/2006
1,2-Dichloroethane	Chronic	2.5E+00	mg/m^3	7.0E-01	(mg/kg/day)	NA	NA	EPA 3	10/26/2006
1,4-Dichlorobenzene	Chronic	8.0E-01	mg/m^3	2.3E-01	(mg/kg/day)	Liver	100/1	IRIS	12/11/2006
Benzene	Chronic	3.0E-02	mg/m^3	8.6E-03	(mg/kg/day)	Blood	300/1	IRIS	12/11/2006
Chloroform	Chronic	4.9E-02	mg/m^3	1.4E-02	(mg/kg/day)	Liver	NA	EPA 3	10/26/2006
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	NA	NA	NA	NA
Tetrachloroethene	Chronic	2.8E-01	mg/m^3	8.0E-02	(mg/kg/day)	Liver	NA	EPA 3	10/26/2006
Trichloroethene	Chronic	6.0E-01	mg/m^3	1.7E-01	(mg/kg/day)	Liver	NA	CA EPA	12/2002
Semivolatile Organic Compounds									
1,4-Dioxane	NA	NA	NA	NA	NA	NA	NA	NA	NA
Inorganics									
Arsenic	NA	NA	NA	NA	NA	NA	NA	IRIS	12/11/2006
Barium	Chronic	5.0E-04	mg/m^3	1.4E-04	(mg/kg/day)	Fetotoxicity	300	HEAST	7/97
Chromium	Chronic	1.0E-04	mg/m^3	2.9E-05	(mg/kg/day)	Lungs	300/1	IRIS	12/11/2006
Iron	NA	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	Chronic	5.0E-05	mg/m^3	1.4E-05	(mg/kg/day)	CNS	1000/1	IRIS	12/11/2006
Nickel	NA	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA	NA

Notes:
1 - Extrapolated RfD = RfC *$20m^3$/day / 70 kg

Definitions:
EPA 3 = U.S. EPA Region 3 RBC Table, October 31, 2006.
IRIS = Integrated Risk Information System
NA = Not Applicable
CA EPA = California EPA, Technical Support Document for Describing Available Cancer Potency Factors, December 2002.

LIST OF TABLES
RAGS PART D TABLE 6
CANCER TOXICITY DATA

Table No.

6-1 Cancer Toxicity Data - Oral/Dermal
6-2 Cancer Toxicity Data - Inhalation

TABLE 6.1
CANCER TOXICITY DATA -- ORAL/DERMAL
NASJRB WILLOW GROVE, PENNSYLVANIA

Chemical of Potential Concern	Oral Cancer Slope Factor		Oral Absorption Efficiency for Dermal[1]	Absorbed Cancer Slope Factor for Dermal[2]		Weight of Evidence/ Cancer Guideline Description	Oral CSF	
	Value	Units		Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds								
1,1,1-Trichloroethane	NA	NA	NA	NA	NA	D	IRIS	12/11/2006
1,1,2-Trichloroethane	5.7E-02	$(mg/kg/day)^{-1}$	1	5.7E-02	$(mg/kg/day)^{-1}$	C	IRIS	12/11/2006
1,1-Dichloroethane	NA	NA	NA	NA	NA	C	IRIS	12/11/2006
1,1-Dichloroethene	NA	NA	NA	NA	NA	C	IRIS	12/11/2006
1,2-Dichloroethane	9.1E-02	$(mg/kg/day)^{-1}$	1	9.1E-02	$(mg/kg/day)^{-1}$	B2	IRIS	12/11/2006
1,4-Dichlorobenzene	2.4E-02	$(mg/kg/day)^{-1}$	1	2.4E-02	$(mg/kg/day)^{-1}$	C	HEAST	7/97
Benzene	5.5E-02	$(mg/kg/day)^{-1}$	1	5.5E-02	$(mg/kg/day)^{-1}$	A	IRIS	12/11/2006
Chloroform	NA	NA	NA	NA	NA	B2	IRIS	12/11/2006
cis-1,2-Dichloroethene	NA	NA	NA	NA	NA	D	IRIS	12/11/2006
Tetrachloroethene	5.4E-01	$(mg/kg/day)^{-1}$	1	5.4E-01	$(mg/kg/day)^{-1}$	NA	EPA 3	10/26/2006
Trichloroethene	1.3E-02	$(mg/kg/day)^{-1}$	1	1.3E-02	$(mg/kg/day)^{-1}$	C	CA EPA	12/2002
Semivolatile Organic Compounds								
1,4-Dioxane	1.1E-02	$(mg/kg/day)^{-1}$	1	1.1E-02	$(mg/kg/day)^{-1}$	B2	IRIS	11/02/2005
Inorganics								
Arsenic	1.5E+00	$(mg/kg/day)^{-1}$	1	1.5E+00	$(mg/kg/day)^{-1}$	A	IRIS	12/11/2006
Barium	NA	NA	NA	NA	NA	D	IRIS	12/11/2006
Chromium	NA	NA	NA	NA	NA	D	IRIS	12/11/2006
Iron	NA	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	NA	B2	IRIS	12/11/2006
Manganese	NA	NA	NA	NA	NA	D	IRIS	12/11/2006
Nickel	NA	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA	NA

Notes:

1 - U.S. EPA, 2004: Risk Assessment Guidance for Superfund (Part E, Supplemental Guidance for Dermal Risk Assessment) Interim. EPA/540/R/99/005.

2 - Adjusted cancer slope factor for dermal = Oral cancer slope factor x Oral Absorption Efficiency for Dermal.

Definitions:

EPA 3 = U.S. EPA Region 3 RBC Table, October 31, 2006.

IRIS = Integrated Risk Information System.

HEAST =U.S. EPA's Health Effects Assessment Summary Tables, July 1997.

NA = Not Available.

CA EPA = California EPA, Technical Support Document for Describing Available Cancer Potency Factors, December 2002.

EPA Group:

A - Human carcinogen.

B1 - Probable human carcinogen - indicates that limited human data are available.

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .

C - Possible human carcinogen.

D - Not classifiable as a human carcinogen.

E - Evidence of noncarcinogenicity.

TABLE 6.2
CANCER TOXICITY DATA -- INHALATION
NASJRB WILLOW GROVE, PENNSYLVANIA

Chemical of Potential Concern	Unit Risk		Inhalation Cancer Slope Factor[1]		Weight of Evidence/ Cancer Guideline Description	Unit Risk : Inhalation CSF	
	Value	Units	Value	Units		Source(s)	Date(s) (MM/DD/YYYY)
Volatile Organic Compounds							
1,1,1-Trichloroethane	NA	NA	NA	NA	D	IRIS	12/11/2006
1,1,2-Trichloroethane	1.6E-02	$(mg/m^3)^{-1}$	5.6E-02	$(mg/kg/day)^{-1}$	C	IRIS	12/11/2006
1,1-Dichloroethane	NA	NA	NA	NA	C	IRIS	12/11/2006
1,1-Dichloroethene	NA	NA	NA	NA	C	IRIS	12/11/2006
1,2-Dichloroethane	2.6E-02	$(mg/m^3)^{-1}$	9.1E-02	$(mg/kg/day)^{-1}$	B2	IRIS	12/11/2006
1,4-Dichlorobenzene	6.3E-03	$(mg/m^3)^{-1}$	2.2E-02	$(mg/kg/day)^{-1}$	C	EPA 3	10/26/2006
Benzene	7.8E-03	$(mg/m^3)^{-1}$	2.7E-02	$(mg/kg/day)^{-1}$	A	IRIS	12/11/2006
Chloroform	2.3E-02	$(mg/m^3)^{-1}$	8.1E-02	$(mg/kg/day)^{-1}$	B2	IRIS	12/11/2006
cis-1,2-Dichloroethene	NA	NA	NA	NA	D	IRIS	12/11/2006
Tetrachloroethene	5.7E-03	$(mg/m^3)^{-1}$	2.0E-02	$(mg/kg/day)^{-1}$	NA	EPA 3	10/26/2006
Trichloroethene	2.0E-03	$(mg/m^3)^{-1}$	7.0E-03	$(mg/kg/day)^{-1}$	C	CA EPA	12/2002
Semivolatile Organic Compounds							
1,4-Dioxane	NA	NA	NA	NA	NA	NA	NA
Inorganics							
Arsenic	4.3E+00	$(mg/m^3)^{-1}$	1.5E+01	$(mg/kg/day)^{-1}$	A	IRIS	12/11/2006
Barium	NA	NA	NA	NA	D	IRIS	12/11/2006
Chromium	1.2E+01	$(mg/m^3)^{-1}$	4.2E+01	$(mg/kg/day)^{-1}$	A	IRIS	12/11/2006
Iron	NA	NA	NA	NA	NA	NA	NA
Lead	NA	NA	NA	NA	B2	IRIS	12/11/2006
Manganese	NA	NA	NA	NA	D	IRIS	12/11/2006
Nickel	NA	NA	NA	NA	NA	NA	NA
Vanadium	NA	NA	NA	NA	NA	NA	NA

Notes:

1 - Inhalation CSF = Unit Risk * 70 kg / $20m^3$/day.

EPA Group:

A - Human carcinogen.

B1 - Probable human carcinogen - indicates that limited human data are available.

B2 - Probable human carcinogen - indicates sufficient evidence in animals and inadequate or no evidence in humans .

C - Possible human carcinogen.

D - Not classifiable as a human carcinogen.

E - Evidence of noncarcinogenicity.

Definitions:

IRIS = Integrated Risk Information System.

NA = Not Available.

EPA 3 = U.S. EPA Region 3 RBC Table, October 31, 2006.

CA EPA = California EPA, Technical Support Document for Describing Available Cancer Potency Factors, December 2002.

LIST OF TABLES
RAGS PART D TABLE 7
CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

Table No.

REASONABLE MAXIMUM EXPOSURES

7.1.RME Child Residents
7.2.RME Adult Residents

CENTRAL TENDENCY EXPOSURES

7.1.CTE Child Residents
7.2.CTE Adult Residents

TABLE 7.1.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 5	Ingestion	1,1,1-Trichloroethane	319	ug/L	1.7E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.0E-02	(mg/kg/day)	2.8E-01	(mg/kg/day)	0.07
				1,1,2-Trichloroethane	7.66	ug/L	4.2E-05	(mg/kg/day)	5.7E-02	(mg/kg/day)$^{-1}$	2.4E-06	4.9E-04	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.1
				1,1-Dichloroethane	169	ug/L	9.3E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.1E-02	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.05
				1,1-Dichloroethene	72.8	ug/L	4.0E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.7E-03	(mg/kg/day)	5.0E-02	(mg/kg/day)	0.09
				1,2-Dichloroethane	1.96	ug/L	1.1E-05	(mg/kg/day)	9.1E-02	(mg/kg/day)$^{-1}$	9.8E-07	1.3E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				1,4-Dichlorobenzene	2.66	ug/L	1.5E-05	(mg/kg/day)	2.4E-02	(mg/kg/day)$^{-1}$	3.5E-07	1.7E-04	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.006
				Benzene	2.99	ug/L	1.6E-05	(mg/kg/day)	5.5E-02	(mg/kg/day)$^{-1}$	9.0E-07	1.9E-04	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.05
				Chloroform	0.330	ug/L	1.8E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.1E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.002
				cis-1,2-Dichloroethene	90.8	ug/L	5.0E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	5.8E-03	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.6
				Tetrachloroethene	17.0	ug/L	9.3E-05	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	5.0E-05	1.1E-03	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.1
				Trichloroethene	163	ug/L	8.9E-04	(mg/kg/day)	1.3E-02	(mg/kg/day)$^{-1}$	1.2E-05	1.0E-02	(mg/kg/day)	5.0E-01	(mg/kg/day)	0.02
				1,4-Dioxane	4.96	ug/L	2.7E-05	(mg/kg/day)	1.1E-02	(mg/kg/day)$^{-1}$	3.0E-07	3.2E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.695	ug/L	3.8E-06	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	5.7E-06	4.4E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.1
				Barium	454	ug/L	2.5E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.9E-02	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.1
				Chromium	13.3	ug/L	7.3E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	8.5E-04	(mg/kg/day)	3.0E-03	(mg/kg/day)	0.3
				Iron	3990	ug/L	2.2E-02	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.6E-01	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.9
				Lead	2.24	ug/L	1.2E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.4E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	144	ug/L	7.9E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	9.2E-03	(mg/kg/day)	2.4E-02	(mg/kg/day)	0.4
				Nickel	18.3	ug/L	1.0E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.2E-03	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.06
				Vanadium	2.82	ug/L	1.5E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.8E-04	(mg/kg/day)	1.0E-03	(mg/kg/day)	0.2
			Exp. Route Total								7.3E-05					3.2
			Dermal	1,1,1-Trichloroethane	319	ug/L	3.1E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.6E-03	(mg/kg/day)	2.8E-01	(mg/kg/day)	0.01
				1,1,2-Trichloroethane	7.66	ug/L	3.8E-06	(mg/kg/day)	5.7E-02	(mg/kg/day)$^{-1}$	2.2E-07	4.4E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.01
				1,1-Dichloroethane	169	ug/L	7.3E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	8.5E-04	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.004
				1,1-Dichloroethene	72.8	ug/L	5.3E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	6.2E-04	(mg/kg/day)	5.0E-02	(mg/kg/day)	0.01
				1,2-Dichloroethane	1.96	ug/L	5.2E-07	(mg/kg/day)	9.1E-02	(mg/kg/day)$^{-1}$	4.8E-08	6.1E-06	(mg/kg/day)	NA	(mg/kg/day)	--
				1,4-Dichlorobenzene	2.66	ug/L	9.4E-06	(mg/kg/day)	2.4E-02	(mg/kg/day)$^{-1}$	2.3E-07	1.1E-04	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.004
				Benzene	2.99	ug/L	2.5E-06	(mg/kg/day)	5.5E-02	(mg/kg/day)$^{-1}$	1.4E-07	2.9E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.007
				Chloroform	0.330	ug/L	1.6E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.9E-06	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.0002
				cis-1,2-Dichloroethene	90.8	ug/L	6.2E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	7.2E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.07
				Tetrachloroethene	17.0	ug/L	5.4E-05	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	2.9E-05	6.3E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.06
				Trichloroethene	163	ug/L	1.4E-04	(mg/kg/day)	1.3E-02	(mg/kg/day)$^{-1}$	1.9E-06	1.7E-03	(mg/kg/day)	5.0E-01	(mg/kg/day)	0.003
				1,4-Dioxane	4.96	ug/L	9.9E-08	(mg/kg/day)	1.1E-02	(mg/kg/day)$^{-1}$	1.1E-09	1.2E-06	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.695	ug/L	2.5E-08	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	3.8E-08	2.9E-07	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.0010
				Barium	454	ug/L	1.6E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.9E-04	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.01
				Chromium	13.3	ug/L	9.6E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.1E-05	(mg/kg/day)	7.5E-05	(mg/kg/day)	0.1
				Iron	3990	ug/L	1.4E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.7E-03	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.006
				Lead	2.24	ug/L	8.1E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	9.5E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	144	ug/L	5.2E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	6.1E-05	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.06
				Nickel	18.3	ug/L	1.3E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.5E-06	(mg/kg/day)	8.0E-04	(mg/kg/day)	0.002
				Vanadium	2.82	ug/L	1.0E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.2E-06	(mg/kg/day)	2.6E-05	(mg/kg/day)	0.05
			Exp. Route Total								3.2E-05					0.5
		Exposure Point Total									1.0E-04					3.6
	Exposure Medium Total										1.0E-04					3.6
Medium Total											1.0E-04					3.6
										Total of Receptor Risks Across All Media	1.0E-04				Total of Receptor Hazards Across All Media	3.6

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 5	Ingestion	1,1,1-Trichloroethane	319	ug/L	3.0E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	8.7E-03	(mg/kg/day)	2.8E-01	(mg/kg/day)	0.03
				1,1,2-Trichloroethane	7.66	ug/L	7.2E-05	(mg/kg/day)	5.7E-02	(mg/kg/day)$^{-1}$	4.1E-06	2.1E-04	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.05
				1,1-Dichloroethane	169	ug/L	1.6E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.6E-03	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.02
				1,1-Dichloroethene	72.8	ug/L	6.8E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.0E-03	(mg/kg/day)	5.0E-02	(mg/kg/day)	0.04
				1,2-Dichloroethane	1.96	ug/L	1.8E-05	(mg/kg/day)	9.1E-02	(mg/kg/day)$^{-1}$	1.7E-06	5.4E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				1,4-Dichlorobenzene	2.66	ug/L	2.5E-05	(mg/kg/day)	2.4E-02	(mg/kg/day)$^{-1}$	6.0E-07	7.3E-05	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.002
				Benzene	2.99	ug/L	2.8E-05	(mg/kg/day)	5.5E-02	(mg/kg/day)$^{-1}$	1.5E-06	8.2E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.02
				Chloroform	0.330	ug/L	3.1E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	9.0E-06	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.0009
				cis-1,2-Dichloroethene	90.8	ug/L	8.5E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.5E-03	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.2
				Tetrachloroethene	17.0	ug/L	1.6E-04	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	8.6E-05	4.7E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.05
				Trichloroethene	163	ug/L	1.5E-03	(mg/kg/day)	1.3E-02	(mg/kg/day)$^{-1}$	2.0E-05	4.5E-03	(mg/kg/day)	5.0E-01	(mg/kg/day)	0.009
				1,4-Dioxane	4.96	ug/L	4.7E-05	(mg/kg/day)	1.1E-02	(mg/kg/day)$^{-1}$	5.1E-07	1.4E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.695	ug/L	6.5E-06	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	9.8E-06	1.9E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.06
				Barium	454	ug/L	4.3E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.2E-02	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.06
				Chromium	13.3	ug/L	1.2E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.6E-04	(mg/kg/day)	3.0E-03	(mg/kg/day)	0.1
				Iron	3990	ug/L	3.7E-02	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.1E-01	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.4
				Lead	2.24	ug/L	2.1E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	6.1E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	144	ug/L	1.4E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.9E-03	(mg/kg/day)	2.4E-02	(mg/kg/day)	0.2
				Nickel	18.3	ug/L	1.7E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	5.0E-04	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.03
				Vanadium	2.82	ug/L	2.6E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	7.7E-05	(mg/kg/day)	1.0E-03	(mg/kg/day)	0.08
			Exp. Route Total								1.2E-04					1.4
			Dermal	1,1,1-Trichloroethane	319	ug/L	5.1E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.5E-03	(mg/kg/day)	2.8E-01	(mg/kg/day)	0.005
				1,1,2-Trichloroethane	7.66	ug/L	6.3E-06	(mg/kg/day)	5.7E-02	(mg/kg/day)$^{-1}$	3.6E-07	1.8E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.005
				1,1-Dichloroethane	169	ug/L	1.2E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.4E-04	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.002
				1,1-Dichloroethene	72.8	ug/L	8.6E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.5E-04	(mg/kg/day)	5.0E-02	(mg/kg/day)	0.005
				1,2-Dichloroethane	1.96	ug/L	8.4E-07	(mg/kg/day)	9.1E-02	(mg/kg/day)$^{-1}$	7.6E-08	2.5E-06	(mg/kg/day)	NA	(mg/kg/day)	--
				1,4-Dichlorobenzene	2.66	ug/L	1.6E-05	(mg/kg/day)	2.4E-02	(mg/kg/day)$^{-1}$	3.7E-07	4.5E-05	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.002
				Benzene	2.99	ug/L	4.0E-06	(mg/kg/day)	5.5E-02	(mg/kg/day)$^{-1}$	2.2E-07	1.2E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.003
				Chloroform	0.330	ug/L	2.6E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	7.7E-07	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.00008
				cis-1,2-Dichloroethene	90.8	ug/L	9.9E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.9E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.03
				Tetrachloroethene	17.0	ug/L	8.9E-05	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	4.8E-05	2.6E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.03
				Trichloroethene	163	ug/L	2.4E-04	(mg/kg/day)	1.3E-02	(mg/kg/day)$^{-1}$	3.1E-06	7.0E-04	(mg/kg/day)	5.0E-01	(mg/kg/day)	0.001
				1,4-Dioxane	4.96	ug/L	1.6E-07	(mg/kg/day)	1.1E-02	(mg/kg/day)$^{-1}$	1.7E-09	4.6E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.695	ug/L	2.9E-08	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	4.4E-08	8.6E-08	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.0003
				Barium	454	ug/L	1.9E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	5.6E-05	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.004
				Chromium	13.3	ug/L	1.1E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.3E-06	(mg/kg/day)	7.5E-05	(mg/kg/day)	0.04
				Iron	3990	ug/L	1.7E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.9E-04	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.002
				Lead	2.24	ug/L	9.5E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.8E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	144	ug/L	6.1E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.8E-05	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.02
				Nickel	18.3	ug/L	1.5E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.5E-07	(mg/kg/day)	8.0E-04	(mg/kg/day)	0.0006
				Vanadium	2.82	ug/L	1.2E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.5E-07	(mg/kg/day)	2.6E-05	(mg/kg/day)	0.01
			Exp. Route Total								5.2E-05					0.2
		Exposure Point Total									1.8E-04					1.5
	Exposure Medium Total										1.8E-04					1.5
	Air	Site 5	Inhalation	1,1,1-Trichloroethane	0.488	mg/m3	1.4E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.0E-03	(mg/kg/day)	NA	(mg/kg/day)	--

TABLE 7.2.RME

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

REASONABLE MAXIMUM EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
				1,1,2-Trichloroethane	0.009	mg/m3	2.7E-05	(mg/kg/day)	5.6E-02	$(mg/kg/day)^{-1}$	1.5E-06	7.8E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				1,1-Dichloroethane	0.289	mg/m3	8.1E-04	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	2.4E-03	(mg/kg/day)	1.4E-01	(mg/kg/day)	0.02
				1,1-Dichloroethene	0.130	mg/m3	3.7E-04	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	1.1E-03	(mg/kg/day)	6.0E-02	(mg/kg/day)	0.02
				1,2-Dichloroethane	0.003	mg/m3	8.0E-06	(mg/kg/day)	9.1E-02	$(mg/kg/day)^{-1}$	7.2E-07	2.3E-05	(mg/kg/day)	7.0E-01	(mg/kg/day)	0.00003
				1,4-Dichlorobenzene	0.004	mg/m3	1.0E-05	(mg/kg/day)	2.2E-02	$(mg/kg/day)^{-1}$	2.2E-07	3.0E-05	(mg/kg/day)	2.3E-01	(mg/kg/day)	0.0001
				Benzene	0.006	mg/m3	1.6E-05	(mg/kg/day)	2.7E-02	$(mg/kg/day)^{-1}$	4.3E-07	4.7E-05	(mg/kg/day)	8.6E-03	(mg/kg/day)	0.005
				Chloroform	5.1E-4	mg/m3	1.4E-06	(mg/kg/day)	8.1E-02	$(mg/kg/day)^{-1}$	1.2E-07	4.2E-06	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.0003
				cis-1,2-Dichloroethene	0.155	mg/m3	4.4E-04	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	1.3E-03	(mg/kg/day)	NA	(mg/kg/day)	--
				Tetrachloroethene	0.023	mg/m3	6.6E-05	(mg/kg/day)	2.0E-02	$(mg/kg/day)^{-1}$	1.3E-06	1.9E-04	(mg/kg/day)	8.0E-02	(mg/kg/day)	0.002
				Trichloroethene	0.249	mg/m3	7.0E-04	(mg/kg/day)	7.0E-03	$(mg/kg/day)^{-1}$	4.9E-06	2.0E-03	(mg/kg/day)	1.7E-01	(mg/kg/day)	0.01
				1,4-Dioxane	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	1.5E+01	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Barium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	1.4E-04	(mg/kg/day)	--
				Chromium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	4.2E+01	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	2.9E-05	(mg/kg/day)	--
				Iron	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Lead	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	1.4E-05	(mg/kg/day)	--
				Nickel	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Vanadium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
			Exp. Route Total								9.2E-06					0.06
		Exposure Point Total									9.2E-06					0.06
	Exposure Medium Total										9.2E-06					0.06
Medium Total											1.9E-04					1.6
										Total of Receptor Risks Across All Media	1.9E-04				Total of Receptor Hazards Across All Media	1.6

TABLE 7.1.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 5	Ingestion	1,1,1-Trichloroethane	319	ug/L	4.1E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.4E-02	(mg/kg/day)	2.8E-01	(mg/kg/day)	0.05
				1,1,2-Trichloroethane	7.66	ug/L	9.8E-06	(mg/kg/day)	5.7E-02	(mg/kg/day)$^{-1}$	5.6E-07	3.4E-04	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.09
				1,1-Dichloroethane	169	ug/L	2.2E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	7.6E-03	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.04
				1,1-Dichloroethene	72.8	ug/L	9.3E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.3E-03	(mg/kg/day)	5.0E-02	(mg/kg/day)	0.07
				1,2-Dichloroethane	1.96	ug/L	2.5E-06	(mg/kg/day)	9.1E-02	(mg/kg/day)$^{-1}$	2.3E-07	8.8E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				1,4-Dichlorobenzene	2.66	ug/L	3.4E-06	(mg/kg/day)	2.4E-02	(mg/kg/day)$^{-1}$	8.2E-08	1.2E-04	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.004
				Benzene	2.99	ug/L	3.8E-06	(mg/kg/day)	5.5E-02	(mg/kg/day)$^{-1}$	2.1E-07	1.3E-04	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.03
				Chloroform	0.330	ug/L	4.2E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.5E-05	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.001
				cis-1,2-Dichloroethene	90.8	ug/L	1.2E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.1E-03	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.4
				Tetrachloroethene	17.0	ug/L	2.2E-05	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	1.2E-05	7.6E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.08
				Trichloroethene	163	ug/L	2.1E-04	(mg/kg/day)	1.3E-02	(mg/kg/day)$^{-1}$	2.7E-06	7.3E-03	(mg/kg/day)	5.0E-01	(mg/kg/day)	0.01
				1,4-Dioxane	4.96	ug/L	6.3E-06	(mg/kg/day)	1.1E-02	(mg/kg/day)$^{-1}$	7.0E-08	2.2E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.695	ug/L	8.9E-07	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	1.3E-06	3.1E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.1
				Barium	454	ug/L	5.8E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.0E-02	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.1
				Chromium	13.3	ug/L	1.7E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	6.0E-04	(mg/kg/day)	3.0E-03	(mg/kg/day)	0.2
				Iron	3990	ug/L	5.1E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.8E-01	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.6
				Lead	2.24	ug/L	2.9E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.0E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	144	ug/L	1.8E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	6.4E-03	(mg/kg/day)	2.4E-02	(mg/kg/day)	0.3
				Nickel	18.3	ug/L	2.3E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	8.2E-04	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.04
				Vanadium	2.82	ug/L	3.6E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.3E-04	(mg/kg/day)	1.0E-03	(mg/kg/day)	0.1
			Exp. Route Total								1.7E-05					2.2
			Dermal	1,1,1-Trichloroethane	319	ug/L	6.0E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.1E-03	(mg/kg/day)	2.8E-01	(mg/kg/day)	0.007
				1,1,2-Trichloroethane	7.66	ug/L	7.3E-07	(mg/kg/day)	5.7E-02	(mg/kg/day)$^{-1}$	4.2E-08	2.6E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.006
				1,1-Dichloroethane	169	ug/L	1.3E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.7E-04	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.002
				1,1-Dichloroethene	72.8	ug/L	9.9E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.5E-04	(mg/kg/day)	5.0E-02	(mg/kg/day)	0.007
				1,2-Dichloroethane	1.96	ug/L	9.7E-08	(mg/kg/day)	9.1E-02	(mg/kg/day)$^{-1}$	8.9E-09	3.4E-06	(mg/kg/day)	NA	(mg/kg/day)	--
				1,4-Dichlorobenzene	2.66	ug/L	1.8E-06	(mg/kg/day)	2.4E-02	(mg/kg/day)$^{-1}$	4.3E-08	6.3E-05	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.002
				Benzene	2.99	ug/L	4.6E-07	(mg/kg/day)	5.5E-02	(mg/kg/day)$^{-1}$	2.5E-08	1.6E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.004
				Chloroform	0.330	ug/L	3.0E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.1E-06	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.0001
				cis-1,2-Dichloroethene	90.8	ug/L	1.1E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.0E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.04
				Tetrachloroethene	17.0	ug/L	1.0E-05	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	5.6E-06	3.6E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.04
				Trichloroethene	163	ug/L	2.8E-05	(mg/kg/day)	1.3E-02	(mg/kg/day)$^{-1}$	3.6E-07	9.7E-04	(mg/kg/day)	5.0E-01	(mg/kg/day)	0.002
				1,4-Dioxane	4.96	ug/L	1.8E-08	(mg/kg/day)	1.1E-02	(mg/kg/day)$^{-1}$	2.0E-10	6.4E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.695	ug/L	2.8E-09	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	4.1E-09	9.7E-08	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.0003
				Barium	454	ug/L	1.8E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	6.3E-05	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.005
				Chromium	13.3	ug/L	1.1E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.7E-06	(mg/kg/day)	7.5E-05	(mg/kg/day)	0.05
				Iron	3990	ug/L	1.6E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	5.6E-04	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.002
				Lead	2.24	ug/L	8.9E-09	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.1E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	144	ug/L	5.7E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.0E-05	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.02
				Nickel	18.3	ug/L	1.5E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	5.1E-07	(mg/kg/day)	8.0E-04	(mg/kg/day)	0.0006
				Vanadium	2.82	ug/L	1.1E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.9E-07	(mg/kg/day)	2.6E-05	(mg/kg/day)	0.02
			Exp. Route Total								6.1E-06					0.2
		Exposure Point Total									2.3E-05					2.4
	Exposure Medium Total										2.3E-05					2.4
Medium Total											2.3E-05					4.8
										Total of Receptor Risks Across All Media	2.3E-05				Total of Receptor Hazards Across All Media	4.8

TABLE 7.2.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Site 5	Ingestion	1,1,1-Trichloroethane	319	ug/L	6.1E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	6.1E-03	(mg/kg/day)	2.8E-01	(mg/kg/day)	0.02
				1,1,2-Trichloroethane	7.66	ug/L	1.5E-05	(mg/kg/day)	5.7E-02	(mg/kg/day)$^{-1}$	8.4E-07	1.5E-04	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.04
				1,1-Dichloroethane	169	ug/L	3.2E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.2E-03	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.02
				1,1-Dichloroethene	72.8	ug/L	1.4E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.4E-03	(mg/kg/day)	5.0E-02	(mg/kg/day)	0.03
				1,2-Dichloroethane	1.96	ug/L	3.8E-06	(mg/kg/day)	9.1E-02	(mg/kg/day)$^{-1}$	3.4E-07	3.8E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				1,4-Dichlorobenzene	2.66	ug/L	5.1E-06	(mg/kg/day)	2.4E-02	(mg/kg/day)$^{-1}$	1.2E-07	5.1E-05	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.002
				Benzene	2.99	ug/L	5.7E-06	(mg/kg/day)	5.5E-02	(mg/kg/day)$^{-1}$	3.2E-07	5.7E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.01
				Chloroform	0.330	ug/L	6.3E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	6.3E-06	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.0006
				cis-1,2-Dichloroethene	90.8	ug/L	1.7E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.7E-03	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.2
				Tetrachloroethene	17.0	ug/L	3.3E-05	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	1.8E-05	3.3E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.03
				Trichloroethene	163	ug/L	3.1E-04	(mg/kg/day)	1.3E-02	(mg/kg/day)$^{-1}$	4.1E-06	3.1E-03	(mg/kg/day)	5.0E-01	(mg/kg/day)	0.006
				1,4-Dioxane	4.96	ug/L	9.5E-06	(mg/kg/day)	1.1E-02	(mg/kg/day)$^{-1}$	1.0E-07	9.5E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.695	ug/L	1.3E-06	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	2.0E-06	1.3E-05	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.04
				Barium	454	ug/L	8.7E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	8.7E-03	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.04
				Chromium	13.3	ug/L	2.6E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.6E-04	(mg/kg/day)	3.0E-03	(mg/kg/day)	0.09
				Iron	3990	ug/L	7.7E-03	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	7.7E-02	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.3
				Lead	2.24	ug/L	4.3E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	4.3E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	144	ug/L	2.8E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.8E-03	(mg/kg/day)	2.4E-02	(mg/kg/day)	0.1
				Nickel	18.3	ug/L	3.5E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	3.5E-04	(mg/kg/day)	2.0E-02	(mg/kg/day)	0.02
				Vanadium	2.82	ug/L	5.4E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	5.4E-05	(mg/kg/day)	1.0E-03	(mg/kg/day)	0.05
			Exp. Route Total								2.5E-05					0.9
			Dermal	1,1,1-Trichloroethane	319	ug/L	1.1E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.1E-03	(mg/kg/day)	2.8E-01	(mg/kg/day)	0.004
				1,1,2-Trichloroethane	7.66	ug/L	1.3E-06	(mg/kg/day)	5.7E-02	(mg/kg/day)$^{-1}$	7.4E-08	1.3E-05	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.003
				1,1-Dichloroethane	169	ug/L	2.4E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.4E-04	(mg/kg/day)	2.0E-01	(mg/kg/day)	0.001
				1,1-Dichloroethene	72.8	ug/L	1.8E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.8E-04	(mg/kg/day)	5.0E-02	(mg/kg/day)	0.004
				1,2-Dichloroethane	1.96	ug/L	1.7E-07	(mg/kg/day)	9.1E-02	(mg/kg/day)$^{-1}$	1.6E-08	1.7E-06	(mg/kg/day)	NA	(mg/kg/day)	--
				1,4-Dichlorobenzene	2.66	ug/L	3.2E-06	(mg/kg/day)	2.4E-02	(mg/kg/day)$^{-1}$	7.7E-08	3.2E-05	(mg/kg/day)	3.0E-02	(mg/kg/day)	0.001
				Benzene	2.99	ug/L	8.2E-07	(mg/kg/day)	5.5E-02	(mg/kg/day)$^{-1}$	4.5E-08	8.2E-06	(mg/kg/day)	4.0E-03	(mg/kg/day)	0.002
				Chloroform	0.330	ug/L	5.4E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	5.4E-07	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.00005
				cis-1,2-Dichloroethene	90.8	ug/L	2.0E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.0E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.02
				Tetrachloroethene	17.0	ug/L	1.8E-05	(mg/kg/day)	5.4E-01	(mg/kg/day)$^{-1}$	1.0E-05	1.8E-04	(mg/kg/day)	1.0E-02	(mg/kg/day)	0.02
				Trichloroethene	163	ug/L	4.9E-05	(mg/kg/day)	1.3E-02	(mg/kg/day)$^{-1}$	6.4E-07	4.9E-04	(mg/kg/day)	5.0E-01	(mg/kg/day)	0.0010
				1,4-Dioxane	4.96	ug/L	3.2E-08	(mg/kg/day)	1.1E-02	(mg/kg/day)$^{-1}$	3.6E-10	3.2E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.695	ug/L	4.3E-09	(mg/kg/day)	1.5E+00	(mg/kg/day)$^{-1}$	6.4E-09	4.3E-08	(mg/kg/day)	3.0E-04	(mg/kg/day)	0.0001
				Barium	454	ug/L	2.8E-06	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.8E-05	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.002
				Chromium	13.3	ug/L	1.6E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.6E-06	(mg/kg/day)	7.5E-05	(mg/kg/day)	0.02
				Iron	3990	ug/L	2.5E-05	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.5E-04	(mg/kg/day)	3.0E-01	(mg/kg/day)	0.0008
				Lead	2.24	ug/L	1.4E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.4E-07	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	144	ug/L	8.9E-07	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	8.9E-06	(mg/kg/day)	9.6E-04	(mg/kg/day)	0.009
				Nickel	18.3	ug/L	2.3E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	2.3E-07	(mg/kg/day)	8.0E-04	(mg/kg/day)	0.0003
				Vanadium	2.82	ug/L	1.7E-08	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.7E-07	(mg/kg/day)	2.6E-05	(mg/kg/day)	0.007
			Exp. Route Total								1.1E-05					0.10
		Exposure Point Total									3.6E-05					1.0
	Exposure Medium Total										3.6E-05					1.0
	Air	Site 5	Inhalation	1,1,1-Trichloroethane	0.145	mg/m3	1.2E-04	(mg/kg/day)	NA	(mg/kg/day)$^{-1}$	- -	1.2E-03	(mg/kg/day)	NA	(mg/kg/day)	--

TABLE 7.2.CTE

CALCULATION OF CHEMICAL CANCER RISKS AND NON-CANCER HAZARDS

CENTRAL TENDENCY EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Non-Cancer Hazard Calculations				
					Value	Units	Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
							Value	Units	Value	Units		Value	Units	Value	Units	
				1,1,2-Trichloroethane	0.003	mg/m3	2.3E-06	(mg/kg/day)	5.6E-02	$(mg/kg/day)^{-1}$	1.3E-07	2.3E-05	(mg/kg/day)	NA	(mg/kg/day)	--
				1,1-Dichloroethane	0.086	mg/m3	7.1E-05	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	7.1E-04	(mg/kg/day)	1.4E-01	(mg/kg/day)	0.005
				1,1-Dichloroethene	0.039	mg/m3	3.2E-05	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	3.2E-04	(mg/kg/day)	6.0E-02	(mg/kg/day)	0.006
				1,2-Dichloroethane	8.4E-4	mg/m3	6.9E-07	(mg/kg/day)	9.1E-02	$(mg/kg/day)^{-1}$	6.3E-08	6.9E-06	(mg/kg/day)	7.0E-01	(mg/kg/day)	0.000010
				1,4-Dichlorobenzene	0.001	mg/m3	8.8E-07	(mg/kg/day)	2.2E-02	$(mg/kg/day)^{-1}$	1.9E-08	8.8E-06	(mg/kg/day)	2.3E-01	(mg/kg/day)	0.00004
				Benzene	0.002	mg/m3	1.4E-06	(mg/kg/day)	2.7E-02	$(mg/kg/day)^{-1}$	3.8E-08	1.4E-05	(mg/kg/day)	8.6E-03	(mg/kg/day)	0.002
				Chloroform	1.5E-4	mg/m3	1.2E-07	(mg/kg/day)	8.1E-02	$(mg/kg/day)^{-1}$	1.0E-08	1.2E-06	(mg/kg/day)	1.4E-02	(mg/kg/day)	0.00009
				cis-1,2-Dichloroethene	0.046	mg/m3	3.8E-05	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	3.8E-04	(mg/kg/day)	NA	(mg/kg/day)	--
				Tetrachloroethene	0.007	mg/m3	5.7E-06	(mg/kg/day)	2.0E-02	$(mg/kg/day)^{-1}$	1.1E-07	5.7E-05	(mg/kg/day)	8.0E-02	(mg/kg/day)	0.0007
				Trichloroethene	0.074	mg/m3	6.1E-05	(mg/kg/day)	7.0E-03	$(mg/kg/day)^{-1}$	4.3E-07	6.1E-04	(mg/kg/day)	1.7E-01	(mg/kg/day)	0.004
				1,4-Dioxane	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Arsenic	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	1.5E+01	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Barium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	1.4E-04	(mg/kg/day)	--
				Chromium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	4.2E+01	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	2.9E-05	(mg/kg/day)	--
				Iron	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Lead	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Manganese	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	1.4E-05	(mg/kg/day)	--
				Nickel	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
				Vanadium	0.0E+0	mg/m3	0.0E+00	(mg/kg/day)	NA	$(mg/kg/day)^{-1}$	- -	0.0E+00	(mg/kg/day)	NA	(mg/kg/day)	--
			Exp. Route Total								8.0E-07					0.02
		Exposure Point Total									8.0E-07					0.02
	Exposure Medium Total										8.0E-07					1.1
Medium Total											3.7E-05					2.1
										Total of Receptor Risks Across All Media	3.7E-05				Total of Receptor Hazards Across All Media	2.1

LIST OF TABLES
RAGS PART D TABLE 9
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

Table No.

REASONABLE MAXIMUM EXPOSURES

9.1.RME Child Residents
9.2.RME Adult Residents
9.3.RME Lifelong Residents

CENTRAL TENDENCY EXPOSURES

9.1.CTE Child Residents
9.2.CTE Adult Residents
9.3.CTE Lifelong Residents

TABLE 9.1.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES
NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 5	1,1,1-Trichloroethane	- -	--	- -	--	- -	None Reported	0.07	- -	0.01	0.09
			1,1,2-Trichloroethane	2E-06	--	2E-07	--	3E-06	Blood	0.1	- -	0.01	0.1
			1,1-Dichloroethane	- -	--	- -	--	- -	Kidney	0.05	- -	0.004	0.06
			1,1-Dichloroethene	- -	--	- -	--	- -	Liver	0.09	- -	0.01	0.1
			1,2-Dichloroethane	1E-06	--	5E-08	--	1E-06	NA	--	- -	--	--
			1,4-Dichlorobenzene	3E-07	--	2E-07	--	6E-07	Liver	0.006	- -	0.004	0.009
			Benzene	9E-07	--	1E-07	--	1E-06	Blood	0.05	- -	0.007	0.06
			Chloroform	- -	--	- -	--	- -	Liver	0.002	- -	0.0002	0.002
			cis-1,2-Dichloroethene	- -	--	- -	--	- -	Blood	0.6	- -	0.07	0.7
			Tetrachloroethene	5E-05	--	3E-05	--	8E-05	Liver	0.1	- -	0.06	0.2
			Trichloroethene	1E-05	--	2E-06	--	1E-05	Liver	0.02	- -	0.003	0.02
			1,4-Dioxane	3E-07	--	1E-09	--	3E-07	NA	--	- -	--	--
			Arsenic	6E-06	--	4E-08	--	6E-06	Skin, CVS	0.1	- -	0.0010	0.1
			Barium	- -	--	- -	--	- -	Blood	0.1	- -	0.01	0.2
			Chromium	- -	--	- -	--	- -	Fetotoxicity, GS, Bone	0.3	- -	0.1	0.4
			Iron	- -	--	- -	--	- -	None Reported	0.9	- -	0.006	0.9
			Lead	- -	--	- -	--	- -	NA	--	- -	--	--
			Manganese	- -	--	- -	--	- -	CNS	0.4	- -	0.06	0.4
			Nickel	- -	--	- -	--	- -	Body Weight	0.06	- -	0.002	0.06
			Vanadium	- -	--	- -	--	- -	Kidney	0.2	- -	0.05	0.2
			Chemical Total	7E-05	--	3E-05	--	1E-04		3	- -	0.5	4
		Exposure Point Total						1E-04					4
	Exposure Medium Total							1E-04					4
Medium Total								1E-04					4
Receptor Total							Receptor Risk Total	1E-04				Receptor HI Total	4

Total Blood HI	1.0
Total Body Weight HI	0.06
Total CNS HI	0.4
Total CVS HI	0.1
Total GS HI	0.4
Total Kidney HI	0.3
Total Liver HI	0.3
Total Skin HI	0.1
Total Fetotoxicity HI	0.4
Total Bone HI	0.4
Total None Reported HI	0.9

TABLE 9.2.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES
NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 5	1,1,1-Trichloroethane	- -	--	- -	--	- -	None Reported	0.03	- -	0.005	0.04
			1,1,2-Trichloroethane	4E-06	--	4E-07	--	4E-06	Blood	0.05	- -	0.005	0.06
			1,1-Dichloroethane	- -	--	- -	--	- -	Kidney	0.02	- -	0.002	0.02
			1,1-Dichloroethene	- -	--	- -	--	- -	Liver	0.04	- -	0.005	0.04
			1,2-Dichloroethane	2E-06	--	8E-08	--	2E-06	NA	--	- -	--	--
			1,4-Dichlorobenzene	6E-07	--	4E-07	--	1E-06	Liver	0.002	- -	0.002	0.004
			Benzene	2E-06	--	2E-07	--	2E-06	Blood	0.02	- -	0.003	0.02
			Chloroform	- -	--	- -	--	- -	Liver	0.0009	- -	0.00008	0.0010
			cis-1,2-Dichloroethene	- -	--	- -	--	- -	Blood	0.2	- -	0.03	0.3
			Tetrachloroethene	9E-05	--	5E-05	--	1E-04	Liver	0.05	- -	0.03	0.07
			Trichloroethene	2E-05	--	3E-06	--	2E-05	Liver	0.009	- -	0.001	0.01
			1,4-Dioxane	5E-07	--	2E-09	--	5E-07	NA	--	- -	--	--
			Arsenic	1E-05	--	4E-08	--	1E-05	Skin, CVS	0.06	- -	0.0003	0.06
			Barium	- -	--	- -	--	- -	Blood	0.06	- -	0.004	0.07
			Chromium	- -	--	- -	--	- -	Fetotoxicity, GS, Bone	0.1	- -	0.04	0.2
			Iron	- -	--	- -	--	- -	None Reported	0.4	- -	0.002	0.4
			Lead	- -	--	- -	--	- -	NA	--	- -	--	--
			Manganese	- -	--	- -	--	- -	CNS	0.2	- -	0.02	0.2
			Nickel	- -	--	- -	--	- -	Body Weight	0.03	- -	0.0006	0.03
			Vanadium	- -	--	- -	--	- -	Kidney	0.08	- -	0.01	0.09
			Chemical Total	1E-04	--	5E-05	--	2E-04		1	- -	0.2	2
		Exposure Point Total						2E-04					2
	Exposure Medium Total							2E-04					2
	Groundwater	Site 5	1,1,1-Trichloroethane	--	- -	--	--	- -	NA	- -	--	- -	--
			1,1,2-Trichloroethane	--	1E-06	--	--	1E-06	NA	- -	--	- -	--
			1,1-Dichloroethane	--	- -	--	--	- -	Kidney	- -	0.02	- -	0.02
			1,1-Dichloroethene	--	- -	--	--	- -	Liver	- -	0.02	- -	0.02
			1,2-Dichloroethane	--	7E-07	--	--	7E-07	None Reported	- -	0.00003	- -	0.00003
			1,4-Dichlorobenzene	--	2E-07	--	--	2E-07	Liver	- -	0.0001	- -	0.0001
			Benzene	--	4E-07	--	--	4E-07	Blood	- -	0.005	- -	0.005
			Chloroform	--	1E-07	--	--	1E-07	Liver	- -	0.0003	- -	0.0003
			cis-1,2-Dichloroethene	--	- -	--	--	- -	NA	- -	--	- -	--
			Tetrachloroethene	--	1E-06	--	--	1E-06	Liver	- -	0.002	- -	0.002
			Trichloroethene	--	5E-06	--	--	5E-06	Liver	- -	0.01	- -	0.01
			1,4-Dioxane	--	- -	--	--	- -	NA	- -	--	- -	--

TABLE 9.2.RME

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

REASONABLE MAXIMUM EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 5	Arsenic	--	- -	--	--	- -	NA	- -	--	- -	--
			Barium	--	- -	--	--	- -	Fetotoxicity	- -	--	- -	--
			Chromium	--	- -	--	--	- -	Lungs	- -	--	- -	--
			Iron	--	- -	--	--	- -	NA	- -	--	- -	--
			Lead	--	- -	--	--	- -	NA	- -	--	- -	--
			Manganese	--	- -	--	--	- -	CNS	- -	--	- -	--
			Nickel	--	- -	--	--	- -	NA	- -	--	- -	--
			Vanadium	--	- -	--	--	- -	NA	- -	--	- -	--
			Chemical Total	--	9E-06	--	--	9E-06		- -	0.06	- -	0.06
		Exposure Point Total						9E-06					0.06
	Exposure Medium Total							9E-06					0.06
Medium Total								2E-04					2
Receptor Total							Receptor Risk Total	2E-04				Receptor HI Total	2

Total Blood HI	0.4
Total Body Weight HI	0.03
Total CNS HI	0.2
Total CVS HI	0.06
Total GS HI	0.2
Total Kidney HI	0.1
Total Liver HI	0.2
Total Skin HI	0.06
Total Fetotoxicity HI	0.2
Total Bone HI	0.2
Total None Reported HI	0.4

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES
NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Lifelong (Child and Adult)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 5	1,1,1-Trichloroethane	- -	--	- -	--	- -					
			1,1,2-Trichloroethane	6E-06	--	6E-07	--	7E-06					
			1,1-Dichloroethane	- -	--	- -	--	- -					
			1,1-Dichloroethene	- -	--	- -	--	- -					
			1,2-Dichloroethane	3E-06	--	1E-07	--	3E-06					
			1,4-Dichlorobenzene	9E-07	--	6E-07	--	2E-06					
			Benzene	2E-06	--	4E-07	--	3E-06					
			Chloroform	- -	--	- -	--	- -					
			cis-1,2-Dichloroethene	- -	--	- -	--	- -					
			Tetrachloroethene	1E-04	--	8E-05	--	2E-04					
			Trichloroethene	3E-05	--	5E-06	--	4E-05					
			1,4-Dioxane	8E-07	--	3E-09	--	8E-07					
			Arsenic	2E-05	--	8E-08	--	2E-05					
			Barium	- -	--	- -	--	- -					
			Chromium	- -	--	- -	--	- -					
			Iron	- -	--	- -	--	- -					
			Lead	- -	--	- -	--	- -					
			Manganese	- -	--	- -	--	- -					
			Nickel	- -	--	- -	--	- -					
			Vanadium	- -	--	- -	--	- -					
			Chemical Total	2E-04	--	8E-05	--	3E-04					
		Exposure Point Total						3E-04					
	Exposure Medium Total							3E-04					
	Groundwater	Site 5	1,1,1-Trichloroethane	--	- -	--	--	- -					
			1,1,2-Trichloroethane	--	1E-06	--	--	1E-06					
			1,1-Dichloroethane	--	- -	--	--	- -					
			1,1-Dichloroethene	--	- -	--	--	- -					
			1,2-Dichloroethane	--	7E-07	--	--	7E-07					
			1,4-Dichlorobenzene	--	2E-07	--	--	2E-07					
			Benzene	--	4E-07	--	--	4E-07					
			Chloroform	--	1E-07	--	--	1E-07					
			cis-1,2-Dichloroethene	--	- -	--	--	- -					
			Tetrachloroethene	--	1E-06	--	--	1E-06					
			Trichloroethene	--	5E-06	--	--	5E-06					
			1,4-Dioxane	--	- -	--	--	- -					

TABLE 9.3.RME
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
REASONABLE MAXIMUM EXPOSURES
NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Lifelong (Child and Adult)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 5	Arsenic	--	- -	--	--	- -					
			Barium	--	- -	--	--	- -					
			Chromium	--	- -	--	--	- -					
			Iron	--	- -	--	--	- -					
			Lead	--	- -	--	--	- -					
			Manganese	--	- -	--	--	- -					
			Nickel	--	- -	--	--	- -					
			Vanadium	--	- -	--	--	- -					
			Chemical Total	--	9E-06	--	--	9E-06					
		Exposure Point Total						9E-06					
	Exposure Medium Total							9E-06					
Medium Total								3E-04					
Receptor Total							Receptor Risk Total	3E-04					

TABLE 9.1.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURES
NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Child

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 5	1,1,1-Trichloroethane	- -	--	- -	--	- -	None Reported	0.05	- -	0.007	0.06
			1,1,2-Trichloroethane	6E-07	--	4E-08	--	6E-07	Blood	0.09	- -	0.006	0.09
			1,1-Dichloroethane	- -	--	- -	--	- -	Kidney	0.04	- -	0.002	0.04
			1,1-Dichloroethene	- -	--	- -	--	- -	Liver	0.07	- -	0.007	0.07
			1,2-Dichloroethane	2E-07	--	9E-09	--	2E-07	NA	--	- -	--	--
			1,4-Dichlorobenzene	8E-08	--	4E-08	--	1E-07	Liver	0.004	- -	0.002	0.006
			Benzene	2E-07	--	3E-08	--	2E-07	Blood	0.03	- -	0.004	0.04
			Chloroform	- -	--	- -	--	- -	Liver	0.001	- -	0.0001	0.002
			cis-1,2-Dichloroethene	- -	--	- -	--	- -	Blood	0.4	- -	0.04	0.4
			Tetrachloroethene	1E-05	--	6E-06	--	2E-05	Liver	0.08	- -	0.04	0.1
			Trichloroethene	3E-06	--	4E-07	--	3E-06	Liver	0.01	- -	0.002	0.02
			1,4-Dioxane	7E-08	--	2E-10	--	7E-08	NA	--	- -	--	--
			Arsenic	1E-06	--	4E-09	--	1E-06	Skin, CVS	0.1	- -	0.0003	0.1
			Barium	- -	--	- -	--	- -	Blood	0.1	- -	0.005	0.1
			Chromium	- -	--	- -	--	- -	Fetotoxicity, GS, Bone	0.2	- -	0.05	0.2
			Iron	- -	--	- -	--	- -	None Reported	0.6	- -	0.002	0.6
			Lead	- -	--	- -	--	- -	NA	--	- -	--	--
			Manganese	- -	--	- -	--	- -	CNS	0.3	- -	0.02	0.3
			Nickel	- -	--	- -	--	- -	Body Weight	0.04	- -	0.0006	0.04
			Vanadium	- -	--	- -	--	- -	Kidney	0.1	- -	0.02	0.1
			Chemical Total	2E-05	--	6E-06	--	2E-05		2	- -	0.2	2
		Exposure Point Total						2E-05					2
	Exposure Medium Total							2E-05					2
Medium Total								2E-05					2
Receptor Total							Receptor Risk Total	2E-05				Receptor HI Total	2

Total Blood HI	0.7
Total Body Weight HI	0.04
Total CNS HI	0.3
Total CVS HI	0.1
Total GS HI	0.2
Total Kidney HI	0.2
Total Liver HI	0.2
Total Skin HI	0.1
Total Fetotoxicity HI	0.2
Total Bone HI	0.2
Total None Reported HI	0.7

TABLE 9.2.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURES
NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 5	1,1,1-Trichloroethane	- -	--	- -	--	- -	None Reported	0.02	- -	0.004	0.03
			1,1,2-Trichloroethane	8E-07	--	7E-08	--	9E-07	Blood	0.04	- -	0.003	0.04
			1,1-Dichloroethane	- -	--	- -	--	- -	Kidney	0.02	- -	0.001	0.02
			1,1-Dichloroethene	- -	--	- -	--	- -	Liver	0.03	- -	0.004	0.03
			1,2-Dichloroethane	3E-07	--	2E-08	--	4E-07	NA	--	- -	--	--
			1,4-Dichlorobenzene	1E-07	--	8E-08	--	2E-07	Liver	0.002	- -	0.001	0.003
			Benzene	3E-07	--	5E-08	--	4E-07	Blood	0.01	- -	0.002	0.02
			Chloroform	- -	--	- -	--	- -	Liver	0.0006	- -	0.00005	0.0007
			cis-1,2-Dichloroethene	- -	--	- -	--	- -	Blood	0.2	- -	0.02	0.2
			Tetrachloroethene	2E-05	--	1E-05	--	3E-05	Liver	0.03	- -	0.02	0.05
			Trichloroethene	4E-06	--	6E-07	--	5E-06	Liver	0.006	- -	0.0010	0.007
			1,4-Dioxane	1E-07	--	4E-10	--	1E-07	NA	--	- -	--	--
			Arsenic	2E-06	--	6E-09	--	2E-06	Skin, CVS	0.04	- -	0.0001	0.04
			Barium	- -	--	- -	--	- -	Blood	0.04	- -	0.002	0.05
			Chromium	- -	--	- -	--	- -	Fetotoxicity, GS, Bone	0.09	- -	0.02	0.1
			Iron	- -	--	- -	--	- -	None Reported	0.3	- -	0.0008	0.3
			Lead	- -	--	- -	--	- -	NA	--	- -	--	--
			Manganese	- -	--	- -	--	- -	CNS	0.1	- -	0.009	0.1
			Nickel	- -	--	- -	--	- -	Body Weight	0.02	- -	0.0003	0.02
			Vanadium	- -	--	- -	--	- -	Kidney	0.05	- -	0.007	0.06
			Chemical Total	3E-05	--	1E-05	--	4E-05		0.9	- -	0.10	1
		Exposure Point Total						4E-05					1
	Exposure Medium Total							4E-05					1
	Groundwater	Site 5	1,1,1-Trichloroethane	--	- -	--	--	- -	NA	- -	--	- -	--
			1,1,2-Trichloroethane	--	1E-07	--	--	1E-07	NA	- -	--	- -	--
			1,1-Dichloroethane	--	- -	--	--	- -	Kidney	- -	0.005	- -	0.005
			1,1-Dichloroethene	--	- -	--	--	- -	Liver	- -	0.006	- -	0.006
			1,2-Dichloroethane	--	6E-08	--	--	6E-08	None Reported	- -	0.000010	- -	0.000010
			1,4-Dichlorobenzene	--	2E-08	--	--	2E-08	Liver	- -	0.00004	- -	0.00004
			Benzene	--	4E-08	--	--	4E-08	Blood	- -	0.002	- -	0.002
			Chloroform	--	1E-08	--	--	1E-08	Liver	- -	0.00009	- -	0.00009
			cis-1,2-Dichloroethene	--	- -	--	--	- -	NA	- -	--	- -	--
			Tetrachloroethene	--	1E-07	--	--	1E-07	Liver	- -	0.0007	- -	0.0007
			Trichloroethene	--	4E-07	--	--	4E-07	Liver	- -	0.004	- -	0.004
			1,4-Dioxane	--	- -	--	--	- -	NA	- -	--	- -	--

TABLE 9.2.CTE

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Adult

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 5	Arsenic	--	- -	--	--	- -	NA	- -	--	- -	--
			Barium	--	- -	--	--	- -	Fetotoxicity	- -	--	- -	--
			Chromium	--	- -	--	--	- -	Lungs	- -	--	- -	--
			Iron	--	- -	--	--	- -	NA	- -	--	- -	--
			Lead	--	- -	--	--	- -	NA	- -	--	- -	--
			Manganese	--	- -	--	--	- -	CNS	- -	--	- -	--
			Nickel	--	- -	--	--	- -	NA	- -	--	- -	--
			Vanadium	--	- -	--	--	- -	NA	- -	--	- -	--
			Chemical Total	--	8E-07	--	--	8E-07		- -	0.02	- -	0.02
		Exposure Point Total						8E-07					0.02
	Exposure Medium Total							8E-07					0.02
Medium Total								4E-05					1
Receptor Total							Receptor Risk Total	4E-05				Receptor HI Total	1

Total Blood HI	0.3
Total Body Weight HI	0.02
Total CNS HI	0.1
Total CVS HI	0.04
Total GS HI	0.1
Total Kidney HI	0.08
Total Liver HI	0.1
Total Skin HI	0.04
Total Fetotoxicity HI	0.1
Total Bone HI	0.1
Total None Reported HI	0.3

TABLE 9.3.CTE
SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs
CENTRAL TENDENCY EXPOSURES
NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Lifelong (Child and Adult)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 5	1,1,1-Trichloroethane	- -	--	- -	--	- -					
			1,1,2-Trichloroethane	1E-06	--	1E-07	--	2E-06					
			1,1-Dichloroethane	- -	--	- -	--	- -					
			1,1-Dichloroethene	- -	--	- -	--	- -					
			1,2-Dichloroethane	6E-07	--	2E-08	--	6E-07					
			1,4-Dichlorobenzene	2E-07	--	1E-07	--	3E-07					
			Benzene	5E-07	--	7E-08	--	6E-07					
			Chloroform	- -	--	- -	--	- -					
			cis-1,2-Dichloroethene	- -	--	- -	--	- -					
			Tetrachloroethene	3E-05	--	2E-05	--	4E-05					
			Trichloroethene	7E-06	--	1E-06	--	8E-06					
			1,4-Dioxane	2E-07	--	6E-10	--	2E-07					
			Arsenic	3E-06	--	1E-08	--	3E-06					
			Barium	- -	--	- -	--	- -					
			Chromium	- -	--	- -	--	- -					
			Iron	- -	--	- -	--	- -					
			Lead	- -	--	- -	--	- -					
			Manganese	- -	--	- -	--	- -					
			Nickel	- -	--	- -	--	- -					
			Vanadium	- -	--	- -	--	- -					
			Chemical Total	4E-05	--	2E-05	--	6E-05					
		Exposure Point Total						6E-05					
	Exposure Medium Total							6E-05					
	Groundwater	Site 5	1,1,1-Trichloroethane	--	- -	--	--	- -					
			1,1,2-Trichloroethane	--	1E-07	--	--	1E-07					
			1,1-Dichloroethane	--	- -	--	--	- -					
			1,1-Dichloroethene	--	- -	--	--	- -					
			1,2-Dichloroethane	--	6E-08	--	--	6E-08					
			1,4-Dichlorobenzene	--	2E-08	--	--	2E-08					
			Benzene	--	4E-08	--	--	4E-08					
			Chloroform	--	1E-08	--	--	1E-08					
			cis-1,2-Dichloroethene	--	- -	--	--	- -					
			Tetrachloroethene	--	1E-07	--	--	1E-07					
			Trichloroethene	--	4E-07	--	--	4E-07					
			1,4-Dioxane	--	- -	--	--	- -					

TABLE 9.3.CTE

SUMMARY OF RECEPTOR RISKS AND HAZARDS FOR COPCs

CENTRAL TENDENCY EXPOSURES

NASJRB WILLOW GROVE

Scenario Timeframe: Future
Receptor Population: Resident
Receptor Age: Lifelong (Child and Adult)

Medium	Exposure Medium	Exposure Point	Chemical of Potential Concern	Carcinogenic Risk					Non-Carcinogenic Hazard Quotient				
				Ingestion	Inhalation	Dermal	External (Radiation)	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Site 5	Arsenic	--	- -	--	--	- -					
			Barium	--	- -	--	--	- -					
			Chromium	--	- -	--	--	- -					
			Iron	--	- -	--	--	- -					
			Lead	--	- -	--	--	- -					
			Manganese	--	- -	--	--	- -					
			Nickel	--	- -	--	--	- -					
			Vanadium	--	- -	--	--	- -					
			Chemical Total	--	8E-07	--	--	8E-07					
		Exposure Point Total						8E-07					
	Exposure Medium Total							8E-07					
Medium Total								6E-05					
Receptor Total							Receptor Risk Total	6E-05					

ATTACHMENT B

SAMPLE CALCULATIONS

CALCULATION WORKSHEET

CLIENT: WILLOW GROVE, PENNSYLVANIA		**JOB NUMBER:** 2192
SUBJECT: CALCULATION OF INTAKE/RISK FROM INGESTION OF GROUNDWATER ADULT RESIDENT		
BASED ON: U.S. EPA, DECEMBER 1989		
BY: R. JUPIN	**CHECKED BY:** T. Jackson	**DATE:** 12/18/2006

PURPOSE: To estimate intake, carcinogenic and noncarcinogenic risks from ingestion of groundwater.

EQUATION:

$$IEX = \frac{Cgw \times CF \times IF \times EF \times ED}{BW \times AT}$$

Where:

IEX	=	estimated exposure intake (mg/kg/day)
Cgw	=	exposure point concentration in groundwater (ug/L)
CF	=	conversion factor (1.0E-3 mg/ug)
IR	=	ingestion rate (L/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days)
CSFo	=	oral carcinogenic slope factor ($(mg/kg/day)^{-1}$)
RfDo	=	oral noncarcinogenic reference dose (mg/kg/day)

RISKS:

ILCR (Carcinogens) = Intake (mg/kg/day) x CSFo (mg/kg/day)-1
HQ (Noncarcinogens) = Intake (mg/kg/day) / RFDo (mg/kg/day)

ASSUMPTIONS:

Cgw	=	163	ug/L	Chemical: Trichloroethene
IR	=	2	L/day	
CF	=	1.0E-03	mg/ug	
EF	=	350	days/year	
ED	=	24	years	
BW	=	70	kg	
ATc	=	25550	days	
ATnc	=	8760	days	
CSFo	=	1.3E-02	$(mg/kg/day)^{-1}$	
RfDo	=	5.0E-01	(mg/kg/day)	

CALCULATION WORKSHEET

CLIENT: WILLOW GROVE, PENNSYLVANIA		**JOB NUMBER:** 2192
SUBJECT: CALCULATION OF INTAKE/RISK FROM INGESTION OF GROUNDWATER ADULT RESIDENT		
BASED ON: U.S. EPA, DECEMBER 1989		
BY: R. JUPIN	**CHECKED BY:**	**DATE:** 12/18/2006

EXAMPLE CARCINOGENIC CALCULATION

$$IEXc = \frac{163\ ug/L \times 0.001\ mg/ug \times 2\ L/day \times 350\ days/year \times 24\ years}{70\ kg \times 25550\ days}$$

IEXc = 1.53E-03 mg/kg/day

ILCR = 1.53E-03 mg/kg/day x 1.30E-02 (mg/kg/day)-1 = Incremental Lifetime Cancer Risk

ILCR = 2.0E-05

EXAMPLE NONCARCINOGENIC CALCULATION

$$IEXnc = \frac{163\ ug/L \times 0.001\ mg/ug \times 2\ L/day \times 350\ days/year \times 24\ years}{70\ kg \times 8760\ days}$$

IEXnc = 4.47E-03 mg/kg/day

$$HQ = \frac{4.47E\text{-}03\ mg/kg/day}{5.0E\text{-}01\ (mg/kg/day)} = \text{Hazard Quotient}$$

HQ = 0.0089

CALCULATION WORKSHEET

CLIENT: WILLOW GROVE, PENNSYLVANIA		**JOB NUMBER:** 2192
SUBJECT: CALCULATION OF INTAKE/RISK FROM DERMAL CONTACT WITH GROUNDWATER ADULT RESIDENT		
BASED ON: U.S. EPA, DECEMBER 1989, JULY 2004		
BY: R. JUPIN	**CHECKED BY:**	**DATE:** 12/18/2006

PURPOSE: To estimate intake, carcinogenic and noncarcinogenic risks from dermal contact with groundwater.

EQUATION:

$$DAD = \frac{DAevent \times EV \times ED \times EF \times A}{BW \times AT}$$

Where:

DAD	=	dermally absorbed dose (mg/kg/day)
DAevent	=	absorbed does per event (mg/cm^2/event)
EV	=	event frequency (events/day)
EF	=	exposure frequency (days/year)
ED	=	exposure duration (years)
A	=	skin surface available for contact (cm^2)
BW	=	body weight (kg)
AT	=	averaging time (days)
CSFo	=	oral carcinogenic slope factor ($(mg/kg/day)^{-1}$)
RfDo	=	oral noncarcinogenic reference dose (mg/kg/day)

RISKS:

ILCR (Carcinogens) = DAD (mg/kg/day) x CSFd (mg/kg/day)-1
HQ (Noncarcinogens) = DAD (mg/kg/day) / RFDd (mg/kg/day)

EQUATIONS for DAevent:

For Inorganics:

DAevent = Kp x Cw x CF x tevent

For Organics:

$$\text{If } tevent \le t^*, \text{ then: } DAevent = 2 \times FA \times Kp \times Cw \times CF \times \sqrt{\frac{6 \times tau \times tevent}{\pi}}$$

$$\text{If } tevent > t^*, \text{ then: } DAevent = FA \times Kp \times Cw \times CF \times \left[\frac{tevent}{1+B} + 2 \times tau \times \left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$$

CLIENT: WILLOW GROVE, PENNSYLVANIA		JOB NUMBER: 2192
SUBJECT: CALCULATION OF INTAKE/RISK FROM DERMAL CONTACT WITH GROUNDWATER ADULT RESIDENT		
BASED ON: U.S. EPA, DECEMBER 1989, JULY 2004		
BY: R. JUPIN	CHECKED BY: T. Jackson	DATE: 12/18/2006

Where:

Kp	=	permeability coefficient from water (cm/hr)
Cgw	=	concentration of chemical in groundwater (mg/L)
tevent	=	duration of event (hr/event)
CF	=	conversion factor (0.001 L/cm^3)
t*	=	time it takes to reach steady-state (hr/event)
τ	=	lag time (hr/event)
B	=	Bunge Model Constant (dimensionless)

EXAMPLE CALCULATION OF DAevent

ASSUMPTIONS:

Cgw	=	0.163	mg/L	Chemical: Trichloroethene
Kp	=	1.16E-02	cm/hr	
FA	=	1	unitless	
tevent	=	0.5	hr/event	
CF	=	0.001	L/cm^3	
t*	=	1.39	hr/event	
τ	=	0.58	hr/event	
B	=	0.051		

tevent < t*, therefore,

$$DAevent = (2 \times 0.0116\ cm/hr)\ (1)\ (0.163\ mg/L)\ (0.001\ L/cm3) \times \sqrt{\frac{6 \times 0.581\ hr/event \times 0.5\ hr/event}{\pi}}$$

DAevent = 2.82E-06 mg/cm^2-event

RISK CALCULATIONS

ASSUMPTIONS:

A	=	18000	cm^2/day
EV	=	1	event/day
ED	=	24	years
EF	=	350	days/year
BW	=	70	kg
ATc	=	25550	days
ATnc	=	8760	days
CSFd	=	1.3E-02	$(mg/kg/day)^{-1}$
RfDd	=	5.0E-01	(mg/kg/day)

CLIENT: WILLOW GROVE, PENNSYLVANIA		JOB NUMBER: 2192
SUBJECT: CALCULATION OF INTAKE/RISK FROM DERMAL CONTACT WITH GROUNDWATER ADULT RESIDENT		
BASED ON: U.S. EPA, DECEMBER 1989, JULY 2004		
BY: R. JUPIN	CHECKED BY:	DATE: 12/18/2006

EXAMPLE CARCINOGENIC CALCULATION

$$DADc = \frac{2.82E\text{-}06 \text{ mg/cm2-event} \times 1 \text{ event/day} \times 24 \text{ years} \times 350 \text{ days/year} \times 18000 \text{ cm2/day}}{70 \text{ kg} \times 25550 \text{ days}}$$

DADc = 2.38E-04 mg/kg/day

DADc = 2.38E-04 mg/kg/day x 1.30E-02 (mg/kg/day)-1 = Incremental Lifetime Cancer Risk

ILCR = 3.1E-06

EXAMPLE NONCARCINOGENIC CALCULATION

$$DADnc = \frac{2.82E\text{-}06 \text{ mg/cm2-event} \times 1 \text{ event/day} \times 24 \text{ years} \times 350 \text{ days/year} \times 18000 \text{ cm2/day}}{70 \text{ kg} \times 8760 \text{ days}}$$

DADnc = 6.95E-04 mg/kg/day

HQ = 6.95E-04 mg/kg/day / 5.00E-01 (mg/kg/day) = Hazard Quotient

HQ = 0.0014

CALCULATION WORKSHEET

CLIENT: WILLOW GROVE, PENNSYLVANIA		**JOB NUMBER:** 2192
SUBJECT: CALCULATION OF INTAKE/RISK FROM INHALATION OF VOLATILES WHILE SHOWERING BY AN ADULT RESIDENT		
BASED ON: U.S. EPA, 1989 AND FOSTER AND CHROSTOWSKI, 1987		
BY: R. JUPIN	**CHECKED BY:** L. Jackson	**DATE:** 12/18/2006

PURPOSE: To estimate intake, carcinogenic and noncarcinogenic risks from inhalation of volatiles while showering by an adult resident.

EQUATIONS:

$$\text{Intake} = \frac{S \times IRsh \times K \times EF \times ED}{BW \times AT \times Ra \times CF}$$

Where:

$$K = Ds + \frac{\exp(-Ra \times Dt) - \exp[Ra \times (Ds - Dt)]}{Ra}$$

$S = Cwd \times FR/SV$ $\qquad$ $Cwd = Cw \times [1-\exp(-Kal \times ts/60d)]$

$Kal = Kl \times [(T1 \times Us)/(Ts \times U1)^{-0.5}$ $\qquad$ $Kl = 1/[1/k1 + RT/(H \times kg)]$

$k1 = 20\ cm/hr \times (44/MW)^{0.5}$ $\qquad$ $kg = 3000\ cm/hr \times (18/MW)^{0.5}$

RISKS:

ILCR (Carcinogens) = Intake (mg/kg/day) x CSFi (mg/kg/day)-1
HQ (Noncarcinogens) = Intake (mg/kg/day) / RFDi (mg/kg/day)

Where:

Intake	=	estimated exposure intake (mg/kg/day)
S	=	volatile chemical generation rate (mg/m3-min - shower)
IRsh	=	inhalation rate (m3/hr)
EF	=	exposure frequency (showers/year)
ED	=	exposure duration (years)
BW	=	body weight (kg)
AT	=	averaging time (days)
Ra	=	air exchange rate (1/min)
Ds	=	shower duration (min)
Dt	=	total time in bathroom (min)
FR	=	shower water flow rate (L/min)
SV	=	shower room air volume (m3)
ts	=	shower droplet drop time (sec)
d	=	shower droplet diameter (mm)
MW	=	molecular weight of compound (g/mole)
H	=	Henry's Law constant (atm-m3/mole)
T1	=	calibration water temperature (K)
Ts	=	shower water temperature (K)
U1	=	water viscosity at T1 (cp)
Us	=	water viscosity at Ts (cp)
CSFi	=	inhalation carcinogenic slope factor ($(mg/kg/day)^{-1}$)
RfDi	=	inhalation noncarcinogenic reference dose (mg/kg/day)

CLIENT: WILLOW GROVE, PENNSYLVANIA		JOB NUMBER: 2192
SUBJECT: CALCULATION OF INTAKE/RISK FROM INHALATION OF VOLATILES WHILE SHOWERING BY AN ADULT RESIDENT		
BASED ON: U.S. EPA, 1989 AND FOSTER AND CHROSTOWSKI, 1987		
BY: R. JUPIN	CHECKED BY: T. Jackson	DATE: 12/18/2006

ASSUMPTIONS: Chemical: Trichloroethene

IRsh	=	0.6	m3/hr
EF	=	350	showers/year
ED	=	24	years
BW	=	70	kg
ATc	=	25550	days
Atn	=	8760	days
Ra	=	0.0167	1/min
CF	=	60	min/hr
Ds	=	30	min
Dt	=	60	min
FR	=	10	L/min
SV	=	12	m3
Cw	=	0.163	mg/L
ts	=	0.5	sec
d	=	1	mm
MW	=	131.4	g/mole
H	=	1.03E-02	atm-m3/mole
RT	=	2.40E-02	atm-m3/mole
T1	=	293	K
Ts	=	320	K
U1	=	0.982	centipoise
Us	=	0.616	centipoise
CSFi	=	7.00E-03	(mg/kg/day)-1
RfDi	=	1.70E-01	(mg/kg/day)

EXAMPLE CALCULATION:

k1 = 20 cm/hr x (44 g/mole / 131.4 g/mole)^0.5

k1 = **11.57 cm/hr**

kg = 3000 cm/hr x (18 g/mole / 131.4 g/mole)^0.5

kg = **1110.35 cm/hr**

Kl = 1/[1/11.6 cm/hr + 2.40E-02 atm-m3/mole/(1.03E-02 atm-m3/mole x 1110.3 cm/hr)]

Kl = **1.13E+01 cm/hr**

CLIENT: WILLOW GROVE, PENNSYLVANIA		JOB NUMBER: 2192
SUBJECT: CALCULATION OF INTAKE/RISK FROM INHALATION OF VOLATILES WHILE SHOWERING BY AN ADULT RESIDENT		
BASED ON: U.S. EPA, 1989 AND FOSTER AND CHROSTOWSKI, 1987		
BY: R. JUPIN	CHECKED BY:	DATE: 12/18/2006

Kal = 1.13E+01 cm/hr x [(293 K x 0.616 centipoise)/(320 K x 0.982 centipoise)]^-0.5

Kal = **14.9 cm/hr**

Cwd = 0.163 mg/L x [1 - exp((-14.9 cm/hr x 0.5 sec)/(60 x 1 mm))]

Cwd = **1.90E-02 mg/L**

S = 1.90E-02 mg/L x 10 L/min / 12 m3

S = **1.59E-02 mg/m3-min-shower**

$$K = 30 \text{ min} + \frac{\exp(-0.0167 \text{ 1/min} \times 60 \text{ min}) - \exp[0.0167 \text{ 1/min} \times (30 \text{ min} - 60 \text{ min})]}{0.0167 \text{ 1/min}}$$

K = **15.70 min**

CARCINOGENIC INTAKE:

$$\text{Intake} = \frac{1.59\text{E-02 mg/m3-min-shower} \times 0.6 \text{ m3/hr} \times 15.70 \text{ min} \times 350 \text{ showers/year} \times 24 \text{ years}}{70 \text{ kg} \times 25550 \text{ days} \times 0.0167 \text{ 1/min} \times 60 \text{ min/hr}}$$

intake = **7.01E-04 mg/kg-day**

Risk = 0.007 (mg/kg/day)-1 x 7.01E-04 mg/kg-day

Risk = **4.9E-06**

NONCARCINOGENIC INTAKE:

$$\text{Intake} = \frac{1.59\text{E-02 mg/m3-min-shower} \times 0.6 \text{ m3/hr} \times 15.70 \text{ min} \times 350 \text{ showers/year} \times 24 \text{ years}}{70 \text{ kg} \times 8760 \text{ days} \times 0.0167 \text{ 1/min} \times 60 \text{ min/hr}}$$

intake = **2.04E-03 mg/kg-day**

HQ = 2.04E-03 mg/kg-day / 1.70E-01 (mg/kg/day)

HQ = **0.012**

ATTACHMENT C

LEAD MODELING RESULTS

LEAD MODEL FOR WINDOWS Version 1.0

==========

Model Version: 1.0 Build 263 (Page 1 of 3)
Location: NASJRB Willow Grove
Site Name: Site 5
Date: 12/18/2006
Run Mode: Site Risk Assessment

Soil/Dust Data
Average concentration of lead in surface soil = 89.7 mg/kg.
Water Data
Average concentration of lead in groundwater = 2.24 ug/L

==========

The time step used in this model run: 1 - Every 4 Hours (6 times a day).

****** Air ******

Indoor Air Pb Concentration: 30.000 percent of outdoor.
Other Air Parameters:

Age	Time Outdoors (hours)	Ventilation Rate (m^3/day)	Lung Absorption (%)	Outdoor Air Pb Conc (ug Pb/m^3)
.5-1	1.000	2.000	32.000	0.100
1-2	2.000	3.000	32.000	0.100
2-3	3.000	5.000	32.000	0.100
3-4	4.000	5.000	32.000	0.100
4-5	4.000	5.000	32.000	0.100
5-6	4.000	7.000	32.000	0.100
6-7	4.000	7.000	32.000	0.100

****** Diet ******

Age	Diet Intake(ug/day)
.5-1	5.530
1-2	5.780
2-3	6.490
3-4	6.240
4-5	6.010
5-6	6.340
6-7	7.000

****** Drinking Water ******

Water Consumption:

Age	Water (L/day)
.5-1	0.200
1-2	0.500
2-3	0.520
3-4	0.530
4-5	0.550
5-6	0.580
6-7	0.590

Drinking Water Concentration: 2.240 ug Pb/L

Location: NASJRB Willow Grove
Site Name: Site 5
Date: 12/18/2006
Run Mode: Site Risk Assessment

****** Soil & Dust ******

Multiple Source Analysis Used
Average multiple source concentration: 72.790 ug/g

Mass fraction of outdoor soil to indoor dust conversion factor: 0.700
Outdoor airborne lead to indoor household dust lead concentration: 100.000
Use alternate indoor dust Pb sources? No

Age	Soil (ug Pb/g)	House Dust (ug Pb/g)
.5-1	89.700	72.790
1-2	89.700	72.790
2-3	89.700	72.790
3-4	89.700	72.790
4-5	89.700	72.790
5-6	89.700	72.790
6-7	89.700	72.790

****** Alternate Intake ******

Age	Alternate (ug Pb/day)
.5-1	0.000
1-2	0.000
2-3	0.000
3-4	0.000
4-5	0.000
5-6	0.000
6-7	0.000

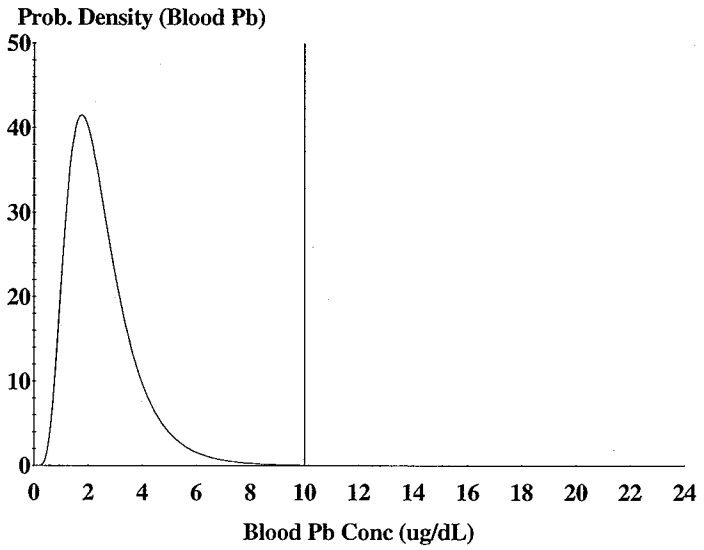
****** Maternal Contribution: Infant Model ******

Maternal Blood Concentration: 2.500 ug Pb/dL

****
CALCULATED BLOOD LEAD AND LEAD UPTAKES:
****

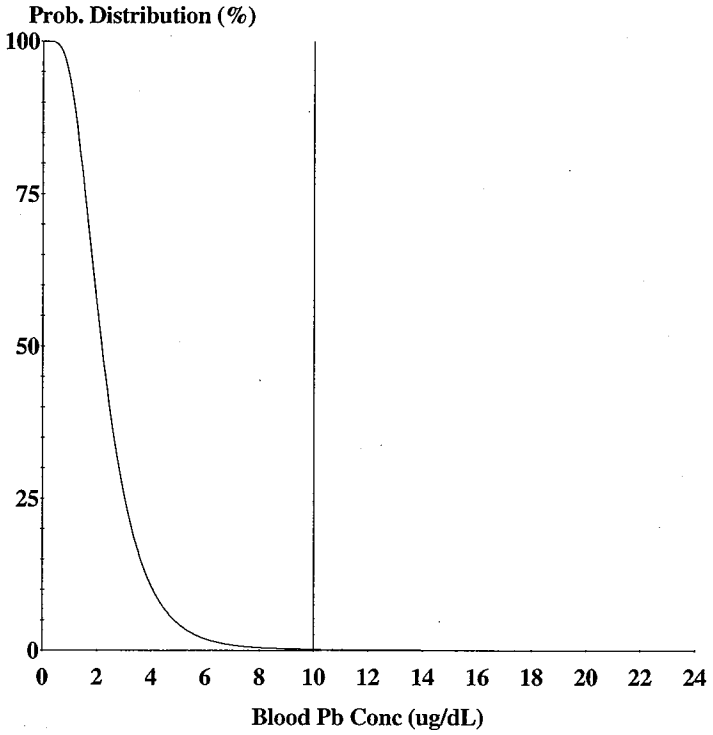
Year	Air (ug/day)	Diet (ug/day)	Alternate (ug/day)	Water (ug/day)
.5-1	0.021	2.619	0.000	0.212
1-2	0.034	2.734	0.000	0.530
2-3	0.062	3.087	0.000	0.554
3-4	0.067	2.991	0.000	0.569
4-5	0.067	2.911	0.000	0.597
5-6	0.093	3.082	0.000	0.632
6-7	0.093	3.407	0.000	0.643

Year	Soil+Dust (ug/day)	Total (ug/day)	Blood (ug/dL)
.5-1	1.942	4.794	2.6
1-2	3.080	6.378	2.7
2-3	3.097	6.800	2.5
3-4	3.121	6.747	2.4
4-5	2.336	5.910	2.1
5-6	2.110	5.917	1.8
6-7	1.996	6.140	1.7



Cutoff = 10.000 ug/dl
Geo Mean = 2.279
GSD = 1.600
% Above = 0.083
% Below = 99.917

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Site Risk Assessment
Comment = Site 5



Cutoff = 10.000 ug/dl
Geo Mean = 2.279
GSD = 1.600
% Above = 0.083

Age Range = 0 to 84 months
Time Step = Every 4 Hours
Run Mode = Site Risk Assessment
Comment = Site 5

ATTACHMENT D

VAPOR INTRUSION MODELING RESULTS

INDUSTRIAL EXPOSURES

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
75343	1.00E+01	1,1-Dichloroethane

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)							
13	30	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
20	40	4600	1565	730	0.1	0.72	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
7.42E-02	1.05E-05	5.61E-03	25	6,895	330.55	523.00	3.16E+01	5.06E+03	0.0E+00	5.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
7.88E+08	580	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	12,330

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
1.05E+06	7.57E+06	1.63E-04	30	7,417	3.32E-03	1.41E-01	1.76E-04	4.28E-03	0.00E+00	0.00E+00	1.40E-04	9.55E-04	580

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, α (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)
30	1.41E+03	0.10	8.33E+01	4.28E-03	1.23E+03	1.04E+137	1.03E-05	1.46E-02	NA	5.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	5.06E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	2.0E-05

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

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
75354	1.25E+01	1,1-Dichloroethylene

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)							
13	30	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
20	40	4600	1565	730	0.1	0.72	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
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	2.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
7.88E+08	580	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	12,330

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
1.05E+06	7.57E+06	1.63E-04	30	6,373	1.66E-02	7.06E-01	1.76E-04	5.20E-03	0.00E+00	0.00E+00	1.58E-04	1.09E-03	580

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, α (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)
30	8.83E+03	0.10	8.33E+01	5.20E-03	1.23E+03	9.81E+112	1.16E-05	1.02E-01	NA	2.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	2.25E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	3.5E-04

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

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
71556	1.25E+01	1,1,1-Trichloroethane

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)							
13	30	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP (g/cm-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)
20	40	4600	1565	730	0.1	0.72	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
7.80E-02	8.80E-06	1.72E-02	25	7,136	347.24	545.00	1.10E+02	1.33E+03	0.0E+00	2.2E+00

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
7.88E+08	580	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	12,330

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
1.05E+06	7.57E+06	1.63E-04	30	7,853	9.84E-03	4.19E-01	1.76E-04	4.50E-03	0.00E+00	0.00E+00	1.38E-04	9.55E-04	580

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, α (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)
30	5.24E+03	0.10	8.33E+01	4.50E-03	1.23E+03	2.35E+130	1.03E-05	5.40E-02	NA	2.2E+00

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	1.33E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	1.7E-05

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

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79005	5.00E+00	1,1,2-Trichloroethane

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)							
13	30	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
20	40	4600	1565	730	0.1	0.72	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
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	0.0E+00

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
7.88E+08	580	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	12,330

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
1.05E+06	7.57E+06	1.63E-04	30	9,540	4.64E-04	1.97E-02	1.76E-04	4.51E-03	0.00E+00	0.00E+00	2.04E-04	1.30E-03	580

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, α (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)
30	9.87E+01	0.10	8.33E+01	4.51E-03	1.23E+03	1.45E+130	1.34E-05	1.32E-03	1.6E-05	NA

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	4.42E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
5.2E-09	NA

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

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
71432	5.00E+00	Benzene

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)							
13	30	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
20	40	4600	1565	730	0.1	0.72	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
8.80E-02	9.80E-06	5.54E-03	25	7,342	353.24	562.16	5.89E+01	1.79E+03	7.8E-06	3.0E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
7.88E+08	580	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	12,330

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
1.05E+06	7.57E+06	1.63E-04	30	8,091	3.12E-03	1.33E-01	1.76E-04	5.08E-03	0.00E+00	0.00E+00	1.64E-04	1.12E-03	580

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, α (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)
30	6.65E+02	0.10	8.33E+01	5.08E-03	1.23E+03	3.44E+115	1.18E-05	7.87E-03	7.8E-06	3.0E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	1.79E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.5E-08	1.8E-04

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

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
127184	5.00E+00	Tetrachloroethylene

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)							
13	30	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
20	40	4600	1565	730	0.1	0.72	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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 (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	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)
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.8E-07	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
7.88E+08	580	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	12,330

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
1.05E+06	7.57E+06	1.63E-04	30	9,523	9.35E-03	3.98E-01	1.76E-04	4.16E-03	0.00E+00	0.00E+00	1.28E-04	8.82E-04	580

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, α (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)
30	1.99E+03	0.10	8.33E+01	4.16E-03	1.23E+03	1.72E+141	9.63E-06	1.92E-02	5.8E-07	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	2.00E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
2.7E-09	2.2E-05

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

SCROLL DOWN TO "END"

END

DATA ENTRY SHEET

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	1.00E+01	Trichloroethylene

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)							
13	30	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
20	40	4600	1565	730	0.1	0.72	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	25	25	250	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	4.0E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
7.88E+08	580	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	12,330

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
1.05E+06	7.57E+06	1.63E-04	30	8,520	5.62E-03	2.39E-01	1.76E-04	4.56E-03	0.00E+00	0.00E+00	1.42E-04	9.82E-04	580

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, α (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)
30	2.39E+03	0.10	8.33E+01	4.56E-03	1.23E+03	5.16E+128	1.06E-05	2.53E-02	1.1E-04	4.0E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
6.8E-07	4.3E-04

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

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

RESIDENTIAL EXPOSURES

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
75343	1.00E+01	1,1-Dichloroethane

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)							
13	200	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
10	40	1000	1000	366	0.1	0.25	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
7.42E-02	1.05E-05	5.61E-03	25	6,895	330.55	523.00	3.16E+01	5.06E+03	0.0E+00	5.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
9.46E+08	410	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
2.54E+04	1.80E+06	2.22E-04	200	7,417	3.32E-03	1.41E-01	1.76E-04	4.28E-03	0.00E+00	0.00E+00	1.40E-04	7.22E-04	410

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, α (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)
200	1.41E+03	0.10	8.33E+01	4.28E-03	4.00E+02	1.51E+211	1.20E-04	1.70E-01	NA	5.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	5.06E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	3.3E-04

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

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
75354	1.25E+01	1,1-Dichloroethylene

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 Totals must add up to value of L_{WT} (cell G28) 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)
13	200	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
10	40	1000	1000	366	0.1	0.25	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
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	2.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
9.46E+08	410	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
2.54E+04	1.80E+06	2.22E-04	200	6,373	1.66E-02	7.06E-01	1.76E-04	5.20E-03	0.00E+00	0.00E+00	1.58E-04	8.24E-04	410

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, α (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)
200	8.83E+03	0.10	8.33E+01	5.20E-03	4.00E+02	1.41E+174	1.36E-04	1.20E+00	NA	2.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	2.25E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	5.8E-03

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

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
71556	1.25E+01	1,1,1-Trichloroethane

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)							
13	200	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
10	40	1000	1000	366	0.1	0.25	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
7.80E-02	8.80E-06	1.72E-02	25	7,136	347.24	545.00	1.10E+02	1.33E+03	0.0E+00	2.2E+00

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
9.46E+08	410	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
2.54E+04	1.80E+06	2.22E-04	200	7,853	9.84E-03	4.19E-01	1.76E-04	4.50E-03	0.00E+00	0.00E+00	1.38E-04	7.20E-04	410

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, α (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)
200	5.24E+03	0.10	8.33E+01	4.50E-03	4.00E+02	8.60E+200	1.20E-04	6.27E-01	NA	2.2E+00

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	1.33E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
NA	2.7E-04

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

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79005	5.00E+00	1,1,2-Trichloroethane

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)							
13	200	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
10	40	1000	1000	366	0.1	0.25	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
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	0.0E+00

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
9.46E+08	410	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
2.54E+04	1.80E+06	2.22E-04	200	9,540	4.64E-04	1.97E-02	1.76E-04	4.51E-03	0.00E+00	0.00E+00	2.04E-04	1.00E-03	410

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, α (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)
200	9.87E+01	0.10	8.33E+01	4.51E-03	4.00E+02	4.07E+200	1.64E-04	1.62E-02	1.6E-05	NA

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	4.42E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.1E-07	NA

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

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
71432	5.00E+00	Benzene

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)							
13	200	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\cdot s^2$)	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)
10	40	1000	1000	366	0.1	0.25	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
8.80E-02	9.80E-06	5.54E-03	25	7,342	353.24	562.16	5.89E+01	1.79E+03	7.8E-06	3.0E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
9.46E+08	410	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
2.54E+04	1.80E+06	2.22E-04	200	8,091	3.12E-03	1.33E-01	1.76E-04	5.08E-03	0.00E+00	0.00E+00	1.64E-04	8.47E-04	410

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, α (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)
200	6.65E+02	0.10	8.33E+01	5.08E-03	4.00E+02	1.18E+178	1.40E-04	9.31E-02	7.8E-06	3.0E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	1.79E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
3.0E-07	3.0E-03

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

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
127184	5.00E+00	Tetrachloroethylene

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)							
13	200	610	610	0	0	A	SIL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

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)
10	40	1000	1000	366	0.1	0.25	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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 (°C)	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ (cal/mol)	Normal boiling point, T_B (°K)	Critical temperature, T_C (°K)	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)
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.8E-07	6.0E-01

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
9.46E+08	410	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	68.18	0.439	0.090	0.349	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
2.54E+04	1.80E+06	2.22E-04	200	9,523	9.35E-03	3.98E-01	1.76E-04	4.16E-03	0.00E+00	0.00E+00	1.28E-04	6.65E-04	410

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, α (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)
200	1.99E+03	0.10	8.33E+01	4.16E-03	4.00E+02	4.76E+217	1.11E-04	2.21E-01	5.8E-07	6.0E-01

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	2.00E+05	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
5.3E-08	3.5E-04

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

SCROLL DOWN TO "END"

END

GW-ADV
Version 3.1; 02/04

Reset to Defaults

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]

ENTER Chemical CAS No. (numbers only, no dashes)	ENTER Initial groundwater conc., C_W (µg/L)	Chemical
79016	1.00E+01	Trichloroethylene

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)							
13	200	610	610	0	0	A	SICL	SIL		

MORE ↓

ENTER Stratum A SCS soil type (Lookup Soil Parameters)	ENTER Stratum A soil dry bulk density, ρ_b^A (g/cm^3)	ENTER Stratum A soil total porosity, n^A (unitless)	ENTER Stratum A soil water-filled porosity, θ_w^A (cm^3/cm^3)	ENTER Stratum B SCS soil type (Lookup Soil Parameters)	ENTER Stratum B soil dry bulk density, ρ_b^B (g/cm^3)	ENTER Stratum B soil total porosity, n^B (unitless)	ENTER Stratum B soil water-filled porosity, θ_w^B (cm^3/cm^3)	ENTER Stratum C SCS soil type (Lookup Soil Parameters)	ENTER Stratum C soil dry bulk density, ρ_b^C (g/cm^3)	ENTER Stratum C soil total porosity, n^C (unitless)	ENTER Stratum C soil water-filled porosity, θ_w^C (cm^3/cm^3)
SIL	1.49	0.439	0.18	C	1.43	0.459	0.215	C	1.43	0.459	0.215

MORE ↓

ENTER Enclosed space floor thickness, L_{crack} (cm)	ENTER Soil-bldg. pressure differential, ΔP ($g/cm\cdot s^2$)	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)
10	40	1000	1000	366	0.1	0.25	5

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 Target risk for carcinogens, TR (unitless)	ENTER Target hazard quotient for noncarcinogens, THQ (unitless)
70	30	30	350	1.0E-06	1
				Used to calculate risk-based groundwater concentration.	

END

CHEMICAL PROPERTIES SHEET

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)
7.90E-02	9.10E-06	1.03E-02	25	7,505	360.36	544.20	1.66E+02	1.47E+03	1.1E-04	4.0E-02

END

INTERMEDIATE CALCULATIONS SHEET

Exposure duration, τ (sec)	Source-building separation, L_T (cm)	Stratum A soil air-filled porosity, θ_a^A (cm^3/cm^3)	Stratum B soil air-filled porosity, θ_a^B (cm^3/cm^3)	Stratum C soil air-filled porosity, θ_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)
9.46E+08	410	0.259	0.244	0.244	0.307	2.83E-09	0.798	2.26E-09	133.93	0.439	0.040	0.399	4,000

Bldg. ventilation rate, $Q_{building}$ (cm^3/s)	Area of enclosed space below grade, A_B (cm^2)	Crack-to-total area ratio, η (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, μ_{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)
2.54E+04	1.80E+06	2.22E-04	200	8,520	5.62E-03	2.39E-01	1.76E-04	4.56E-03	0.00E+00	0.00E+00	1.82E-05	5.53E-05	410

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, α (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)
200	2.39E+03	0.10	8.33E+01	4.56E-03	4.00E+02	2.39E+198	9.52E-06	2.28E-02	1.1E-04	4.0E-02

END

RESULTS SHEET

RISK-BASED GROUNDWATER CONCENTRATION CALCULATIONS:

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)
NA	NA	NA	1.47E+06	NA

INCREMENTAL RISK CALCULATIONS:

Incremental risk from vapor intrusion to indoor air, carcinogen (unitless)	Hazard quotient from vapor intrusion to indoor air, noncarcinogen (unitless)
1.0E-06	5.5E-04

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

MESSAGE: Risk/HQ or risk-based groundwater concentration is based on a route-to-route extrapolation.

SCROLL DOWN TO "END"

END