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Appendix I

Baseline Risk Assessment

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Appendix I - Baseline Risk Assessment

Shakespeare Composite Structures Site

Voluntary Cleanup Contract 14-6271-RP

File # 51025

19845 US Highway 76

Newberry, South Carolina

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ADAF	age-dependent adjustment factor
ATSDR	Agency for Toxic Substances and Disease Registry
bgs	below ground surface
BRA	Baseline Risk Assessment
CAF	cancer adjustment factor
CalEPA	California Environmental Protection Agency
COC	chemical of concern
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
CSM	conceptual site model
ED	exposure duration
EF	exposure frequency
EPC	exposure point concentration
EPD	exposure pathway diagram
ERA	Ecological Risk Assessment
ERAGS	Ecological Risk Assessment Guidance for Superfund
ESV	ecological screening value
ET	exposure time
GI	gastrointestinal
HEAST	Health Effects Assessment Summary Tables
HHRA	Human Health Risk Assessment
HI	hazard index
HQ	hazard quotient
IRIS	Integrated Risk Information System
IUR	inhalation unit risk
MAF	mutagenic adjustment factor
NRWQC	National Recommended Water Quality Criteria

PPRTV	Provisional Peer-Reviewed Toxicity Value
RAGS	Risk Assessment Guidance for Superfund
RfC	reference concentration
RfD	reference dose
RME	reasonable maximum exposure
RSL	Regional Screening Level
SF	slope factor
SLERA	screening-level ecological risk assessment
SMDP	scientific/management decision point
UCL	upper confidence limit
USEPA	United States Environmental Protection Agency
VISL	vapor intrusion screening level
VOC	volatile organic compound

1.0 HUMAN HEALTH RISK ASSESSMENT

A Baseline Risk Assessment (BRA) is an integral part of remedial response programs designed to protect human health and ecological resources from current and potential future environmental threats (United States Environmental Protection Agency [USEPA], December 1989). It provides a basis for determining whether remedial action is necessary and, if so, the levels and extent of cleanup needed to reduce potential risk to acceptable levels. The principal components of a BRA are a Human Health Risk Assessment (HHRA) and an Ecological Risk Assessment (ERA). The results of this BRA for the Shakespeare Composite Structures Site (the Site) can be used to determine if additional data or additional steps in the BRA process are needed and to identify remediation levels protective of receptors if determined to be at risk.

This section presents the HHRA, including a description of data collection and evaluation for the BRA. The ERA is presented in Section 2.

1.1 Site Description

The Shakespeare Composite Structures Site includes the property occupied by a fiberglass production facility (the facility), and several adjacent properties to the north, west, and south of the facility are also evaluated as part of the Site due to the presence of contaminated groundwater beneath those properties (**Figure 1-2**). The Site surrounds the facility property. A more detailed description of the Site is included in Section 1 of the RI Report.

1.2 DATA COLLECTION AND EVALUATION

Data collection and evaluation, the first component of a BRA, is a two-step, medium-specific task involving the compilation and evaluation of analytical data. A summary of the samples (including sample locations, dates collected, and analytical parameters) used in both the HHRA and the ERA is presented in **Table 1-1**.

1.2.1 Data Collection

Samples used in this BRA were collected between April 2014 and March 2018 during previous investigations and include data obtained from analysis of surface and subsurface soil, groundwater, surface water, and subslab vapor samples. All samples were analyzed for Target Compound List - Volatile Organic Compounds (TCLVOCs) by USEPA Method 8260B. Additionally, ten groundwater samples were analyzed for iron and manganese by USEPA Method 6010D.

Surface soil was collected from nine locations between April and June 2014 and from six locations in March 2018 from depths of 1 to 2 feet below ground surface (bgs). Subsurface soil was collected at various depth intervals from 63 locations between April and June 2014 and from six locations in March 2018 from depths ranging from 2 to 10 feet bgs. Soil sample locations are shown on **Figure 3-1** in the RI Report.

Groundwater samples were collected in June 2017 from 35 shallow monitoring wells, 10 of which were temporary wells, and from 12 intermediate monitoring wells. Four additional shallow monitoring wells were sampled in April 2018. Samples were collected from nine (9) water supply wells and 23 bedrock wells between June 2014 and July 2017 **(Figures 3-3 through 3-7** in the RI Report**).**

Subslab vapor data were collected in March 2018 from two locations underneath the pole winder building and from five locations underneath the main building (**Figure 3-2** in the RI Report).

Surface water data were collected from three locations in September 2015 at an intermittent stream, north of the facility, and from two locations in June 2017 at an intermittent stream, southwest of the facility (**Figure 3-8** in the RI Report).

1.2.2 Data Evaluation

The analytical data obtained from the 2018 subslab vapor sampling event, the 2017 RI-related sampling efforts at the site, as well as previous investigations, were evaluated prior to use in the BRA. The steps involved in evaluation and aggregation of data are common to both the human health and ecological risk assessments. The goal of data evaluation is to select data that are valid for use in the BRA and to identify chemicals that potentially are site-related. The initial steps in identifying human health chemicals of potential concern (COPCs) and chemicals of potential ecological concern (COPECs) involve evaluation and aggregation of data. These steps are common to both the HHRA and ERA.

<u>Step A.1:</u> Sort the data into exposure groups.

After the analytical data were compiled, they were sorted based on medium, depth interval, and exposure area to form data groups for evaluation in the BRA. An exposure area is a geographical area over which receptors are likely to average their exposures, based on observed or assumed patterns of receptor behavior and the patterns and extent of contamination. The data groups for each medium were sorted based on exposure areas to form exposure groups to be used in evaluating risk.

Surface soil samples were collected at the site from a depth interval of 1 to 2 feet bgs. Ten of these samples were collected from beneath pavement or asphalt and five were collected from uncovered areas. Two exposure groups were identified for surface soil. One exposure group contained only the five exposed surface soil samples (identified as “exposed surface soil” for evaluating an industrial scenario). The other exposure group contained all 15 surface soil samples (identified as “surface soil” for evaluating a construction scenario). Subsurface soil samples, collected from depths ranging from 2 feet to 10 feet bgs, were considered a single exposure group. Surface water samples collected from three locations north of the facility and from two locations southwest of the facility, were considered a single exposure group.

Groundwater was collected using data from shallow, intermediate, and bedrock monitoring wells across the site. Under future conditions, it was assumed that groundwater exposure pathways potentially could be complete for a hypothetical future on-site resident. To be conservative, it was assumed that the residents' potable water could be obtained from a well installed at any location in the core of each contaminant plume on the site and screened at any depth. Under this scenario, an on-site resident could be exposed through direct ingestion of and dermal contact with groundwater and inhalation of vapors during showering and other household uses of groundwater. Samples from shallow and intermediate wells were considered to represent a single groundwater exposure group because they are not from separate layers. Samples from bedrock wells were considered a separate exposure group. In addition, the nine residential or drinking water wells (Boazman well and wells PW-1 through PW-8) were considered individually for the purpose of evaluating potential risk, as recommended by USEPA (February 2014).

Data collected from three separate intervals (PW-2-84, PW-2-120-130, and PW-2-130-140) and from four separate intervals (PW-8-70, PW-8-105-115, PW-8-145-155, and PW-8-160-182) at drinking water wells PW-2 and PW-8 were averaged for each location.

The subslab vapor data, collected from beneath the floors of the pole winder and main buildings, were defined as separate exposure groups for these buildings for modeling indoor air concentrations and evaluating current and future risk to industrial workers from vapor intrusion.

Vapor intrusion also is a potentially complete groundwater pathway for a hypothetical future on-site resident. In this scenario, future residents could be exposed to groundwater VOCs as a result of vapor intrusion, as described above for industrial workers. In the absence of subslab vapor data for such a scenario, indoor air concentrations were modeled based on groundwater concentrations. The vapor intrusion pathway is of concern only for VOC contamination in shallow groundwater within 100 feet of an occupied building. It was assumed that under future conditions a house could be constructed and occupied by residents anywhere on the site.

Step A.2: Eliminate non-detected analytes.

Those analytes not detected in any samples in a particular medium or exposure group were eliminated from the data set.

Step A.3: Determine data parameters.

For each analyte in each exposure group, the following data parameters are presented in **Tables 1-2 through 1-7**: minimum and maximum detected concentrations, location of the maximum detected concentration, detection frequency, and range of lab reporting limits.

After the completion of Steps A.1 through A.3, separate procedures were used for COPC/COPEC selection for human health and ecological receptors. These procedures are discussed below in Sections 6.3 and 7.2, respectively.

1.3 HUMAN HEALTH RISK ASSESSMENT

The purpose of the HHRA portion of a BRA is to characterize the potential for carcinogenic risk and noncarcinogenic hazard to human receptors exposed to site-related contaminants under current and hypothetical future land use conditions if no remedial action is performed. The preliminary steps of an HHRA include an evaluation of exposure setting, development of a preliminary conceptual site model and associated exposure pathway diagram (EPD), and conservative screening of existing data. Contaminants determined to have the potential to pose risk or hazard to human receptors are identified as human health COPCs. Information from the preliminary steps of the HHRA supports risk management decisions regarding the need for additional data or additional steps of the HHRA at the site.

The HHRA was conducted in accordance with the following USEPA guidance documents:

Risk Assessment Guidance for Superfund (RAGS)*, Volume I, Human Health Evaluation Manual (Part A), Interim Final* (USEPA, December 1989);

RAGS, Volume I, Human Health Evaluation Manual (Part D, Standardized Planning, Reporting, and Review of Superfund Risk Assessments), Final (USEPA, December 2001);

RAGS, Volume I, Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final (USEPA, July 2004);

RAGS, Volume I, Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment), Final (USEPA, January 2009);

Region 4 Human Health Risk Assessment Supplemental Guidance (USEPA, March 2018a); and

OSWER Technical Guide for Assessing and Mitigating the Vapor Intrusion Pathway from Subsurface Vapor Sources to Indoor Air (USEPA, June 2015).

1.3.1 Identification of Chemicals of Potential Concern

The selection of COPCs is a step-wise process that evaluates appropriate analytical data in order to identify those chemicals that are likely to be site-related (i.e., not present at the site due to natural conditions or detected in samples due to field or laboratory error) and that have the potential to pose risk or hazard to human receptors. If a chemical is selected as a COPC, it does not imply that the chemical poses a health risk or that it will contribute to a significant risk in an environmental medium. COPCs are merely those chemicals that need to be further evaluated for their potential human health effects.

The COPC selection process used for the HHRA is described in Steps B.1 through B.4 below. The rationale and criteria used to identify COPCs follow USEPA Region 4 guidance (USEPA, March 2018a).

The analytes that passed through the data evaluation procedure described in Section 6.2.2 (Steps A.1 – A.3) were evaluated to identify COPCs.

Step B.1: Compare analyte concentrations to risk-based screening levels.

Screening Level Sources

An analyte is eliminated as a COPC if its maximum detected concentration is less than its risk-based screening level. The chemical-specific screening levels for each medium are from the following sources:

Surface Soil

USEPA Regional Screening Levels (RSLs) for residential exposure to soil, at a risk level of 10^{-6} or a hazard quotient (HQ) of 0.1 (USEPA, May 2018a), based on exposure via direct contact.

Subsurface Soil

USEPA RSLs for industrial exposure to soil, at a risk level of 10^{-6} or an HQ of 0.1 (USEPA, May 2018a), based on exposure via direct contact.

Groundwater

USEPA RSLs for tap water, at a risk level of 10^{-6} or an HQ of 0.1 (USEPA, May 2018a), based on exposure of residents via direct contact. A chemical detected in groundwater is retained as a COPC, however, if its maximum detected concentration exceeded its USEPA maximum contaminant level (MCL; March 2018b).

Surface Water

USEPA National Recommended Water Quality Criteria (NRWQC) – Human Health, based on consumption of water and organisms (USEPA, January 2018).

USEPA RSLs for tap water, at a risk level of 10^{-6} or an HQ of 0.1 (USEPA, May 2018a). The tap water RSLs were used only if an NRWQC value was unavailable.

Surface Soil Screening

Both surface soil exposure groups (exposed surface soil samples and surface soil samples) were screened against residential RSLs for soil (**Tables 1-2 and 1-3**, respectively). Both analytes detected in exposed surface soil and all nine analytes detected in surface soil were below the relevant residential RSLs. Accordingly, no COPCs were identified in either surface soil exposure group, and neither was retained as a medium of concern for human health risk.

Subsurface Soil Screening

Subsurface soil samples were screened against industrial RSLs for soil (**Table 1-4**). All 21 analytes detected in subsurface soil were below the relevant industrial RSLs. Accordingly, no COPCs were identified in the subsurface soil exposure group, and it was not retained as a medium of concern for human health risk.

Surface Water Screening

Surface water samples were screened against NRWQC (for consumption of water and organism) values. If NRWQC values were unavailable, tapwater RSLs were used (**Table 1-5**). Four of the five analytes detected in surface water were below their human health screening values. Trichloroethene concentrations slightly exceeded its USEPA NRWQC (for consumption of water and organism) value at two locations, each on a different, very small, headwater stream (one located north and the other southwest of the facility). The NRWQC is based on the assumption that a person regularly consumes water from the stream as drinking water, as well as regularly consuming fish from the stream. Because such exposure does not occur in either of these small streams, the use of the NRWQC for screening is extremely conservative. Nevertheless, the exceedances of the NRWQC (0.6 µg/L) by the two estimated concentrations (0.93 and 0.92 µg/L) below the reporting limit were minimal. Given the conservatism of using the NRWQC to screen surface water from these streams, the negligible potential for actual exposure, and the minimal exceedances of the NRWQC, trichloroethene was not identified as a COPC and surface water was not retained as a medium of concern for human health risk.

Groundwater Screening

Groundwater samples were screened against tapwater RSLs. Seven of the 19 VOCs and both metals detected in shallow/intermediate groundwater exceeded the relevant criteria (**Table 1-6**). Four of the 12 VOCs detected in bedrock groundwater collected from the bedrock monitoring wells exceeded their RSLs, while iron, the single metal detected, did not (**Table 1-7**). In a separate screening for the nine drinking water wells screened in the bedrock aquifer, trichloroethene exceeded its RSL in the Boazman well and wells PW-2, PW-4, PW-5, and PW-8 (**Table 1-7**).

Vapor Intrusion Screening

Risk-based screening levels for subslab vapor concentrations (used for an industrial scenario) and groundwater concentrations (used for a residential scenario), based on risk from the indoor air exposure pathway, were derived using the USEPA Vapor Intrusion Screening Level (VISL) Calculator (USEPA, June 2018), which uses current USEPA inhalation toxicity data in its calculations. Screening concentrations were derived for both commercial/industrial and residential exposure scenarios using a site groundwater temperature of 17 degrees Celsius and a target risk of 1 x 10^{-6} for carcinogens and a target HQ of 0.1 for noncarcinogens. The VISL Calculator includes those chemicals that are sufficiently volatile and toxic to potentially pose risk; that is, screening levels are calculated for chemicals that could volatilize from subslab vapors or groundwater and enter indoor air and that have been identified as potentially causing cancer risk or noncancer hazard through the inhalation pathway. Such VOCs were evaluated in the VISL calculator if they were detected in subslab vapor samples from beneath the main building or the pole winder building (for the industrial scenario) or in shallow/intermediate groundwater (for the residential scenario).

The “Sub-Slab and Exterior Soil Gas Concentrations” and the “Target Groundwater Concentrations,” identified by the VISL Calculator, were used as preliminary screening values for the industrial and residential scenarios, respectively. A VOC was eliminated as a vapor intrusion COPC if its maximum detected concentration was less than its VISL concentration. The VISL calculator for commercial/industrial and residential exposure scenarios is presented in **Appendix I.1** as **Tables I.1-1 and I.1-2**, respectively, and the vapor intrusion preliminary COPCs are presented in **Tables 1-8 and 1-9** for the industrial and residential scenarios, respectively.

The vapor intrusion preliminary COPCs were further evaluated by estimating exposure point concentrations (EPCs) for vapors in indoor air using version 6.0 of the Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings (USEPA, September 2017). The “Predicted Indoor Air Concentrations Due to Vapor Intrusion” from the model were compared to industrial (**Table 1-10**) and residential (**Table 1-11**) RSLs for industrial and residential scenarios, respectively. The vapor intrusion pathway was evaluated for both current and future on-site industrial workers and future residents. The predicted indoor air concentrations derived in these spreadsheets are based on a target risk level of 1 x 10^{-6} for carcinogens and a target hazard index of 1.0 for noncarcinogenic effects. Printouts from the model runs are provided as **Tables I.1-3 and I.1-4** (industrial scenario) and **Tables I.1-5 through I.1-7** (residential scenario) in **Appendix I.1** for the individual COPCs.

Site-specific values were used as input for the model variables to the extent possible. The site-specific values used as input to the spreadsheet program for both an industrial worker and a resident included “soil stratum A SCS soil type” (sandy clay) and “average groundwater temperature” (17 degrees Celsius). For the worker, inputs also included “depth below grade to soil gas sample” and “thickness of soil stratum A” (0.3 meters), a “slab-on-grade” building foundation, an enclosed space floor area (2600 square meters for the pole winder building and 7800 square meters for the main building), and an “enclosed space mixing height” (5 meters). The arithmetic mean of the subslab vapor concentration was used as the soil gas concentration for each preliminary COPC. For the resident, inputs included “depth below grade to water table,” “thickness of soil stratum A” (2.44 meters), and a “closed crawl space with dirt floor” building foundation type. The arithmetic mean of the shallow/intermediate groundwater concentration was used as the groundwater concentration for each preliminary COPC.

Default values included an indoor air exchange rate of 1.5 for the worker. For the resident, default values included "enclosed space floor area" of 150 square meters, "enclosed building space height" of 2.44 meters, and "indoor air exchange rate" of 0.45. The site-specific and default values, along with the predicted indoor air concentrations due to vapor intrusion, are shown on the printouts provided in **Appendix I.1**.

<u>Step B.2:</u> Compare analyte concentrations to background levels

An analyte may be eliminated as a COPC if its maximum detected concentration is less than its background concentration. However, background concentrations were not available for the media evaluated in this BRA.

<u>Step B.3:</u> Delete media and/or exposure groups

In this step, it is determined whether any COPCs remain for each medium and exposure group. If not, the medium and/or exposure group is dropped from consideration in the HHRA. COPCs remained in groundwater (shallow/intermediate and bedrock exposure groups) and in groundwater based on indoor air exposure. COPCs were not identified in exposed surface soil, surface soil, subsurface soil, or subslab vapors based on indoor air exposure.

<u>Step B.4:</u> Define COPCs and exposure groups.

The chemicals remaining in each medium and exposure group after the completion of Steps A.1 to A.3 and B.1 to B.3 constitute the human health COPCs. The COPCs identified through the methods and rationale described above are presented in **Tables 1-2 through 1-7** for exposed surface soil, surface soil, subsurface soil, surface water, shallow/intermediate groundwater, and bedrock groundwater/drinking water wells, respectively. These tables list the analytes detected in the exposure group, their occurrence (maximum and minimum detected concentrations, location of maximum concentration), frequency of detection, range of laboratory reporting limits, and screening value; also, they indicate which analytes are COPCs and the rationale for their selection or deletion. **Tables 1-8 and 1-9** present the preliminary vapor intrusion COPCs identified in subslab vapors and groundwater for industrial/commercial and residential scenarios, respectively, and **Tables 1-10 and 1-11** show the final vapor intrusion COPCs for these two media and scenarios. A summary of the COPCs is provided in **Table 1-12**.

1.3.2 Exposure Assessment

This section of the HHRA addresses the potential pathways by which human populations could be exposed to the COPCs identified in Section 6.3.1. Both current land uses and future, hypothetical land uses on the site and surrounding areas were considered in identifying principal pathways of exposure. The exposure assessment describes exposure scenarios, develops information on exposure pathways, estimates the concentrations of COPCs at points of human exposure, and calculates receptor intakes.

1.3.2.1 Characterization of Exposure Setting

This section describes the overall exposure setting in terms of the natural environment and land use. The description of the exposure setting provides information pertinent to the identification of potential human exposure pathways and the estimation of exposure factors for current and hypothetical future human receptors.

The Shakespeare Composite Structures Site includes an active manufacturing facility that produces fiberglass products (24.2 acres), and several adjacent properties to the north, west, and south of the facility that are also evaluated as part of the Site due to the presence of contaminated groundwater beneath those properties (**Figure 1-2**). Operations at the facility include the design and manufacture of large fiberglass utility poles and cross arms, and a variety of other fiberglass outdoor products such as posts, signs, sheet piling, and sign posts. The facility property includes the main building and the pole winder building, which total approximately 250,000 square feet under roof. The facility property also includes several smaller buildings and paved parking lots. Undeveloped areas between the buildings and paved areas are covered in turfgrass that is regularly mowed. A buffer of trees surrounds the facility to the west, north, and east, including a narrow line of trees between the facility property and the CSX rail line adjoining the north-northwest property line. In addition to the facility property, the Site includes several surrounding properties with land uses that include agricultural, residential, commercial/light industrial, and undeveloped. Beyond the CSX rail line to the north-northwest, the land is undeveloped and planted with pine trees. The facility is bordered immediately to the east by a residential parcel, beyond which is land that is planted in pine trees and includes vacant buildings formerly occupied by the Dickert Lumber Company. The facility is bordered to the south by U.S. Highway 76, property owned by the Newberry County Airport, and private property owned by W. Shealy. The Shealy property is primarily farmland with a few small residences (rental homes) located sporadically across more than 60 acres. Three privately owned properties are located immediately to the west of the facility.

The topography of the former Shakespeare facility is generally flat, with a gradual slope to the west-northwest. The property appears to have been graded during the construction of the facility, with the elevation at the western edge an average 7 feet higher than the adjacent Boazman property to the west. Storm water falling on the facility is directed via a series of storm water drains and piping to a discharge point on the northwest side of the facility, where it discharges to a drainage swale on the Boazman property.

The Dickert and Folk properties to the north and northwest of the facility, across the CSX rail line, are heavily wooded with planted pine trees. These properties slope to the north toward an unnamed intermittent stream and a wetland area. The Boazman, Ringer, and Chapman properties lie to the west of the former Shakespeare facility. The Boazman property adjoins the west side of the facility, the Ringer property adjoins the west side of the Boazman property, and the Chapman property adjoins the west side of the Ringer property. These properties have rolling topography with gentle slopes. The Shealy property lies to the south, across US Highway 76 from the former Shakespeare facility. The Shealy property also has a rolling surface topography that generally slopes to the west and the south. The property slopes more significantly to the south to an unnamed intermittent stream. Elevations range from near 560 ft msl near US Highway 76 to less than 520 ft msl at the unnamed intermittent stream.

CVOC-impacted groundwater in the shallow zone has migrated several hundred yards to the north of the facility and, to a lesser extent, to the west and southwest of the facility. CVOC-impacted groundwater is also migrating into the uppermost fracture zones in the granite bedrock underlying the facility and to the southwest. Two private water wells in bedrock located to the west and southwest of the Site have been found to contain elevated CVOC concentrations.

Intermittent streams on the Dickert property to the north and the Shealy property to the south generally flow from east to west-southwest. Both intermittent streams discharge to unnamed tributaries that flow southwest to their confluences with Reedy Creek.

Under current conditions, the most likely potential receptors are industrial workers who work indoors at the facility. Under future conditions, the reasonably anticipated land use on the facility property is expected to remain industrial, and industrial workers and construction workers are considered to be the most likely potential future receptors. Residents living in homes on surrounding properties are not current receptors because they have city water and do not use well water for household purposes. However, residents in these locations potentially could be receptors in the future if they decided to use well water instead of city water. On-site residents also could be future receptors in the unlikely event that land use on the facility changes from industrial to residential and wells were installed to obtain water for household use.

1.3.2.2 Identification of Human Health Exposure Pathways

Potential human exposure pathways were identified for the Site based on current and potential future land uses as well as the extent and distribution of COPCs. A complete pathway includes: (1) a chemical source and release mechanism, (2) a transport or retention medium, (3) an exposure point where human contact with the contaminated exposure medium occurs, and (4) an exposure route for intake of the contaminant into the body at the exposure point. If any of these elements is missing, the pathway is incomplete and is not considered further in the HHRA. An exposure pathway diagram has been developed to illustrate the potential exposure pathways for the Site. This EPD is presented graphically in **Figure 1-1** and in text form in **Table 1-13.** In the diagram, the potentially complete pathways to be quantitatively evaluated in the HHRA are indicated by an "X." A box without an "X" indicates an incomplete pathway, which occurs when at least one of the pathway elements is missing. An asterisk indicates a pathway that potentially could be complete but would contribute insignificantly to exposure and, therefore, does not warrant quantitative evaluation.

1.3.2.2.1 Current Land Use Scenario

Under current conditions, the environmental media with the potential to contain site-related chemicals include groundwater, soil, and surface water. Current industrial workers do not have a potential for exposure to site-related chemicals in groundwater because potable water used at the facility is not obtained from groundwater. However, exposure to groundwater contaminants via vapor intrusion is a potentially complete pathway for workers in buildings located above or near (within approximately 100 feet horizontally or vertically) VOCs in shallow groundwater (i.e., the uppermost saturated zone) (USEPA, June 2015). Indoor workers potentially can be exposed to volatile groundwater contaminants by inhaling indoor air containing vapor that has infiltrated the buildings in which they work. Current industrial workers also have a potential for exposure to surface soil that is not covered by buildings or pavement on the facility. Possible exposure routes for exposed surface soil are incidental ingestion and dermal absorption.

1.3.2.2.2 Future Land Use Scenarios

Future land use at the site is expected to remain industrial, so future industrial workers also may have the potential for exposure to site-related chemicals. The future industrial scenario assumes that the current manufacturing buildings at the site will remain. A future industrial worker is assumed to have the same exposure routes as under current conditions: incidental ingestion and dermal contact with exposed surface soil, and inhalation of vapors migrating from surficial groundwater to soil gas to indoor air via vapor intrusion. It is assumed that potable water will continue to be obtained from an off-site source (i.e., the City of Newberry) and that no potable water supply wells will be installed for use on the Site.

A construction worker is another receptor that may be exposed on the site under a future industrial scenario. A construction worker involved in excavation activities such as installing or repairing underground utilities or installing footings potentially could be exposed to site-related contaminants in surface soil and subsurface soil, including soils that are beneath buildings or pavement. Potential exposure routes for soil exposure include incidental ingestion and dermal absorption. The construction worker is not expected to perform excavation activities at depths that would result in contact with groundwater.

For an unlikely future scenario in which land use on the facility property would change to residential, it is conservatively assumed that direct exposures to groundwater could occur through the use of an on-site well as a potable water source for residents (adult and child). Future residents living off the facility property but on the downgradient (with regard to groundwater flow) properties in the vicinity also may be exposed to site-related groundwater contaminants through the use of off-site wells at the residences as sources of potable water. Potentially complete groundwater exposure pathways for a future on-site resident include groundwater ingestion, dermal absorption while bathing, and inhalation of vapors from showering and other household uses of groundwater. In order to evaluate risk to a future resident in the area of the facility property, a residential well was assumed to be located within the core of each of the chemical-specific plumes in each of the groundwater layers (shallow/intermediate and bedrock), and the exposure concentration of each chemical was based on the concentrations detected in each layer.

In addition to these pathways involving the direct use of groundwater, inhalation of vapors migrating from groundwater into indoor air may also be a potentially complete exposure pathway for a future on-site resident due to the presence of VOCs in the shallow groundwater layer on the site. This vapor intrusion pathway would not have the potential to be complete for off-site residents because off-site groundwater contamination is present or expected only in the deeper groundwater layers, where it would not contribute to vapor intrusion.

A conservative screening for each medium was performed (Section 6.3.1), and no COPCs were identified in surface or subsurface soil. Therefore, a current and future industrial worker will not be evaluated for exposure to surface soil and a future construction worker will not be evaluated for exposure to surface or subsurface soil, because these pathways are incomplete.

1.3.2.2.3 Exposure Point Concentrations

Human exposures were evaluated based on a reasonable maximum exposure (RME), which is the maximum exposure that is reasonably expected to occur at a site. The RME is a conservative exposure case that is within the range of possible exposures for each potentially complete pathway (USEPA, December 1989). Sampling data collected at the site were used to calculate EPCs. The media evaluated in the HHRA after screening are shallow/intermediate and bedrock groundwater, and groundwater based on indoor air vapors.

In order to address USEPA's recommendation to base groundwater EPCs on "data from the core of a contaminant plume" (USEPA, February 2014), the groundwater data set used to calculate EPCs for each groundwater exposure group includes only concentrations from locations that make up the plume of contamination for a given chemical. In order to identify the individual groundwater plumes, concentrations of each groundwater COPC and their locations were identified for each exposure group, and the core of the groundwater plume of contamination was determined based on the highest concentrations and the relative proximity of these groundwater locations. The locations identified as the core of the groundwater plume for each chemical are shown below for each exposure group.

<u>Shallow/Intermediate Groundwater</u>

- 1,2-Dichloroethane — MW-10 (the only location where detected)
- Benzene — MW-4, -6, and -7I
- Chloroform — MW-5, -8, -9I, -22; TMW-22, -23, -24, and -30

- cis-1,2-Dichloroethene — MW-3, -3I, -4, -5, -5I, -6, -6I, -7, -7I, -8, -9, -9I, -22, -26, -27, -28, -29; TMW-21, -22, -23, -24, -25, -29, -30, -31, -32, and -33
- Tetrachloroethene — MW-7I, -8, -9I, and -20I
- Trichloroethene — MW-6, -6I, -7, -7I, -8, -9, -9I, -10, -10I, -26, -27, -28, -29; TMW-21, -22, -23, -24, -29, -30, -31, -32, and -33
- Vinyl Chloride — MW-6, -7, and -8
- Iron — MW-6, -7I, -9I, -20, and -20I
- Manganese — MW-7I, -8, and -9I

Bedrock Groundwater

- 1,2-Dichloroethane — MW-6D (the only location where detected)
- Chloroform — MW-9D, -12D, and -17D
- cis-1,2-Dichloroethene — MW-3D (the only location considered in the core of the plume)
- Trichloroethene — MW-6D, PW-2, PW-8, and RDW-1.

Bedrock Drinking Water Wells

- The single, detected concentration of trichloroethene was used as the EPC for each well.

The RME EPCs for the COPCs in these media are presented in **Table 1-14** (shallow/intermediate groundwater on the facility used as potable water) and **Table 1-15** (bedrock groundwater on the facility and drinking water wells off the facility used as potable water). The RME EPCs for the groundwater VOCs migrating into indoor air samples are presented in **Table 1-11** (output from the Johnson and Ettinger Model used as the EPCs).

To determine the RME concentrations of COPCs in on-site groundwater, USEPA's ProUCL Version 5.1.002 software (Singh and Maichle, 2013) was used. This program determines the computation of the upper confidence limit (UCL) on the mean that best fits the analytical data for each COPC. ProUCL is designed to test the normality of a data set and compute a conservative and stable UCL of the true population mean while considering sample size, the distribution of the data, and the skewness of the data. ProUCL calculates UCLs on the arithmetic mean with a specific confidence level (95% or greater) using 15 computational methods for full data sets without any nondetected results and several computation methods for data sets containing non-detects. It then recommends the most appropriate UCL(s) based on the data. In identifying the appropriate data for use with ProUCL, non-detects and estimated concentrations below the laboratory reporting limit were reported. ProUCL output for each COPC in groundwater used as potable water is provided in **Appendix I.2**.

Because of the uncertainty associated with any estimate of an EPC, the 95% UCL is generally used as the RME concentration. In cases where the 95% UCL exceeds the maximum detected concentration, the maximum detected concentration was used to estimate the RME concentration, in accordance with USEPA guidance (USEPA, December 1989). Also, in cases where the 95% UCL could not be calculated (e.g., due to too few detected concentrations), the maximum concentration was used to estimate the RME concentration.

Analytical data are not available for two potential exposure points that involve the transfer of contaminants from one medium to another: vapors in shower air from groundwater used as potable water and vapors in indoor air from migration of VOCs in soil gas via vapor intrusion. Therefore, appropriate modeling techniques were used to estimate EPCs for these exposure points, as described below:

<u>Vapors in Shower Air while Showering with Groundwater</u>

EPCs in indoor air for VOCs that volatilize from water into air while showering were calculated by applying the Andelman volatilization factor of 0.5 L/m^3 (USEPA, December 1991) to the exposure concentrations determined for VOCs in groundwater. Although VOCs may be present in ambient air from most typical household uses of groundwater, such as dishwashing, laundering, and cooking, showering may represent the upper bound because the warm water temperature of a shower facilitates volatilization, and the VOCs released are contained in a relatively small space with the receptor.

<u>Vapors from Migration of Volatiles into Indoor Air</u>

EPCs for vapors in indoor air were estimated for VOCs in soil gas using the Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings (USEPA, September 2017). Use of the Johnson and Ettinger model for calculating EPCs is discussed previously in Section 6.3.1.

1.3.2.2.4 Development of Chemical Intakes

Chemical-specific intakes, or doses, were calculated for the receptors and exposure pathways identified for quantitative evaluation in Section 6.3.2.2. The development of chemical intakes is based on USEPA methodology presented in RAGS Part A, Part E, and Part F (USEPA, December 1989; USEPA, July 2004; USEPA, January 2009) and the Office of Solid Waste and Emergency Response Directive 9285.6-03 (USEPA, March 1991).

An RME estimate of intake was developed for each exposure pathway. The RME estimate is the highest exposure that is reasonably expected to occur in a small but definable “high-end” segment of a potentially exposed population. It is derived using upper-bound values for a few of the most sensitive exposure parameters (e.g., contact rate, exposure frequency and duration) and average values for the remaining parameters (USEPA, March 1991).

The estimates of intake and dose were based on the EPCs for COPCs and on site-specific exposure assumptions developed using USEPA guidance such as RAGS Part A, Part E, and

Part F (USEPA, December 1989; USEPA, July 2004; USEPA, January 2009), the Exposure Factors Handbook (USEPA, September 2011), and Human Health Risk Assessment Supplemental Guidance (USEPA, March 2018a). The exposure factors used to estimate intake and dose for the future on-site resident, as well as the equations required to calculate intake and dose, are presented and defined in **Tables I.3-1 and I.3-2** for ingestion of groundwater and inhalation of vapors (from groundwater use and vapor intrusion), respectively. The equations and parameters used to derive absorbed dose (DA_{event}) for COPCs in groundwater, which is a component of the dermal intake calculation, are provided in **Tables I.3-3 through I.3-9**.

Chemical-specific intakes were developed for the potentially complete exposure pathways and are presented with the risk and hazard calculations (see Section 6.3.4, Risk Characterization).

1.3.2.2.4.1 Intake Parameters

The values used for the RME exposure parameters and the guidance on which they are based are presented in **Tables I.3-1 and I.3-2** for the resident, the only receptor evaluated for risk after COPC screening. Some exposure parameters, such as body weight and averaging time, have general application in all intake estimations. Other parameters, such as ingestion rate and skin surface area, are specific to the exposure pathway. Three parameters are used to estimate the total time a receptor may be exposed to a contaminated medium. Exposure frequency (EF) is the number of days per year that the exposure occurs, exposure duration (ED) is the number of years over which exposure occurs, and exposure time (ET) is the number of hours per day that a receptor may be exposed to a contaminated medium.

All of the exposure parameters are USEPA default values that are available in the risk assessment guidance documents (as referenced in **Tables I.3-1 and I.3-2**). These include such factors as ingestion rate, residential EF and duration, body weight, and averaging time. Under the future residential land use scenario, receptors are assumed to be both resident adult and child, age birth to 6 years.

1.3.2.2.4.2 Intake Equations

Equations for calculating chemical intakes based on exposures to groundwater and for calculating exposure concentrations based on exposure to air were obtained from RAGS Part A, Part E, and Part F (USEPA, December 1989; USEPA, July 2004; USEPA, January 2009). The equations are presented in **Tables I.3-1 and I.3-2**. The equations that were used for the calculation of chemical intakes include those for: estimation of exposure concentrations via inhalation (used for groundwater vapors), ingestion of chemicals in drinking water (groundwater), and dermal contact with chemicals in water (groundwater).

1.3.3 Toxicity Assessment

The following section provides an overview of the human health toxicity of those chemicals identified as COPCs for the Site. The objective of the toxicity assessment is to weigh available evidence regarding the potential for each chemical to cause adverse health effects in exposed individuals and to provide, where possible, an estimate of the relationship between the extent of exposure and the severity of the adverse effects (USEPA, December 1989).

Based on USEPA guidance (USEPA, December 2003), the most current toxicity values (slope factors [SFs], inhalation unit risks [IURs], reference doses [RfDs], and reference concentrations [RfCs]) were obtained from the following hierarchy of sources: (1) USEPA Integrated Risk Information System (IRIS); (2) USEPA Provisional Peer-Reviewed Toxicity Values (PPRTV) Database; and (3) California Environmental Protection Agency (CalEPA) values, Health Effects Assessment Summary Tables (HEAST) (USEPA, July 1997), Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels, and other peer reviewed sources. Toxicological data for the COPCs, including carcinogens and noncarcinogens, are presented in **Table 1-16 through Table 1-19**.

1.3.3.1 Carcinogens

The toxicity criterion used to evaluate potential carcinogens in a risk assessment is the cancer potency slope (potency factor). A potency factor is defined as the “plausible upper-bound estimate of the probability of a response (i.e., cancer) per unit intake of a chemical over a lifetime” (USEPA, December 1989). Potency factor values are specific to the route of exposure (i.e., ingestion or inhalation). The oral potency factor is the SF, which is “an upper bound, approximating a 95% confidence limit, on the increased cancer risk from a lifetime exposure to an agent. This estimate [is] usually expressed in units of proportion (of a population) affected per mg/kg-day [milligrams per kilogram per day]...” (USEPA, May 2011). The inhalation potency factor, the IUR, is “the upper bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 $\mu g/m^3$ in air” (USEPA, May 2011). The interpretation of IUR would be as follows: if unit risk = 2×10^{-6} per $\mu g/m^3$, this means that an individual could have, at most, a 2 in 1 million chance of developing cancer if exposed daily over a 70-year lifetime to 1 µg of the chemical per m^3 of air. Oral and inhalation carcinogenic toxicity data, including the SF and IUR and weight-of-evidence classification, for the COPCs are summarized in **Table 1-16 and Table 1-17**, respectively.

When toxicity information for a chemical was not available from IRIS, other sources were searched. An oral SF for chloroform from CalEPA was used.

The USEPA weight-of-evidence classification system (USEPA, September 1986) assigns each chemical to one of the following classes based on the strength of evidence that it exhibits carcinogenic effects in humans:

A Human carcinogen

B1 Probable human carcinogen – limited human data are available

B2 Probable human carcinogen – sufficient evidence in animals and inadequate or no evidence in humans

C Possible human carcinogen

D Not classifiable as a human carcinogen.

For some chemicals, USEPA has assigned a weight-of-evidence classification based on the revised *Guidelines for Carcinogen Risk Assessment* (USEPA, March 2005). Under this classification system, a chemical is assigned one of the following descriptors:

- Carcinogenic to Humans
- Likely to Be Carcinogenic to Humans
- Suggestive Evidence of Carcinogenic Potential
- Inadequate Information to Assess Carcinogenic Potential
- Not Likely to Be Carcinogenic to Humans.

Six of the nine COPCs are classified as potential carcinogens for both the oral route and for the inhalation route and are assigned to a carcinogenicity weight-of-evidence group by USEPA or CalEPA (**Tables 1-16 and 1-17**). Benzene, trichloroethene, and vinyl chloride are the only COPCs categorized as Group A (human carcinogens) or Known (carcinogenic to humans). Exposure to benzene and trichloroethene is associated with leukemia and kidney cancer, respectively, and vinyl chloride is associated with liver cancer through all routes of exposure.

1.3.3.2 Noncarcinogens

For exposure to noncarcinogens through ingestion, the dose-response information is presented by USEPA in the form of an RfD. The RfD is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (USEPA, May 2011). For exposure to noncarcinogens through inhalation, the dose-response information is presented by USEPA in the form of an RfC. The RfC is defined as "an estimate (with uncertainty spanning perhaps an order of magnitude) of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime" (USEPA, May 2011). Oral and inhalation noncancer toxicity data available for the COPCs, including target organ(s), are summarized in **Tables 1-18 and 1-19**, respectively. A target organ is the organ (or system) typically most affected by the toxic effects of a chemical. The affected organs are often influenced by the route of exposure to a chemical.

When toxicity information for a chemical was not available from IRIS, other sources were searched. Provisional RfD values from the PPRTV database were used for 1,2-dichloroethane and iron, and RfC values obtained from PPRTV and ATSDR were used for 1,2-dichloroethane and chloroform, respectively.

1.3.3.3 Dermal Toxicity Values

Few toxicology studies have focused on the dermal exposure route; therefore, it is often necessary to use oral toxicity values for dermal toxicity values. However, most oral toxicity values are derived from critical studies that use an administered dose, while a dermal toxicity value should reflect the fact that dermal exposure is a measure of an absorbed dose. Consequently, and consistent with USEPA risk assessment guidance, oral toxicity values should be adjusted from administered to absorbed doses for use in evaluating dermal toxicity.

When appropriate, oral SFs and RfDs derived from a critical study that used an administered dose were adjusted using the gastrointestinal (GI) absorption efficiency (percent absorbed by the GI tract following oral intake). If the GI absorption of the chemical (from a medium similar to the one used in the toxicity value critical study) is less than 50%, its oral absorption efficiency (percent absorbed) was used to calculate an adjusted SF or RfD. For a chemical whose absorption is greater than 50%, a default value of 100% (complete oral absorption) was used. Adjusted SF and RfD values, based on USEPA recommendations of chemicals to adjust as well as their absorption efficiencies provided in *RAGS, Part E* (USEPA, July 2004), are provided in **Table 1-16 and Table 1-18**. No COPC had its oral SF was adjusted. The oral RfD of manganese was adjusted by multiplying it by the oral absorption efficiency to derive the absorbed RfD

1.3.3.4 Assessing Early-Life Exposure to Carcinogens

Based on the *Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens* (USEPA, March 2005), risk assessors should consider lifestage differences in both exposure and dose-response when assessing cancer risk resulting from early-life exposures. Age-dependent adjustment factors (ADAFs) for dose response (i.e., slope factors) have been developed by USEPA and are combined with age-specific exposure estimates when assessing cancer risks. ADAFs are to be used only for chemicals with a mutagenic mode of action for carcinogenesis when chemical-specific data are absent. For all modes of action, when chemical-specific data are available for early-life exposure, those data are used in this HHRA instead of ADAFs. Two of the chemicals identified as COPCs for the Site have been designated by USEPA as having a mutagenic mode of action for carcinogenesis (USEPA, May 2018a): trichloroethene and vinyl chloride.

This is a departure from the way cancer risks have historically been based upon the premise that risk is proportional to the daily average of lifetime dose. The early life exposure guidance (USEPA, March 2005) recommends an integrative approach that can be used to assess total lifetime risk resulting from lifetime or less-than-lifetime exposure during a specific portion of a lifetime.

To calculate lifetime risk for a population with average life expectancy of 70 years, the lifetime risks associated with each of the four relevant time periods are summed:

- Risk from birth up to 2 years of age (ADAF = 10)
- Risk from 2 up to 6 years of age (ADAF = 3)
- Risk from 6 up to 16 years of age (ADAF = 3)
- Risk from 16 up to 70 years of age (ADAF = 1; i.e., no adjustment).

For the HHRA, potential risks to 26-year receptors (i.e., residents) are estimated for less than lifetime exposures. To estimate these risks, age-specific exposures were estimated separately for four relevant time periods: birth up to 2 years of age, 2 up to 6 years, 6 up to 16 years, and 16 up to 26 years. ADAFs were applied to the age-specific exposures to estimate cancer risk for each receptor exposure pathway for chemicals with a mutagenic mode of action for carcinogenesis when chemical-specific data are absent. The following provides an example of ADAFs applied to oral exposures to calculate risk for each of the four relevant time periods for a 26-year resident receptor:

- Risk from birth to 2 years of age (ADAF = 10)
    - Daily Intake for Child (0 to 2 years) x 10 (ADAF) x SF
- Risk for ages 2 to 6 years (ADAF = 3)
    - Daily Intake for Child (2 to 6 years) x 3 (ADAF) x SF
- Risk for ages 6 to 16 years (ADAF = 3)
    - Daily Intake for Child (6 to 16 years) x 3 (ADAF) x SF
- Risk for ages 16 to 26 years (ADAF = 1)
    - Daily Intake for Adult (16 to 26 years) x 1 (ADAF) x SF

Risks from each of these four time periods are then summed to estimate the total risk for the 26-year resident receptor.

Risks associated with inhalation exposure to carcinogens that act via a mutagenic mode of action are calculated in similar fashion by applying the appropriate ADAF(s) along with the corresponding inhalation unit risk estimate, using pertinent estimates of exposure concentration.

Potential risks estimated using this methodology for trichloroethylene and vinyl chloride are provided in the mutagenic risk tables in **Appendix I.4**. The exposure factors used to estimate age-specific exposures for receptors are also provided in these risk tables.

Trichloroethylene

Along with applying ADAFs to estimate cancer risk, the evaluation of trichloroethylene requires the use of different toxicity values for cancer and mutagenic effects (USEPA, 2018b). The liver cancer and non-Hodgkin's lymphoma risks are addressed using the standard cancer equations, and the kidney risk is assessed using the mutagenic equations. In order to calculate risk for trichloroethene, a carcinogenic adjustment factor (CAF) and a mutagenic adjustment factor (MAF) were developed. The adjustment factors for oral routes of exposure were calculated as follows:

- CAF = $SF_{\text{Non-Hodgkin's and Liver}}$ / SF_{Adult} = 3.72E-2 $(mg/kg\text{-}day)^{-1}$ / 4.6E-2 $(mg/kg\text{-}day)^{-1}$ = 0.804
- MAF = SF_{Kidney} / SF_{Adult} = 9.3E-3 $(mg/kg\text{-}day)^{-1}$ / 4.6E-2 $(mg/kg\text{-}day)^{-1}$ = 0.202

The adjustments for inhalation exposures were calculated as follows:

- CAF = $IUR_{\text{Non-Hodgkin's and Liver}}$ / IUR_{Adult} = 3.1E-6 $(ug/m^3)^{-1}$ / 4.1E-6 $(ug/m^3)^{-1}$ = 0.756
- MAF = IUR_{Kidney} / IUR_{Adult} = 1E-6 $(ug/m^3)^{-1}$ / 4.1E-6 $(ug/m^3)^{-1}$ = 0.244

The adjustment factors are used in the calculation of cancer risk for trichloroethene, as shown on **Tables I.4-1 through I.4-4** for ingestion of groundwater, dermal absorption from groundwater, inhalation from groundwater while showering, and inhalation from vapor intrusion, respectively.

Vinyl Chloride

USEPA's assessment of vinyl chloride toxicity concludes that higher cancer risks result from exposure early in life compared to exposure during adulthood (USEPA, May 2018b). Accordingly, IRIS provides two oral SFs for vinyl chloride: 7.2×10^{-1} $(mg/kg\text{-}day)^{-1}$ for continuous lifetime exposure during adulthood, and 1.5 $(mg/kg\text{-}day)^{-1}$ for continuous lifetime exposure from birth (**Table 1-16**). IRIS also provides two IURs for vinyl chloride: 4.4×10^{-6} $(ug/m^3)^{-1}$ for continuous lifetime exposure during adulthood and 8.8×10^{-6} $(ug/m^3)^{-1}$ for continuous lifetime exposure from birth (**Table 1-17**). The early-life exposure, which is not limited by exposure duration and frequency, appears to be independent of and additive to the standard carcinogenic risk. Therefore, for the on-site adult and child resident, the early life risk is calculated separately and added to the child (0 to 6 years) and adult (6 to 26 years) risk.

The continuous lifetime exposure during adulthood SF of 0.72 $(mg/kg\text{-}day)^{-1}$ is used to calculate the adult and child risk. A SF for early life oral exposure, which is used to calculate early life risk, was derived as follows:

> $SF_{\text{early life}}$ = SF for lifetime exposure from birth - SF for lifetime exposure during adulthood = 1.5 $(mg/kg\text{-}day)^{-1}$ - 0.72 (mg/kg-day)-1 = 0.78 $(mg/kg\text{-}day)^{-1}$

The continuous lifetime exposure during adulthood IUR of 4.4 x 10^{-6} $(ug/m3)^{-1}$ is used to calculate the adult and child risk. An IUR for early life inhalation exposure was derived as follows:

> $IUR_{early\ life}$ = IUR for lifetime exposure from birth - IUR for lifetime exposure during adulthood = 8.8E-6 $(ug/m^3)^{-1}$ - 4.4E-6 $(ug/m^3)^{-1}$ = 4.4E-6 $(ug/m^3)^{-1}$

The calculation of cancer risk for vinyl chloride is shown on **Tables I.4-5 through I.4-7** for ingestion of groundwater, dermal absorption from groundwater, and inhalation while showering with groundwater, respectively.

1.3.4 Risk Characterization

This section presents the results of the HHRA. These results include estimates of the potential for excess lifetime cancer risks and noncancer health effects for the current land use and hypothetical future land use scenarios for the Shakespeare Composite Structures Site. Cancer risk and/or noncancer hazard estimates are calculated for each COPC for which toxicity values are available, the significance of the calculated risks and hazards are characterized, and the uncertainties associated with these estimates are described. Chemical-specific RME risks and hazards for each pathway are presented in **Table I.5-1 through Table I.5-14** (the risk and hazard calculation tables). Risk estimation tables for chemicals with a mutagenic mode of action for carcinogenesis when chemical-specific data are absent are provided in **Tables I.4-1 through I.4-4** for trichloroethene and **Tables I.4-5 through I.4-7** for vinyl chloride.

Excess lifetime cancer risks reflect the incremental upper bound probability of an individual developing cancer over a 70-year lifetime from continuous, pathway-specific exposure to potentially carcinogenic chemicals. The excess lifetime cancer risk for the ingestion and dermal pathways was calculated by multiplying the chronic daily intake by the cancer SF. For the inhalation pathway, the excess lifetime cancer risk was calculated by multiplying the inhalation exposure concentration by the IUR. The carcinogenic risk estimate is generally an upper-bound estimate because the SF and IUR are typically derived as the upper 95th percentile confidence limit of the probability of response based on experimental animal data (USEPA, May 2011; USEPA, December 1989). Thus, USEPA is reasonably confident that the “true risk” will not exceed the risk estimate derived through use of the SF and IUR and is likely to be less than that predicted (USEPA, December 1989). The estimation of daily intakes and exposure concentrations (averaged over a lifetime) is described in Section 6.3.2.4, Development of Chemical Intakes. Excess lifetime cancer risks were calculated for each COPC and were also summed to calculate total risks for the ingestion, dermal, and inhalation exposure pathways for groundwater and the inhalation pathway for subslab vapors.

The excess lifetime cancer risk is typically expressed in exponential form (i.e., 1 x 10^{-6}, meaning one in one million), which describes the increased probability of an individual developing cancer from the evaluated exposure scenario over a 70-year lifetime. USEPA Region 4 has generally indicated that risks falling within the range of one in one million (1×10^{-6}) to 100 in one million (1×10^{-4}) should be evaluated to determine if risk reduction is feasible. Risk levels less than 1×10^{-6} generally are considered acceptable. Risks greater than 1×10^{-4} generally are considered significant (USEPA, March 2018a). Thus, COPCs identified in the risk characterization as contributing significantly (chemical-specific risk of 1×10^{-6} or greater) to a pathway with a cancer risk greater than 1×10^{-4} were identified as human health chemicals of concern (COCs) and are further discussed in the risk characterization section.

Noncancer hazards were evaluated by comparing the estimated intake or exposure level over a specified time period to an RfD or RfC derived for a similar exposure period. The value derived is a chemical-specific HQ. HQs were calculated by dividing the oral or dermal intake by the oral or dermal RfD, and dividing the inhalation exposure concentration by the RfC. Thus, the oral/dermal HQ is a ratio of the chronic daily intake to the RfD and the inhalation HQ is a ratio of the estimated chronic daily exposure concentration to the RfC. If the intake or exposure concentration exceeds the RfD or RfC (HQ exceeds 1), there may be concern for potential noncancer adverse health effects from that chemical.

The HQs for individual chemicals were summed for each exposure pathway to calculate a pathway-specific hazard index (HI) for each exposure route, exposure point, and exposure medium. As a conservative first step, the HQs were summarized across all COPCs, regardless of the target organs potentially affected by the COPCs. If the HI was greater than 1 using this approach, the summation was recalculated for groups of COPCs with similar types of target organs (USEPA, December 1989). Generally, as the HQ or HI increases above 1, the level of concern for adverse health effects similarly increases. If a particular COPC was determined to contribute significantly (HQ of 0.1 or greater) to a total cumulative target organ HI greater than 1 for a particular pathway, it was identified as a human health COC (USEPA, March 2018a). HQs and HIs less than or equal to 1 generally indicate no human health concerns.

Seven exposure groups (shallow/intermediate groundwater, bedrock groundwater, groundwater from four individual drinking water wells, and groundwater based on risk from indoor air) and one exposure scenario (future residents) were evaluated for the Site. A summary presenting the medium-specific risks and hazards for the future resident, is provided in **Table 1-20**.

1.3.4.1 Current/Future Land Use

Under the current/future land use scenario, cancer risks and noncancer hazards from exposure to COPCs were to be characterized for industrial workers at the facility, which were assumed to be exposed to surface soil that is not covered by buildings or pavement via ingestion and dermal contact, and to groundwater vapors in indoor air in buildings above or near VOC groundwater plumes. However, no COPCs were identified for this receptor in exposed surface soil or subslab vapors, so risks and hazards were not calculated.

1.3.4.2 Future Land Use

Under the future land use scenario, cancer risks and noncancer hazards from exposure to COPCs were to be characterized for a construction worker working in excavations on the facility and exposed to surface and subsurface soil via ingestion and dermal contact. However, no COPCs were identified for this receptor in surface or subsurface soil, so risks and hazards were not calculated.

Potential cancer risks and noncancer hazards were calculated for groundwater based on its residential use as tap water and the potential for VOCs in groundwater to volatilize into indoor air for hypothetical future site residents (representing an age-adjusted childhood through adulthood exposure). The total cumulative HIs for the future resident child were also considered separately from the age-adjusted childhood through adulthood exposure.

Future On-Facility Resident (Shallow/Intermediate Groundwater)

Total excess lifetime cancer risk and noncancer hazard estimates for a hypothetical future adult resident (representing an age-adjusted childhood through adulthood exposure) assumed to live on the facility is summarized in **Table I.5-15**. Potentially complete groundwater exposure pathways for an on-facility resident include groundwater ingestion, dermal absorption while bathing, and inhalation of vapors from showering and other household uses of groundwater. Additionally, inhalation of vapors migrating into indoor air is considered a potentially complete exposure pathway.

The total cumulative excess lifetime cancer risk for a hypothetical future on-facility adult resident exposed to shallow/intermediate groundwater used as potable water and exposed via vapor intrusion is 9×10^{-4}, which exceeds the USEPA target risk range of 1×10^{-6} to 1×10^{-4}. Chloroform, trichloroethene, and vinyl chloride are the carcinogenic COCs identified for the adult on-facility resident in groundwater (**Table I.5-19**).

The total cumulative noncancer HI for a hypothetical future on-facility adult resident exposed to groundwater used as potable water and exposed via vapor intrusion into indoor air is 39, which is above the USEPA benchmark of 1. Following evaluation of the target organ HIs, the noncarcinogenic COCs identified for a future on-facility adult resident were cis-1,2-dichloroethene and trichloroethene (**Table I.5-19**).

The total cumulative HI for the future on-facility resident child is considered separately from the age-adjusted childhood through adulthood exposure (**Table I.5-16**). The total cumulative noncarcinogenic HI for an on-facility resident child exposed to groundwater is 58, which exceeds the USEPA benchmark of 1. The noncarcinogenic COCs in groundwater identified for the future on-facility child resident were cis-1,2-dichloroethene and trichloroethene (**Table I.5-20**).

Future Off-Facility Resident (Bedrock Groundwater)

Total excess lifetime cancer risk and noncancer hazard estimates for a hypothetical future off-facility adult resident (representing an age-adjusted childhood through adulthood exposure) assumed to use water from the bedrock wells is summarized in **Table I.5-17**. Potentially complete groundwater exposure pathways for an off-facility resident include groundwater ingestion, dermal absorption while bathing, and inhalation of vapors from showering and other household uses of groundwater.

Total cumulative excess lifetime cancer risks for hypothetical future off-facility adult resident exposure to bedrock groundwater used as potable water is 2×10^{-4}, which exceeds the USEPA target risk range of 1×10^{-6} to 1×10^{-4}. Chloroform, 1,2-dichloroethane, and trichloroethene are the carcinogenic COCs identified in groundwater for the adult off-facility resident (**Table I.5-21**).

The total cumulative noncancer HI for exposure of a future off-facility adult resident to bedrock groundwater used as potable water is 12, which is above the USEPA benchmark of 1. The noncarcinogenic COC identified is trichloroethene (**Table I.5-21**).

The total cumulative HI for the future off-facility resident child is shown on **Table I.5-18**. The total cumulative noncarcinogenic HI for the off-facility resident child exposure to bedrock groundwater is 18, which exceeds the USEPA benchmark of 1. Trichloroethene was identified as a noncarcinogenic COC (**Table I.5-22**).

Future Off-Facility Resident (Drinking Water Wells)

Total excess lifetime cancer risk and noncancer hazard estimates for a hypothetical future off-site adult resident assumed to use groundwater from existing drinking water wells is summarized in **Tables I.5-5 through I.5-14**. Potentially complete groundwater exposure pathways for an off-site resident include groundwater ingestion, dermal absorption while bathing, and inhalation of vapors from showering and other household uses of groundwater.

Total cumulative excess lifetime cancer risks for a hypothetical future off-site adult resident exposed to groundwater used as potable water from the Boazman, PW-2, PW-4, PW-5, and PW-8 wells range from 9×10^{-7} at PW-4 to 5×10^{-5} at PW-8, which are within the USEPA target risk range of 1×10^{-6} to 1×10^{-4}.

The total cumulative noncancer HIs for a future off-site adult resident exposed to groundwater used as potable water from the individual drinking water wells range from 0.07 at PW-4 to 4 at PW-8. The HIs of 3 at PW-2 and 4 at PW-8 exceed the USEPA benchmark of 1. The noncarcinogenic COC identified at both locations is trichloroethene.

The total cumulative noncarcinogenic HIs for the off-site resident child exposure to groundwater from the individual drinking water wells range from 0.1 at PW-4 to 6 at PW-8. The HIs of 4 at PW-2, 2 at PW-5, and 6 at PW-8 exceed the USEPA benchmark of 1. The noncarcinogenic COC identified at these locations is trichloroethene.

1.3.4.4 Uncertainty

The evaluation of chemical risks to human health is, by necessity, based on a number of assumptions with inherent uncertainties. This section provides a discussion of the uncertainties associated with key site-related variables and major assumptions used in the HHRA in order to address their potential effect on the resulting identification of COCs.

1.3.4.4.1 Uncertainty in Data Evaluation and COPC Selection

The sampling data collected at locations at the site are inevitably a limited subset of the nearly unlimited quantity of data that potentially could be collected, and as such, may not be completely representative of site contaminant levels. However, samples were not collected on a random basis (e.g., sampling focused in potential source areas) and are likely to be biased toward overestimation of chemical concentrations. The samples used in the BRA data set (15 surface soil, 87 subsurface soil, 51 shallow/intermediate groundwater, 23 bedrock groundwater, seven subslab vapor, and five surface water samples) are considered to be representative of the suspected source areas and potential exposure areas associated with the Site.

Those analytes not detected in any samples in a particular medium or exposure group were eliminated from the data set. There is the possibility that some chemicals thus eliminated actually may be present at levels below their detection limit, and that these levels may be above criteria or risk-based screening levels for the chemical. The laboratory methods used in analyzing the samples provide essentially the lowest detection limits and reporting limits practicable. Therefore, the occurrence of such a situation for certain chemicals is a possibility and may result in underestimation of risks in the HHRA. However, the significance of such chemicals at consistently low concentrations (never above the detection limit) to the overall risk posed by chemicals at a site is expected to be minimal.

Uncertainty also is inherent in the selection of site-related COPCs. Uncertainty in contaminant identification is considered low because sampling protocols generally target appropriate analytes based on historical information and guidance. Eliminating contaminants in the COPC screening process can lead to lower estimates of potential health effects than would inclusion of all analytes. However, the chemicals excluded from the risk evaluation (i.e., not identified as final COPCs) were those detected at concentrations below conservative risk-based screening levels based on the most current USEPA guidance or those for which readily available lines of evidence indicated that their potential to pose significant risk was negligible.

The lack of risk-based screening levels for some of the analytes detected at the site increases the uncertainty in COPC identification. Surrogate screening values from chemicals with similar chemical structures and toxicological effects on humans were used for one analyte in surface water. The use of this surrogate screening value may overestimate or underestimate risk. There is uncertainty associated with use of the VISL Calculator. The calculator is based on assumptions about the site, including homogenous vadose zone soil and a building with a poured concrete foundation (USEPA, May 2018c). The VISL calculator uses generic attenuation factors developed by USEPA that assume vapor concentrations will be reduced as they migrate upward from the groundwater and that concentrations will be further reduced as they mix with air in the buildings. The attenuation factors were derived to be highly conservative.

1.3.4.4.2 Uncertainty in Exposure Assessment

Factors that contribute to uncertainty in the exposure assessment include the identification of exposure pathways, assumptions for scenario development, intake parameters, and exposure point concentrations.

The identification of potential exposure pathways and receptors was based on site-specific, plausible, current, and hypothetical future land use scenarios. Site-specific receptors were identified to the extent possible in order to minimize uncertainty in the postulated exposure scenarios. The exposure parameters are generally based on conservative assumptions and would tend to overestimate rather than underestimate risk. In accordance with USEPA Region 4 guidance, future residential exposure scenarios were included. The on-site residential scenario is highly unlikely given that the future land use at the site is expected to remain industrial, similar to current conditions.

Values assumed for exposure parameters (e.g., ingestion rate and EF) used in calculations of intakes were based primarily on USEPA guidance (USEPA, March 1991; July 2004; September 2011; and May 2018b). These assumptions might result in underestimating or overestimating the intakes calculated for specific receptors, depending on the accuracy of the assumptions relative to actual site conditions and land uses.

The maximum detected concentration was used as the exposure point concentration when calculating risk and hazard for one of the nine COPCs in shallow/intermediate groundwater (used for ingestion, dermal, and inhalation exposure); two of four bedrock groundwater COPCs used for ingestion, dermal, and inhalation exposure; and all four off-site drinking water well COPCs used for ingestion/dermal and inhalation exposure. This conservative default value was used because the 95% UCL could not be calculated for those COPCs. The use of maximum detected concentrations as exposure point concentrations most likely resulted in elevated risk and hazard levels and increased uncertainty for these exposure groups and the associated receptors evaluated in the HHRA.

Modeling was used to estimate the transfer of contaminants from one medium to another for indoor air concentrations resulting from vapor intrusion (Johnson and Ettinger model). The Johnson and Ettinger model for subsurface vapor intrusion into buildings is based on a number of assumptions and has certain inherent limitations/uncertainties. Major model assumptions and limitations are outlined in Section 5.0 of the User's Guide (USEPA, February 2004). Site-specific values were used as input for the model variables to the extent possible, with USEPA-defined default values used where site data were not available (refer to the model run output in **Appendix I.1** for a summary of input parameters used). The use of default input parameters is a source of site-specific uncertainties because default/assumed building conditions may not accurately represent actual future conditions at those sites evaluated for future residential use. This may overestimate or underestimate risk.

1.3.4.4.3 Uncertainty in Toxicity Assessment

Uncertainty is inherent in the toxicity values used to evaluate cancer risk and noncancer hazard. Such uncertainty is chemical-specific and is incorporated into the toxicity value during its development. For example, an uncertainty factor may be applied for interspecies and intrahuman variability, for extrapolation from subchronic to chronic exposures, or for epidemiological data limitations. Application of uncertainty factors is expected to overestimate risks.

A CalEPA oral SF was used for chloroform. Provisional values from PPRTV for 1,2-dichloroethane (RfD and RfC) and iron (RfD), and from ATSDR for chloroform (RfC) also were used. The use of provisional values contributed uncertainty that may overestimate or underestimate risk.

The absence of toxicity values for some of the COPCs may tend to underestimate risks and hazards. An inhalation RfC was not available for cis-1,2-dichloroethene.

There is uncertainty in the identification of toxicity values for the dermal route of exposure. Toxicity information was not available for dermal exposure; hence, several assumptions for adjustment of the exposure estimate from an administered to an absorbed dose (based on the GI absorption rates of the COPCs) were made in order to calculate dermal adjusted SFs and RfDs, which may overestimate or underestimate risk.

1.3.4.4.4 Uncertainty in Risk Characterization

Uncertainties in the exposure and toxicity assessments are reflected in the quantitative risk estimates developed for the COPCs in the risk characterization. Some of the procedures used and uncertainties inherent in the HHRA process may tend to underestimate potential risk. Overall, however, the numerous conservative assumptions built into this HHRA, including dose additivity for multiple substance exposure and combining of risk across pathways, are considered more likely to overestimate than underestimate potential risks.

1.3.4.5 Human Health Risk Summary

An HHRA was conducted for the Shakespeare Composite Structures Site to evaluate chemicals detected in site-related media, including surface and subsurface soils, shallow/intermediate and bedrock groundwater, surface water, and subslab vapors. Based on initial screening, COPCs were not identified in surface soil, subsurface soil, surface water, or subslab vapors. These media and two receptors potentially exposed to them (current/future industrial worker and future construction worker) were not evaluated further. Potential risks to human health under hypothetical future land use scenarios were quantitatively evaluated. Adult and child residents assumed to live on the site and off the site were evaluated as future receptors. Both on-site and off-site residents were evaluated based on exposure to groundwater used as potable water, while the on-site resident was also evaluated for exposure to shallow/intermediate groundwater via vapor intrusion.

COCs were identified in the Risk Characterization based on the risk and hazard calculations. The human health COCs identified for each receptor were the following:

- Current and Future Industrial Worker – no COCs identified
- Future Construction Worker – no COCs identified
- Future On-Facility Resident (Adult) –

  chloroform, cis-1,2-dichloroethene, trichloroethene, and vinyl chloride in shallow/intermediate groundwater
- Future On-Facility Resident (Child) –

  cis-1,2-dichloroethene and trichloroethene in shallow/intermediate groundwater
- Future Off-Facility Resident (Adult) –

  1,2-dichloroethane, chloroform, and trichloroethene in bedrock groundwater;
  trichloroethene in drinking water wells PW-2 and PW-8
- Future Off-Facility Resident (Child) –

  trichloroethene in bedrock groundwater;
  trichloroethene in drinking water wells PW-2, PW-5, and PW-8.

2.0 ECOLOGICAL RISK ASSESSMENT

2.1 The Ecological Risk Assessment (ERA) Process

The ERA component of a BRA evaluates whether unacceptable risks are posed to ecological receptors from chemical stressors in the environment. The ERA identifies contaminant levels that would not pose unacceptable ecological risks and provides information for risk management decisions regarding the need for and extent of potential remedial action (USEPA, November 2001). The process followed in performing the ERA was based on the current USEPA model for conducting ecological risk assessment, as described in the *Ecological Risk Assessment Guidance for Superfund* (ERAGS): *Process for Designing and Conducting Ecological Risk Assessments* (USEPA, June 1997) and *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (USEPA, June 2001). Additional risk assessment guidance considered in developing the ERA process includes the *Guidelines for Ecological Risk Assessment* (USEPA, April 1998) and the *Region 4 Ecological Risk Assessment Supplemental Guidance* (USEPA, March 2018c).

The ERAGS process is the principal model for ERAs in USEPA Region 4. The eight steps of the ERAGS process in Region 4 are as follows:

<u>Screening-Level Ecological Risk Assessment (SLERA)</u>

Step 1: Initial Problem Formulation and Effects Evaluation

Step 2: Exposure Estimation and Risk Calculation

<u>Baseline Ecological Risk Assessment</u>

Step 3: Baseline ERA Problem Formulation

- Step 3a: Problem Formulation and Refinement Screening
- Step 3b: Additional Problem Formulation

Step 4: Study Design and Data Quality Objectives Process

Step 5: Field Verification of Sampling Design

Step 6: Site Investigation and Data Analysis

Step 7: Risk Characterization

Step 8: Risk Management

In conjunction with these steps, the ERAGS process also requires interim decisions and deliverables following several steps in the process. These scientific/management decision points (SMDPs) are defined as points in the process at which risk managers evaluate the work completed to a given step and either approve the work and the planned approach or redirect additional work (i.e., decide whether or not the ERA should continue to the next step in the process). Up to six SMDPs potentially may be incorporated into the eight-step ERAGS process, depending on the number of ERA steps required at a particular site and circumstances specific to the site. SMDPs typically occur after Steps 2, 3, 4, and 7 of the ERAGS process, with a possible SMDP within Step 3 and another after Step 5 if approval is required for needed changes to the sampling design. This ERA concludes with SMDP 1.

2.2 Screening-Level Ecological Risk Assessment (SLERA)

The purpose of the SLERA is to provide an initial screening to eliminate detected chemicals that are expected to pose essentially no risk to ecological receptors. The ERA consists of two phases, the SLERA followed by the Baseline ERA. In the SLERA, preliminary COPECs are identified from among the analytes detected in exposure media at the site. The SLERA is intended to address the overall protection of the habitats and associated species within the study area based on comparison of maximum detected concentrations in site media to conservative ecological screening values (ESVs). ESVs are chemical-specific media concentrations intended to be protective of a range of sensitive ecological receptors.

The SLERA serves to focus the ERA on preliminary COPECs that may have the potential to pose ecological risk so that those contaminants then may be evaluated more closely in the context of current and future conditions. The SLERA is designed to be a very conservative, screening-level evaluation so that if the assessment indicates there is no ecological risk there can be a high degree of certainty associated with this conclusion. The SLERA includes Steps 1 and 2 of the ERA process, which are described below. At the conclusion of these initial steps, a decision is made at SMDP 1 about whether additional ecological assessment is warranted to address possible ecological concerns identified by the SLERA.

2.2.1 Step 1: Initial Problem Formulation and Effects Evaluation

The initial Problem Formulation step of the SLERA includes the evaluation and aggregation of the data collected at the site, and the identification of conservative ESVs for use in the risk calculation in Step 2.

2.2.1.1 Data Evaluation and Aggregation

As described in Section 3, site data were evaluated to determine their usability and applicability for the ERA. The potential exposure medium at the site through which ecological receptors potentially could be exposed to site-related contaminants is surface water, as discussed in Section 7.2.2.1. This is the medium for which conservative screening values protective of a variety of ecological receptors were identified.

2.2.1.2 Identification of ESVs

The only medium through which ecological receptors potentially may be exposed to site-related contaminants at the Site is surface water. The latest version of the *Region 4 Ecological Risk*

Assessment Supplemental Guidance (USEPA, March 2018c) was the preferred source for surface water ESVs to be used in the SLERA screening. A total of five VOCs were detected among the total of five surface water samples collected from the two streams near the Site: acetone, chloromethane, cis-1,2-dichloroethene, toluene, and trichloroethene (**Table 7-1**). A surface water ESV was not available for chloromethane, so an ESV for bromomethane was used as a surrogate. Bromomethane has the lowest ESV of the chlorinated or brominated methanes with screening values in Table 1a of USEPA (March 2018c), and its ESV is expected to provide a reasonably conservative surrogate for chloromethane.

2.2.2 Step 2: Exposure Estimation and Risk Calculation

The second step of the SLERA includes an estimation of the potential for exposure of ecological receptors to site-related contaminants, including description of the ecological setting and development of a preliminary ecological conceptual site model (CSM). To ensure that possible contributors to risk are not overlooked, the preliminary COPEC screening (risk calculation) is based on consistently conservative assumptions regarding exposure, in accordance with USEPA guidance (USEPA, June 1997). For example, the concentrations used in screening are the maximum detected concentrations in a given medium, the receptors assumed to be exposed are organisms with the greatest potential for contact with the exposure medium, and the detected concentrations of chemicals are assumed to be completely bioavailable.

2.2.2.1 Ecological Setting and Exposure Pathways

Surface soil samples were collected from developed areas of the facility, either beneath buildings and pavement or in small areas of lawn between buildings and paved areas. The potential for exposure of ecological receptors to these soils is negligible; therefore, soil was not included as an exposure medium for evaluation in the ERA.

The only exposure medium at the Site with the potential to be impacted by site-related contaminants and thereby affect ecological receptors is surface water of the two small streams located north and southwest of the facility. Both appear to be intermittent, headwater streams, generally less than 3 feet wide and several inches deep in pools. Both are in wooded areas: the northern stream flows east through a pine plantation and the southern stream flows west through a hardwood forest. Both are likely to support a very limited community of aquatic fauna consisting mainly of insects and amphibians.

The ecological CSM for the site is illustrated in the EPD (**Figure 6-1**), which shows the potential contaminant migration and exposure pathways through which ecological receptors may be exposed to site-related contaminants. Ecological receptors in the EPD are represented by two general categories, terrestrial receptors (considered to be organisms that breathe air, including those that feed on aquatic food chains) and aquatic receptors (organisms that do not breathe air). Potentially complete pathways that would not result in significant exposure or warrant quantitative evaluation are identified in the diagram by an asterisk. Potentially complete exposure pathways that are considered to be significant and to possibly warrant evaluation in the ERA are identified in the diagram by an “X.”

As noted above, the potential for terrestrial receptors to be exposed to site-related contaminants in soil on the facility is insignificant and does not warrant evaluation.

Migration of contaminants from source media to exposure media at the Site may involve transport mechanisms that include: (1) leaching from subsurface soil to groundwater, followed by discharge of groundwater to surface water; and (2) uptake of chemicals from soil or surface water by plants and animals and transfer through the food chain. Because groundwater discharges to the small streams north and southwest of the facility, surface water samples were collected in both streams for evaluation. Based on the low bioaccumulation potential of the volatile chemicals detected in Site media, food chain exposures are predicted to be insignificant and are not considered to warrant quantitative evaluation.

2.2.2.2 Screening-Level Risk Calculation

A concentration less than or equal to a conservative screening level generally indicates that a chemical is unlikely to pose significant risk to ecological receptors in the area sampled and does not warrant further evaluation in the ERA. If the concentration is greater than the screening level, or a screening level is not available, the chemical is initially identified as a preliminary COPEC in that medium. HQs are calculated by dividing the maximum detected concentration of a chemical by an ESV for that chemical and medium:

HQ = Concentration / ESV

A chemical with an HQ greater than or equal to 1 is identified as a preliminary COPEC. A total of five surface water samples were collected from the two streams near the Site: three samples from the stream north of the Site and two samples from the stream southwest of the Site (**Figure 3-8** in the RI Report). When the maximum detected concentration of each VOC in surface water was divided by its surface water ESV, none of the HQs was greater than or equal to 1, and no preliminary COPECs were identified (**Table 2-1**).

USEPA Region 4 guidance indicates that groundwater contaminant concentrations should be screened using surface water ESVs if there is the potential for contaminated groundwater to discharge and impact surface water nearby (USEPA, March 2018c). Given that the contaminants in surficial groundwater have reached the nearby, downgradient streams, existing concentrations in stream surface water are expected to represent the results of groundwater fate and transport processes at the Site (e.g., degradation, dispersion, and dilution). Accordingly, measured surface water concentrations are representative of potential future impacts, and the conservative screening of groundwater concentrations against surface water ESVs was not warranted.

2.2.3 Uncertainty

Uncertainty is inherent in the risk assessment process. The principal activities performed in an ERA can be grouped into three components: exposure assessment, effects assessment, and risk characterization. The uncertainties associated with this SLERA are discussed below based on these components.

Among the sources of uncertainty in exposure assessment is the detection of chemicals and their concentrations in environmental media. Those analytes not detected in any sample in a particular medium or exposure group were eliminated from the data set for the SLERA. There is the possibility that a chemical thus eliminated actually may be present at levels below its detection limit. This is a concern only if the detection limit is higher than the level at which the chemical causes toxicity, which potentially could result in the underestimation of risk from that chemical.

Uncertainty in exposure assessment is minimized by making conservative assumptions. In the initial screening of surface water, for example, the ESVs used have been established based on the protection of aquatic receptors considered to be maximally exposed and to provide a conservative representation of the range of exposures that may be experienced by other species not evaluated. Exposure concentrations used in the SLERA were maximum detected concentrations, and 100 percent bioavailability was assumed. The use of conservative exposure assumptions and concentrations provide confidence that the screening in the SLERA does not underestimate the potential for receptor populations to be affected by exposures to chemicals at the Site.

Uncertainty in toxicity assessment may result from many sources. There is a moderate level of uncertainty associated with screening against ESVs from the literature. For example, there is uncertainty associated with the performance of the toxicity tests on which ESVs are based and with the relevance of specific toxicity values to native organisms at the site. However, conformance by laboratories using standard methods and sensitive test species reduces uncertainty of the test results on which ESVs are based, and ESVs are derived to be conservative values that are protective of a range of ecological receptors. The conservatism of the ESVs used in calculating HQs in the SLERA increases confidence that any potential risks of adverse toxicological effects on ecological receptors are not underestimated.

Uncertainty in the risk calculation and identification of preliminary COPECs is affected by the methodologies employed in the preceding sections of the SLERA. The conservative approach used in identifying the exposure concentrations and ESVs for calculation of HQs are intended to minimize the possibility of underestimating risk while not significantly overestimating risk.

2.2.4 Ecological Risk Summary

The results of the risk calculation in conjunction with other lines of evidence regarding the minimal potential for exposure and risk to ecological receptors support the conclusion that there are no chemicals in Site media that warrant identification as COPECs at this site.

2.2.5 Scientific/Management Decision Point 1

Scientific/Management Decision Point 1 follows the completion of Steps 1 and 2 of the SLERA and determines whether there is justification to continue to the next step of the ERA process. The results of the SLERA are evaluated at this point to determine whether site-related chemicals pose negligible ecological risk (thereby providing a basis for recommending no further action with regard to ecological risk at the Site) or have the potential to pose significant ecological risk (thereby providing a basis for recommending continuation of the ERA, additional field study, or an interim action). The evaluation determined that there are no chemicals in Site media with the potential to pose significant risk to ecological receptors. Therefore, none of the chemicals in Site media warrant designation as COPECs, and further evaluation of ecological risk in a Baseline ERA is not needed.

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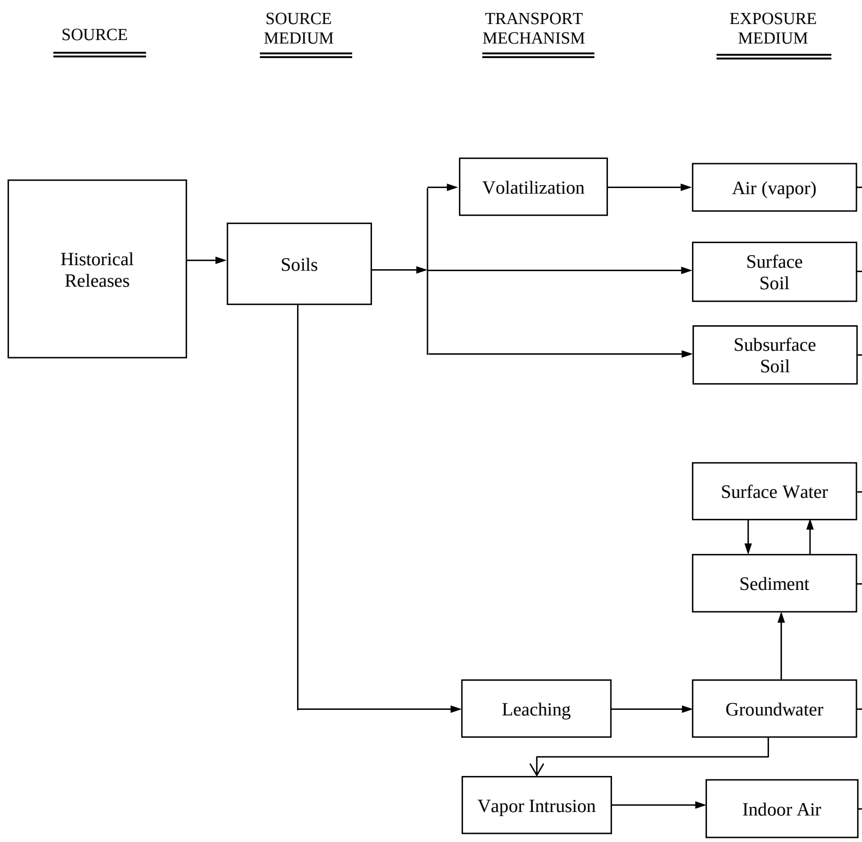
FIGURES



Exposure Medium	Exposure Route	HUMAN RECEPTORS – CURRENT / FUTURE: Industrial Worker	HUMAN RECEPTORS – FUTURE: Construction Worker	HUMAN RECEPTORS – FUTURE: Resident	ECOLOGICAL RECEPTORS – CURRENT / FUTURE: Terrestrial	ECOLOGICAL RECEPTORS – CURRENT / FUTURE: Aquatic
Air (vapor)	Inhalation	*	*	*		
Surface Soil	Ingestion	X^1	X	*		
Surface Soil	Dermal	X^1	X	*		
Subsurface Soil	Ingestion		X	*		
Subsurface Soil	Dermal		X	*		
Surface Water	Ingestion			*	*	X
Surface Water	Dermal			*	*	X
Sediment	Ingestion			*	*	*
Sediment	Dermal			*	*	*
Groundwater	Ingestion			X		
Groundwater	Dermal			X		
Groundwater	Inhalation			X		
Indoor Air	Inhalation	X		X		

LEGEND

X = Pathway potentially complete
X^1 = Industrial worker evaluated for exposed surface soil (not covered by buildings or pavement).
* = Pathway potentially complete but insignificant and not quantitatively evaluated
Blank = Incomplete pathway

Figure I - 1
Exposure Pathway Diagram
Philips Electronics Facility
Newberry, South Carolina

TABLES

Table 1-1
Summary of Sample Locations and Analyses
Shakespeare Composite Structures Site
Newberry, South Carolina

Sample ID	Date Collected	VOCs (USEPA Method 8260B)	Iron and Manganese (USEPA Method 6010D)
Exposed Surface Soil			
B12B (1-2)	04/17/14	X	
B-20-2	05/20/14	X	
B-21-2	05/20/14	X	
B-22-2	05/20/14	X	
B-23-2	05/20/14	X	
Covered Surface Soil			
B-27-2	05/22/14	X	
B-34-2	05/28/14	X	
B-43-2	06/05/14	X	
B-45PW(2')	03/29/18	X	
B-46(2')	03/29/18	X	
B-47(2')	03/29/18	X	
B-48(2')	03/29/18	X	
B-49(2')	03/29/18	X	
B-50(2')	03/29/18	X	
TMW-20-2	05/19/14	X	
Subsurface Soil			
B12A (2-3)	04/17/14	X	
B12A (5-6)	04/17/14	X	
B12B (5-6)	04/17/14	X	
B12C (4-5)	04/17/14	X	
B12D (2-3)	04/17/14	X	
B12D (5-6)	04/17/14	X	
B13A (2-3)	04/17/14	X	
B13A (5-6)	04/17/14	X	
B13B (3-5)	04/17/14	X	
B13C (2-3)	04/17/14	X	
B13C (5-6)	04/17/14	X	
B16A (7-8)	04/17/14	X	
B16B (8-9)	04/18/14	X	
B16C (9-10)	04/18/14	X	
B16D (8-9)	04/18/14	X	
B-21-9	05/20/14	X	
B-22-8	05/20/14	X	
B-23-8	05/20/14	X	
B-24-4	05/20/14	X	
B-24-8	05/20/14	X	
B-25-4	05/21/14	X	
B-25-10	05/21/14	X	
B-26-4	05/22/14	X	
B27-4	05/22/14	X	
B-28-6	05/22/14	X	
B-28-10	05/22/14	X	
B-29-4	05/23/14	X	
B-29-10	05/23/14	X	
B-30-6	05/23/14	X	
B-30-10	05/23/14	X	
B-31-4	05/27/14	X	
B-31-10	05/27/14	X	
B-32-3	05/27/14	X	
B-32-7	05/27/14	X	
B-33-6	05/28/14	X	
B-34-10	05/28/14	X	

Table 1-1
Summary of Sample Locations and Analyses
Shakespeare Composite Structures Site
Newberry, South Carolina

Sample ID	Date Collected	VOCs (USEPA Method 8260B)	Iron and Manganese (USEPA Method 6010D)
Subsurface Soil (Continued)			
B-35-6	05/29/14	X	
B-36-6	05/29/14	X	
B-37-7	05/29/14	X	
B-37-10	05/29/14	X	
B-38-4	06/03/14	X	
B-38-8	06/03/14	X	
B-39-4	06/03/14	X	
B-39-6	06/03/14	X	
B-39-8	06/03/14	X	
B-40-4	06/04/14	X	
B-40-10	06/04/14	X	
B-41-4	06/04/14	X	
B-41-8	06/04/14	X	
B-42-4	06/04/14	X	
B-42-7	06/04/14	X	
B-43-10	06/05/14	X	
B-44-3	06/05/14	X	
B-44-8	06/05/14	X	
B-45PW(4')	03/29/18	X	
B-45-6	06/05/14	X	
B-45PW(6')	03/29/18	X	
B-45(8')	03/29/18	X	
B-45-10	06/05/14	X	
B-45PW(10')	03/29/18	X	
B-46(4')	03/29/18	X	
B-46(6')	03/29/18	X	
B-46(8')	03/29/18	X	
B-46(10')	03/29/18	X	
B-47(4')	03/29/18	X	
B-47(6')	03/29/18	X	
B-47(8')	03/29/18	X	
B-47(10')	03/29/18	X	
B-48(4')	03/29/18	X	
B-48(6')	03/29/18	X	
B-48(8')	03/29/18	X	
B-48(10')	03/29/18	X	
B-49(4')	03/29/18	X	
B-49(6')	03/29/18	X	
B-49(8')	03/29/18	X	
B-49(10')	03/29/18	X	
B-50(4')	03/29/18	X	
B-50(6')	03/29/18	X	
B-50(8')	03/29/18	X	
B-50(10')	03/29/18	X	
TMW-20-8	05/19/14	X	
TMW-21-4	05/21/14	X	
TMW-21-10	05/21/14	X	
TMW-22-4	05/21/14	X	
TMW-22-8	05/21/14	X	
TMW-29-6	06/03/14	X	
TMW-29-9	06/03/14	X	

Table 1-1
Summary of Sample Locations and Analyses
Shakespeare Composite Structures Site
Newberry, South Carolina

Sample ID	Date Collected	VOCs (USEPA Method 8260B)	Iron and Manganese (USEPA Method 6010D)
Shallow/Intermediate Groundwater			
MW-1	06/19/17	X	X
MW-2	06/13/17	X	
MW-2I	06/21/17	X	
MW-3	06/12/17	X	
MW-3I	06/15/17	X	
MW-4	06/12/17	X	
MW-5	06/12/17	X	
MW-5I	06/21/17	X	
MW-6	06/19/17	X	X
MW-6I	06/15/17	X	
MW-7	06/12/17	X	
MW-7I	06/19/17	X	X
MW-8	06/19/17	X	X
MW-9	06/12/17	X	
MW-9I	06/20/17	X	X
MW-10	06/19/17	X	X
MW-10I	06/20/17	X	X
MW-11	06/15/17	X	
MW-12	06/16/17	X	
MW-12I	06/22/17	X	
MW-13	06/16/17	X	
MW-14	06/16/17	X	
MW-15	06/16/17	X	
MW-16	06/15/17	X	
MW-17	06/15/17	X	
MW-18	06/20/17	X	
MW-19	06/13/17	X	
MW-19I	06/23/17	X	
MW-20	06/20/17	X	X
MW-20I	06/20/17	X	X
MW-21	06/15/17	X	
MW-21I	06/15/17	X	
MW-22	06/13/17	X	
MW-23	06/13/17	X	
MW-24	06/13/17	X	
MW-24I	06/13/17	X	
MW-25	06/13/17	X	
MW-26	04/03/18	X	
MW-27	04/03/18	X	
MW-28	04/03/18	X	
MW-29	04/03/18	X	
TMW-21	06/14/17	X	
TMW-22	06/14/17	X	
TMW-23	06/14/17	X	
TMW-24	06/13/17	X	
TMW-25	06/13/17	X	
TMW-29	06/04/14	X	
TMW-30	06/14/17	X	
TMW-31	06/14/17	X	
TMW-32	06/13/17	X	
TMW-33	06/13/17	X	

Table 1-1
Summary of Sample Locations and Analyses
Shakespeare Composite Structures Site
Newberry, South Carolina

Sample ID	Date Collected	VOCs (USEPA Method 8260B)	Iron and Manganese (USEPA Method 6010D)
Bedrock Groundwater			
Boazman Well	06/22/17	X	
MW-2D	06/22/17	X	
MW-3D	06/21/17	X	
MW-6D	06/19/17	X	X
MW-7D	06/22/17	X	
MW-9D	06/21/17	X	
MW-12D	07/24/17	X	
MW-17D	07/25/17	X	
MW-18D	06/19/17	X	
MW-19D	07/27/17	X	
PW-1	08/04/15	X	
PW-2 (1)	02/11/15	X	
PW-3	08/04/15	X	
PW-4	06/21/17	X	
PW-5	06/26/14	X	
PW-6	06/26/14	X	
PW-7	07/18/14	X	
PW-8 (2)	02/10/15	X	
RDW-1	06/21/17	X	
RDW-2	06/15/17	X	
SDW-1	06/21/17	X	
SDW-2	06/22/17	X	
SDW-3	07/25/17	X	
Surface Water			
SW-1	09/17/15	X	
SW-2	09/17/15	X	
SW-3	09/17/15	X	
SW4	06/27/17	X	
SW5	06/27/17	X	
Subslab Vapor			
SV20	03/13/18	X	
SV23	03/13/18	X	
SV31	03/13/18	X	
SV45	03/13/18	X	
SV46	03/13/18	X	
SV49	03/13/18	X	
SV54	03/13/18	X	

Notes:

(1) Data from samples collected from three separate intervals (PW-2-84, PW-2-120-130, and PW-2-130-140) were averaged for this location.

(2) Data from samples collected from four separate intervals (PW-8-70, PW-8-105-115, PW-8-145-155, and PW-8-160-182) were averaged for this location.

Table 1-2
Identification of COPCs in Exposed Surface Soil
Shakespeare Composite Structures Site
Newberry, South Carolina

Detected Chemical (1)	Minimum Concentration (2)	Maximum Concentration (2)	Units	Sample Designation of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening (3)	Screening Value (4)	Background Value (5)	COPC?	Rationale Code (6)
VOCs											
Acetone	0.027	0.027	mg/kg	B12B (1-2)	1 / 5	0.016 - 0.018	0.027	6100	NSV	No	BSL
Styrene	0.0015 J//	0.0041 J//	mg/kg	B-23-2	2 / 5	0.0042 - 0.0044	0.0041	600	NSV	No	BSL

Notes:

(1) Only detected chemicals in exposed surface soil, collected from depths down to 2 feet below ground surface, are shown.

(2) Minimum/maximum detected concentration and associated qualifiers.

(3) Maximum concentration is used for screening.

(4) The screening value is the residential soil value from the Regional Screening Level (RSL) Table based on risk of 1E-06 for carcinogens and HQ of 0.1 for noncarcinogens (USEPA, May 2018).

(5) Background values are not available.

(6) Rationale Codes:

Selection Reason: ASL - Above Screening Level

Deletion Reason: BSL - Below Screening Level

Bold font indicates selection as a COPC.

Data Qualifiers:

The "/" separates the laboratory added data qualifiers from the validation data qualifiers. The laboratory added data qualifiers precede the first "/". The result qualifiers follow the first "/", and the analysis qualifiers follow the second "/".

J// - Estimated result less than the reporting limit and greater than or equal to the method detection limit.

Definitions:

mg/kg - Milligrams per Kilogram

COPC - Chemical of Potential Concern

NSV - No Screening Value

USEPA - United States Environmental Protection Agency

Table 1-3
Identification of COPCs in Surface Soil
Shakespeare Composite Structures Site
Newberry, South Carolina

Detected Chemical [1]	Minimum Concentration [2]	Maximum Concentration [2]	Units	Sample Designation of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening [3]	Screening Value [4]	Background Value [5]	COPC?	Rationale Code [6]
VOCs											
2-Butanone (MEK)	0.0043 J//	0.0099 J//	mg/kg	B-27-2	3 / 15	0.008 - 1.1	0.0099	2700	NSV	No	BSL
Acetone	0.0058 J//	0.17	mg/kg	B-48(2')	9 / 15	0.016 - 1.1	0.17	6100	NSV	No	BSL
cis-1,2-Dichloroethene	0.0026 J//	0.057	mg/kg	B-49(2')	3 / 15	0.0039 - 0.29	0.057	16	NSV	No	BSL
Methylene chloride	0.0084	0.012	mg/kg	B-47(2')	2 / 15	0.0039 - 0.29	0.012	35	NSV	No	BSL
Styrene	0.0015 J//	0.54	mg/kg	B-45(2')	8 / 15	0.0039 - 0.49	0.54	600	NSV	No	BSL
Toluene	0.0018 J//	0.0018 J//	mg/kg	B-48(2')	1 / 15	0.0039 - 0.29	0.0018	490	NSV	No	BSL
trans-1,2-Dichloroethene	0.0049 J//	0.0049 J//	mg/kg	B-27-2	1 / 15	0.0039 - 0.29	0.0049	160	NSV	No	BSL
Trichloroethene	0.051	0.06	mg/kg	B-49(2')	2 / 15	0.0039 - 0.29	0.06	0.41	NSV	No	BSL
Xylenes (total)	0.0039 J//	0.0039 J//	mg/kg	B-48(2')	1 / 15	0.004 - 0.57	0.0039	58	NSV	No	BSL

Notes:

(1) Only detected chemicals in surface soil, collected from depths down to 2 feet below ground surface, are shown.

(2) Minimum/maximum detected concentration and associated qualifiers.

(3) Maximum concentration is used for screening.

(4) The screening value is the residential soil value from the Regional Screening Level (RSL) Table based on risk of 1E-06 for carcinogens and HQ of 0.1 for noncarcinogens (USEPA, May 2018).

(5) Background values are not available.

(6) Rationale Codes:

Selection Reason: ASL - Above Screening Level

Deletion Reason: BSL - Below Screening Level

Bold font indicates selection as a COPC.

Data Qualifiers:

The "/" separates the laboratory added data qualifiers from the validation data qualifiers. The laboratory added data qualifiers precede the first “/”. The result qualifiers follow the first “/”, and the analysis qualifiers follow the second “/”.

J// - Estimated result less than the reporting limit and greater than or equal to the method detection limit.

Definitions:

mg/kg - Milligrams per Kilogram

COPC - Chemical of Potential Concern

NSV - No Screening Value

USEPA - United States Environmental Protection Agency

Table 1-4
Identification of COPCs in Subsurface Soil
Shakespeare Composite Structures Site
Newberry, South Carolina

Detected Chemical (1)	Minimum Concentration (2)	Maximum Concentration (2)	Units	Sample Designation of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening (3)	Screening Value (4)	Background Value (5)	COPC?	Rationale Code (6)
VOCs											
1,1,2,2-Tetrachloroethane	0.027	0.027	mg/kg	B-22-8	1 / 87	0.0038 - 0.28	0.027	2.7	NSV	No	BSL
1,1-Dichloroethane	0.0056	0.0056	mg/kg	B13B (3-5)	1 / 87	0.0038 - 0.28	0.0056	16	NSV	No	BSL
1,1-Dichloroethene	0.0029 J//	0.0044 J//	mg/kg	B-49(6')	3 / 87	0.0038 - 0.28	0.0044	100	NSV	No	BSL
2-Butanone (MEK)	0.0022 J//	0.019	mg/kg	B-49(8')	14 / 87	0.0079 - 0.98	0.019	19000	NSV	No	BSL
4-Methyl-2-pentanone	0.23	0.23	mg/kg	B16D (8-9)	1 / 87	0.0076 - 0.57	0.23	14000	NSV	No	BSL
Acetone	0.011 J//	0.36	mg/kg	B-48(10')	67 / 87	0.015 - 1.1	0.36	67000	NSV	No	BSL
Carbon disulfide	0.002 J//	0.002 J//	mg/kg	B-48(4')	1 / 87	0.0038 - 0.28	0.002	350	NSV	No	BSL
Carbon tetrachloride	0.0053	0.0053	mg/kg	B-22-8	1 / 87	0.0038 - 0.28	0.0053	2.9	NSV	No	BSL
Chloroform	0.0013 J//	0.0014 J//	mg/kg	B-34-10	2 / 87	0.0038 - 0.28	0.0014	1.4	NSV	No	BSL
cis-1,2-Dichloroethene	0.00097 J//	0.9	mg/kg	B-49(6')	33 / 87	0.0038 - 0.31	0.9	230	NSV	No	BSL
Cyclohexane	0.00094 J//	0.00094 J//	mg/kg	B-22-8	1 / 87	0.0038 - 0.28	0.00094	2700	NSV	No	BSL
Ethylbenzene	0.0026 J//	4.9	mg/kg	B-46(4')	10 / 87	0.0038 - 0.28	4.9	25	NSV	No	BSL
Isopropylbenzene	0.0056	0.0056	mg/kg	B13A (5-6)	1 / 87	0.0038 - 0.28	0.0056	990	NSV	No	BSL
Methyl acetate	0.0033 J//	0.15 J//	mg/kg	B-41-8	3 / 87	0.0038 - 0.28	0.15	120000	NSV	No	BSL
Methylene chloride	0.0048 J//	0.018	mg/kg	B-45PW(4')	10 / 87	0.0038 - 0.28	0.018	320	NSV	No	BSL
Styrene	0.0013 J//	0.3 E//	mg/kg	B-48(4')	45 / 87	0.0038 - 0.28	0.3	3500	NSV	No	BSL
Tetrachloroethene	0.00048 J//	0.011	mg/kg	B-49(4')	9 / 87	0.0038 - 0.28	0.011	39	NSV	No	BSL
Toluene	0.0023 J//	0.6	mg/kg	B16D (8-9)	5 / 87	0.0038 - 0.28	0.6	4700	NSV	No	BSL
trans-1,2-Dichloroethene	0.0029 J//	0.027	mg/kg	TMW-21-10	7 / 87	0.0038 - 0.28	0.027	2300	NSV	No	BSL
Trichloroethene	0.0026 J//	1.4	mg/kg	B-49(6')	30 / 87	0.0038 - 0.31	1.4	1.9	NSV	No	BSL
Xylenes (total)	0.029	0.47	mg/kg	B16D (8-9)	4 / 87	0.0039 - 0.49	0.47	250	NSV	No	BSL

Notes:

(1) Only detected chemicals in subsurface soil, collected from 2 to 10 feet below ground surface, are shown.
(2) Minimum/maximum detected concentration and associated qualifiers.
(3) Maximum concentration is used for screening.
(4) The screening value is the industrial soil value from the Regional Screening Level (RSL) Table based on risk of 1E-06 for carcinogens and HQ of 0.1 for noncarcinogens (USEPA, May 2018).
(5) Background values are not available.
(6) Rationale Codes:
Selection Reason: ASL - Above Screening Level
Deletion Reason: BSL - Below Screening Level

Bold font indicates selection as a COPC.

Data Qualifiers:

The "/" separates the laboratory added data qualifiers from the validation data qualifiers. The laboratory added data qualifiers precede the first “/”. The result qualifiers follow the first “/”, and the analysis qualifiers follow the second “/”.
E// - Quantitation of compound exceeded the calibration range.
J// - Estimated result less than the reporting limit and greater than or equal to the method detection limit.

Definitions:

mg/kg - Milligrams per Kilogram
COPC - Chemical of Potential Concern
NSV - No Screening Value
USEPA - United States Environmental Protection Agency

Table 1-5
Identification of COPCs in Surface Water
Shakespeare Composite Structures Site
Newberry, South Carolina

Detected Chemical (1)	Minimum Concentration (2)	Maximum Concentration (2)	Units	Sample Designation of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening (3)	Screening Value (4)		Background Value (5)	COPC?	Rationale Code (6)
VOCs												
Acetone	2.6 J//	3.7 J//	µg/L	SW-1	3 / 5	20	3.7	1400	b	NSV	No	BSL
Chloromethane	0.24 J//	0.24 J//	µg/L	SW-3	1 / 5	5	0.24	19	b	NSV	No	BSL
cis-1,2-Dichloroethene	0.52 J//	6.3	µg/L	SW-2	2 / 5	5	6.3	100	a	NSV	No	BSL
Toluene	0.38 J//	0.38 J//	µg/L	SW-2	1 / 5	5	0.38	57	a	NSV	No	BSL
Trichloroethene	0.92 J//	0.93 J//	µg/L	SW-5	2 / 5	5	0.93	0.6	a	NSV	No	ASL (7)

Notes:

(1) Only detected chemicals in surface water are shown.

(2) Minimum/maximum detected concentration and associated qualifiers.

(3) Maximum concentration is used for screening.

(4) The following hierarchy of surface water human health screening values is used:

a - National Recommended Water Quality Criteria - Human Health, value for the Consumption of Water + Organism (USEPA, January 2018).

The value for trans-1,2-dichloroethene was used as a surrogate value for cis-1,2-dichloroethene.

b - Tap water value from the Regional Screening Level (RSL) Table based on risk of 1E-6 for carcinogens and HQ of 0.1 for noncarcinogens (USEPA, May 2018). Tapwater value is conservatively used to screen surface water used as drinking water.

(5) Background values are not available.

(6) Rationale Codes:

Selection Reason: ASL - Above Screening Level

Deletion Reason: BSL - Below Screening Level

(7) As discussed in Section 6.3.1, although estimated concentrations of trichloroethene minimally exceed its screening value at two locations, given the negligible exceedances and the conservatism of the screening, it was not selected as a COPC.

Bold font indicates selection as a COPC.

Data Qualifiers:

The "/" separates the laboratory added data qualifiers from the validation data qualifiers. The laboratory added data qualifiers precede the first "/". The result qualifiers follow the first "/", and the analysis qualifiers follow the second "/".

J// - Estimated result less than the reporting limit and greater than or equal to the method detection limit.

Definitions:

µg/L - micrograms per liter

COPC - Chemical of Potential Concern

NSV - No Screening Value

USEPA - United States Environmental Protection Agency

Table 1-6
Identification of COPCs in Shallow/Intermediate Groundwater
Shakespeare Composite Structures Site
Newberry, South Carolina

Detected Chemical [1]	Minimum Concentration [2]	Maximum Concentration [2]	Units	Sample Designation of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening [3]	Screening Value [4]	Background Value [5]	COPC?	Rationale Code [6]
VOCs											
1,1-Dichloroethane	0.5 J//	2.4 J//	µg/L	MW-7I	4 / 51	5 - 100	2.4	2.8	NSV	No	BSL
1,1-Dichloroethene	0.46 J//	5.2	µg/L	MW-7I	7 / 51	5 - 100	5.2	28	NSV	No	BSL
1,2-Dichloroethane	**0.54 J//**	**0.54 J//**	**µg/L**	**MW-10**	**1 / 51**	**5 - 100**	**0.54**	**0.17**	**NSV**	**Yes**	**ASL**
2-Butanone (MEK)	3.7 J//	3.7 J//	µg/L	TMW-25	1 / 51	10 - 200	3.7	560	NSV	No	BSL
Acetone	2.1 J/B/T	150	µg/L	TMW-24	18 / 51	20 - 400	150	1400	NSV	No	BSL
Benzene	**0.49 J//**	**0.66 J//**	**µg/L**	**MW-6**	**3 / 51**	**5 - 100**	**0.66**	**0.46**	**NSV**	**Yes**	**ASL**
Carbon disulfide	0.68 BJ/B/K	0.93 J/B/KT	µg/L	MW-6I	2 / 51	5 - 100	0.93	81	NSV	No	BSL
Chloroform	**0.41 J//**	**5.7 J//**	**µg/L**	**TMW-22**	**12 / 51**	**5 - 100**	**5.7**	**0.22**	**NSV**	**Yes**	**ASL**
cis-1,2-Dichloroethene	**0.54 J//**	**530**	**µg/L**	**MW-6**	**22 / 51**	**5 - 100**	**530**	**3.6**	**NSV**	**Yes**	**ASL**
Isopropylbenzene	0.59 J//	3.6 J//	µg/L	MW-6	3 / 51	5 - 100	3.6	45	NSV	No	BSL
Methyl acetate	8.1 J//	8.1 J//	µg/L	TMW-21	1 / 51	5 - 100	8.1	2000	NSV	No	BSL
Methylene chloride	0.41 J//	0.41 J//	µg/L	MW-7I	1 / 51	5 - 100	0.41	11	NSV	No	BSL
Styrene	1.5 J//	81	µg/L	TMW-29	9 / 51	5 - 100	81	120	NSV	No	BSL
Tetrachloroethene	**0.6 J//**	**5**	**µg/L**	**MW-8**	**10 / 51**	**5 - 100**	**5**	**4.1**	**NSV**	**Yes**	**ASL**
Toluene	0.54 J//	2.2 J//	µg/L	MW-29	3 / 51	5 - 100	2.2	110	NSV	No	BSL
trans-1,2-Dichloroethene	0.43 J//	21	µg/L	MW-6	4 / 51	5 - 100	21	36	NSV	No	BSL
Trichloroethene	**0.56 J//**	**1400**	**µg/L**	**TMW-31**	**37 / 51**	**5 - 100**	**1400**	**0.28**	**NSV**	**Yes**	**ASL**
Vinyl chloride	**0.4 J//**	**8.1**	**µg/L**	**MW-6**	**4 / 51**	**2 - 40**	**8.1**	**0.019**	**NSV**	**Yes**	**ASL**
Xylenes (Total)	0.52 J//	1.8 J//	µg/L	MW-7I	2 / 51	5 - 100	1.8	19	NSV	No	BSL
Metals											
Iron	**110**	**11000**	**µg/L**	**MW-6**	**9 / 9**	**100**	**11000**	**1400**	**NSV**	**Yes**	**ASL**
Manganese	**11 J//**	**200**	**µg/L**	**MW-7I**	**9 / 9**	**15**	**200**	**43**	**NSV**	**Yes**	**ASL**

Notes:

(1) Only detected chemicals in shallow/intermediate groundwater are shown.

(2) Minimum/maximum detected concentration and associated qualifiers.

(3) Maximum concentration is used for screening.

(4) The screening value is the tapwater value from the Regional Screening Level (RSL) Table based on risk of 1E-06 for carcinogens and HQ of 0.1 for noncarcinogens (USEPA, May 2018).
A chemical is also considered a COPC if its maximum detected concentration exceeds its MCL (USEPA, March 2018); this did not occur, however, for any chemical not already identified as a COPC.

(5) Background values are not available.

(6) Rationale Codes:
Selection Reason: ASL - Above Screening Level
Deletion Reason: BSL - Below Screening Level

Bold font indicates selection as a COPC.

Data Qualifiers:

The "/" separates the laboratory added data qualifiers from the validation data qualifiers. The laboratory added data qualifiers precede the first "/". The result qualifiers follow the first "/", and the analysis qualifiers follow the second "/".

B// - Detected in the method blank.

J// - Estimated result less than the reporting limit and greater than or equal to the method detection limit.

/B/ - The analyte was found in an associated blank as well as in the sample.

//K - Detected in the sample at a concentration less than or equal to five times the concentration detected in the associated method blank. Professional judgment must be used to determine if the detect is site-related.

//T - Detected in the associated trip blank.

Definitions:

µg/L - Micrograms per liter

Table 1-6
Identification of COPCs in Shallow/Intermediate Groundwater
Shakespeare Composite Structures Site
Newberry, South Carolina

COPC - Chemical of Potential Concern
MCL - Maximum Contaminant Level
NSV - No Screening Value
USEPA - United States Environmental Protection Agency

Table 1-7
Identification of COPCs in Bedrock Groundwater and Drinking Water Wells
Shakespeare Composite Structures Site
Newberry, South Carolina

Detected Chemical [1]	Minimum Concentration [2]	Maximum Concentration [2]	Units	Sample Designation of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening [3]	Screening Value [4]	Background Value [5]	COPC?	Rationale Code [6]
All Bedrock Wells											
VOCs											
1,1-Dichloroethane	0.9	0.9	µg/L	Boazman Well	1 / 23	0.5 - 5	0.9	2.8	NSV	No	BSL
1,2-Dichloroethane	**0.73 J//**	**0.73 J//**	**µg/L**	**MW-6D**	**1 / 23**	**0.5 - 5**	**0.73**	**0.17**	**NSV**	**Yes**	**ASL**
2-Butanone (MEK)	11	11	µg/L	MW-18D	1 / 19	10	11	560	NSV	No	BSL
2-Hexanone	2.2 J//	2.2 J//	µg/L	MW-18D	1 / 19	10	2.2	3.8	NSV	No	BSL
Acetone	2.2 J/B/T	73	µg/L	MW-18D	4 / 19	20	73	1400	NSV	No	BSL
Chloroform	**0.42 J//**	**2 J//**	**µg/L**	**MW-17D**	**3 / 23**	**0.5 - 5**	**2**	**0.22**	**NSV**	**Yes**	**ASL**
Chloromethane (Methyl chloride)	0.42 J//	0.42 J//	µg/L	SDW-2	1 / 23	0.5 - 5	0.42	19	NSV	No	BSL
cis-1,2-Dichloroethene	**0.56 J//**	**11**	**µg/L**	**MW-3D**	**9 / 23**	**0.5 - 5**	**11**	**3.6**	**NSV**	**Yes**	**ASL**
Styrene	0.53 J//	0.53 J//	µg/L	MW-18D	1 / 23	0.5 - 5	0.53	120	NSV	No	BSL
Tetrachloroethene	0.44 J//	2.04	µg/L	PW-8-145-155	4 / 23	0.5 - 5	2.04	4.1	NSV	No	BSL
Toluene	0.56 J//	7.55	µg/L	PW-8-105-115	4 / 23	0.5 - 5	7.55	110	NSV	No	BSL
Trichloroethene	**0.9**	**160**	**µg/L**	**MW-6D**	**14 / 23**	**0.5 - 25**	**160**	**0.28**	**NSV**	**Yes**	**ASL**
Metals											
Iron	40 J//	40 J//	µg/L	MW-6D	1 / 1	100	40	1400	NSV	No	BSL
Private Wells											
Boazman Well											
VOCs											
1,1-Dichloroethane	0.9	0.9	µg/L	Boazman Well	1/1	0.5	0.9	2.8	NSV	No	BSL
cis-1,2-Dichloroethene	1.9	1.9	µg/L	Boazman Well	1/1	0.5	1.9	3.6	NSV	No	BSL
Trichloroethene	**1.5**	**1.5**	**µg/L**	**Boazman Well**	**1/1**	**0.5**	**1.5**	**0.28**	**NSV**	**Yes**	**ASL**
PW-1											
No chemicals were detected.											
PW-2											
VOCs											
cis-1,2-Dichloroethene	2.9 J	2.9 J	µg/L	PW-2	1/1	5	2.9	3.6	NSV	No	BSL
Tetrachloroethene	1.82	1.82	µg/L	PW-2	1/1	5	1.82	4.1	NSV	No	BSL
Toluene	3.27	3.27	µg/L	PW-2	1/1	5	3.27	110	NSV	No	BSL
Trichloroethene	**38.33**	**38.33**	**µg/L**	**PW-2**	**1/1**	**5**	**38.33**	**0.28**	**NSV**	**Yes**	**ASL**
PW-3											
No chemicals were detected.											
PW-4											
VOCs											
Trichloroethene	**0.9**	**0.9**	**µg/L**	**PW-4**	**1/1**	**0.5**	**0.9**	**0.28**	**NSV**	**Yes**	**ASL**

Table 1-7
Identification of COPCs in Bedrock Groundwater and Drinking Water Wells
Shakespeare Composite Structures Site
Newberry, South Carolina

Detected Chemical [1]	Minimum Concentration [2]	Maximum Concentration [2]	Units	Sample Designation of Maximum Concentration	Detection Frequency	Range of Reporting Limits	Concentration Used for Screening [3]	Screening Value [4]	Background Value [5]	COPC?	Rationale Code [6]
PW-5											
VOCs											
cis-1,2-Dichloroethene	0.94 J	0.94 J	µg/L	PW-5	1/1	5	0.94	3.6	NSV	No	BSL
Trichloroethene	**15**	**15**	**µg/L**	**PW-5**	**1/1**	**5**	**15**	**0.28**	**NSV**	**Yes**	**ASL**
PW-6											
No chemicals were detected.											
PW-7											
No chemicals were detected.											
PW-8											
VOCs											
cis-1,2-Dichloroethene	2.25	2.25	µg/L	PW-8	1/1	5	2.25	3.6	NSV	No	BSL
Tetrachloroethene	2.04	2.04	µg/L	PW-8	1/1	5	2.04	4.1	NSV	No	BSL
Toluene	7.55	7.55	µg/L	PW-8	1/1	5	7.55	110	NSV	No	BSL
Trichloroethene	**49.95**	**49.95**	**µg/L**	**PW-8**	**1/1**	**5**	**49.95**	**0.28**	**NSV**	**Yes**	**ASL**

Notes:

(1) Only detected chemicals in bedrock groundwater are shown.

(2) Minimum/maximum detected concentration and associated qualifiers.

(3) Maximum concentration is used for screening.

(4) The screening value is the tapwater value from the Regional Screening Level (RSL) Table based on risk of 1E-06 for carcinogens and HQ of 0.1 for noncarcinogens (USEPA, May 2018).
A chemical is also considered a COPC if its maximum detected concentration exceeds its MCL (USEPA, March 2018); this did not occur, however, for any chemical not already identified as a COPC.

(5) Background values are not available.

(6) Rationale Codes:
Selection Reason: ASL - Above Screening Level
Deletion Reason: BSL - Below Screening Level

Bold font indicates selection as a COPC.

Data Qualifiers:

The "/" separates the laboratory added data qualifiers from the validation data qualifiers. The laboratory added data qualifiers precede the first "/". The result qualifiers follow the first "/", and the analysis qualifiers follow the second "/".
J// - Estimated result less than the reporting limit and greater than or equal to the method detection limit.
/B/ - The analyte was found in an associated blank as well as in the sample.
//T - Detected in the associated trip blank.

Definitions:

µg/L - Micrograms per liter
COPC - Chemical of Potential Concern
MCL - Maximum Contaminant Level
NSV - No Screening Value
USEPA - United States Environmental Protection Agency

Table 1-8
Identification of Preliminary COPCs in Sub-Slab Vapor Samples (Industrial Scenario)
Shakespeare Composite Structures Site
Newberry, South Carolina

		Pole Winder Building		Main Building				
Sample ID	**Screening Value** [(1)]	SV20	SV23	SV31	SV45	SV46	SV49	SV54
Laboratory ID		L977783-06	L977783-07	L977783-01	L977783-02	L977783-03	L977783-05	L977783-04
Date Collected		03/13/18	03/13/18	03/13/18	03/13/18	03/13/18	03/13/18	03/13/18
VOCs by Method TO-15 (µg/m3)								
1,2,4-Trimethylbenzene	876	13.3	8.07	3.28	1.98	1.59	2.01	1.15
Benzene	52.4	7.28	9.34	14.4	1.62	0.739	2.48	0.689
cis-1,2-Dichloroethene	—	1.78	1.07	307	< 0.793	< 0.793	< 0.793	< 0.793
Ethylbenzene	164	8.74	188	8.11	2.18	1.35	4.12	1.1
Isopropylbenzene	5840	9.7	2.77	< 1.97	< 0.983	< 0.983	2.84	< 0.983
m&p-Xylene	1460	14.8	365	26.8	7.64	4.45	102	3.55
o-Xylene	1460	4.99	62.3	8.11	2.17	1.54	48.8	1.36
Tetrachloroethene	584	3.99	< 1.36	30.6	32.2	24.7	23.3	11.4
Toluene	73,000	10.3	158	42.1	7.28	5.76	17.9	3.73
trans-1,2-Dichloroethene	—	< 0.793	< 0.793	8.24	< 0.793	< 0.793	< 0.793	< 0.793
Trichloroethene	29.2	1.41	< 1.07	1020	35.9	14.6	83.1	3.76
Vinyl Chloride	92.9	< 0.511	< 0.511	< 1.02	< 0.511	< 0.511	< 0.511	< 0.511

Notes:

(1) Screening value is the Sub-Slab and Exterior Soil Gas Concentration from the USEPA online Vapor Intrusion Screening Level (VISL) Calculator, based on a target cancer risk of 1E-06 or target hazard quotient of 0.1. Values were calculated using a commercial scenario and a groundwater temperature of 17 degrees C.

Shading indicates an exceedance of the screening value.

— - No inhalation toxicity information

µg/m3 - Micrograms per cubic meter

COPC - Chemical of Potential Concern

Table 1-9
Identification of Preliminary COPCs for Groundwater Vapors in Indoor Air (Residential Scenario)
Shakespeare Composite Structures Site
Newberry, South Carolina

Chemical	**Units**	**Maximum Detected Concentration**	**Residential Scenario**	
			Target Groundwater Concentration (1)	**COPC? (Max Detection Exceeds Target GW Concentration)**
VOCs				
1,1-Dichloroethane	ug/L	2.4	10.5	No
1,1-Dichloroethene	ug/L	5.2	25.7	No
1,2-Dichloroethane	ug/L	0.54	3.23	No
2-Butanone (MEK)	ug/L	3.7	322000	No
Acetone	ug/L	150	3100000	No
Benzene	ug/L	0.66	2.25	No
Carbon disulfide	ug/L	0.93	164	No
Chloroform	**ug/L**	**5.7**	**1.12**	**Yes**
cis-1,2-Dichloroethene	ug/L	530	—	No
Isopropylbenzene	ug/L	3.6	155	No
Methyl acetate	ug/L	8.1	—	No
Methylene chloride	ug/L	0.41	634	No
Styrene	ug/L	81	1460	No
Tetrachloroethene	ug/L	5	8.72	No
Toluene	ug/L	2.2	2850	No
trans-1,2-Dichloroethene	ug/L	21	—	No
Trichloroethene	**ug/L**	**1400**	**0.742**	**Yes**
Vinyl chloride	**ug/L**	**8.1**	**0.178**	**Yes**
Xylene (Total)	ug/L	1.8	60	No

Notes:

(1) Target Groundwater Concentration from the USEPA online Vapor Intrusion Screening Level (VISL) Calculator, based on a target cancer risk of 1E-06 or target hazard quotient of 0.1. Values were calculated using a residential scenario and a groundwater temperature of 17 degrees C.

— - No Inhalation Toxicity Information

COPC - Chemical of Potential Concern

VISL - Vapor Intrusion Screening Level

Bold font indicates selection as a preliminary COPC.

Table 1-10
Identification of COPCs in Sub-Slab Vapor Samples (Industrial Scenario)
Shakespeare Composite Structures Site
Newberry, South Carolina

Preliminary COPC [1]	Units	J&E Model [2]		Screening Level [5]	COPC?	Rationale Code [6]
		Input [3]	Output (EPC) [4]			
Industrial Scenario						
Pole Winder Building						
VOCs						
Ethylbenzene	ug/m3	98.37	0.295	4.9	No	BSL
Main Building						
VOCs						
Trichloroethene	ug/m3	231.47	0.694	3	No	BSL

Notes:

(1) Preliminary COPCs for vapor intrusion into indoor air identified on Table 6-8.

(2) J&E Model - Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings, Version 6.0 (USEPA, September 2017).

(3) J&E Model input is the average concentration from subslab vapor samples. Concentrations are shown on Table 6-8.

(4) J&E Model output (EPC) is the "Predicted Indoor Air Concentration Due to Vapor Intrusion."

(5) The screening level is the industrial air value from the Regional Screening Level (RSL) Table based on a target risk of 1E-06 for carcinogens and a target HQ of 1 for noncarcinogens (USEPA, May 2018).

(6) Rationale Codes:

Selection Reason: ASL - Above Screening Level

Deletion Reason: BSL - Below Screening Level

Definitions:

$\mu g/m^3$ - Micrograms per cubic meter

COPC - Chemical of Potential Concern

EPC -Exposure Point Concentration

Table 1-11
Identification of COPCs for Groundwater Vapors in Indoor Air (Residential Scenario)
Shakespeare Composite Structures Site
Newberry, South Carolina

Preliminary COPC (1)	**J&E Model (2)**		**Screening Value (5) (μg/m³)**	**COPC?**	**Rationale Code (6)**
	Input (3) (μg/L)	**Output (EPC) (4) (μg/m³)**			
Residential Scenario					
VOCs					
Chloroform	2.438	0.010	0.12	No	BSL
Trichloroethene	**390.9**	**1.8**	**0.21**	**Yes**	**ASL**
Vinyl chloride	3.233	0.039	0.17	No	BSL

Notes:

(1) Preliminary COPCs for vapor intrusion into indoor air identified on Table 6-9.

(2) J&E Model - Johnson and Ettinger Model for Subsurface Vapor Intrusion into Buildings, Version 6.0 (USEPA, September 2017).

(3) J&E Model input is the average concentration from groundwater samples in the core of the plume.
See Table 6-12 for a list of locations identified as the core of the plume for each COPC.

(4) J&E Model output (EPC) is the "Predicted Indoor Air Concentration Due to Vapor Intrusion."

(5) The screening value is the residential air value from the Regional Screening Level (RSL) Table based on risk of 1E-06 for carcinogens and HQ of 0.1 for noncarcinogens (USEPA, May 2018).

(6) Rationale Codes:
Selection Reason: ASL - Above Screening Level
Deletion Reason: BSL - Below Screening Level; NSV - No Screening Value

Bold font indicates selection as a COPC.

Definitions:

μg/m³ - Micrograms per cubic meter
COPC - Chemical of Potential Concern
EPC -Exposure Point Concentration
NSV - No Screening Value (No inhalation toxicity data is available to calculate a screening value)

Table 1-12
Summary of Chemicals of Potential Concern
Shakespeare Composite Structures Site
Newberry, South Carolina

COPC	Soil			Surface Water	Groundwater			
	Exposed Surface Soil	Surface Soil	Subsurface Soil		Shallow/ Intermediate	Bedrock	Vapors in Indoor Air (Industrial Scenario)	Vapors in Indoor Air (Residential Scenario)
VOCs								
1,2-Dichloroethane					X	X		
Benzene					X			
Chloroform					X	X		(2)
cis-1,2-Dichloroethene					X	X		
Ethylbenzene							(1)	
Tetrachloroethene					X			
Trichloroethene					X	X	(1)	X (2)
Vinyl chloride					X			(2)
Metals								
Iron					X			
Manganese					X			

Notes:

(1) Ethylbenzene and trichloroethene are identified as preliminary COPCs (for the pole winder and main buildings, respectively) from subslab vapors migrating into indoor air (See Table 6-8). Based on modeled indoor air concentrations, however, neither of these preliminary COPCs is retained as a COPC for this medium (See Table 6-14).

(2) Chloroform, trichloroethene, and vinyl chloride are identified as preliminary COPCs (See Table 6-9) from the intrusion of groundwater vapors into indoor air. Based on modeled indoor air concentrations, however, only trichloroethene is retained as a COPC for this medium (See Table 6-15).

X - Indicates chemical is designated as a COPC for the exposure medium;
Blank space indicates the chemical is not a COPC for the exposure medium.

COPC - Chemical of Potential Concern

Table 1-13
Selection of Exposure Pathways
Shakespeare Composite Structures Site
Newberry, South Carolina

Scenario Timeframe	Medium [1]	Exposure Medium	Exposure Point	Receptor Population	Receptor Age	Exposure Route	Type of Analysis	Rationale for Selection or Exclusion of Exposure Pathway
Current and Future	Surface Soil [1]	Surface Soil	Surface Soil	Industrial Worker	Adult	Oral	Quant	Direct contact with soil while working on site
						Dermal	Quant	Direct contact with soil while working on site
		Air	Vapors in Air	Industrial Worker	Adult	Inhalation	None	VOCs will quickly volatilize; therefore, exposure via inhalation of VOCs is insignificant
	Groundwater	Air	Indoor Air	Industrial Worker	Adult	Inhalation	Quant	Contact with indoor air contaminated via vapor intrusion inside an industrial building
Future	Surface Soil	Surface Soil	Surface Soil	Construction Worker	Adult	Oral	Quant	Direct contact with surface soil during excavation activities on site
						Dermal	Quant	Direct contact with surface soil during excavation activities on site
		Air	Vapors in Air	Construction Worker	Adult	Inhalation	Quant	Indirect contact with surface soil contaminants that volatilize during excavation activities
	Subsurface Soil	Subsurface Soil	Subsurface Soil	Construction Worker	Adult	Oral	Quant	Direct contact with subsurface soil during excavation activities on site
						Dermal	Quant	Direct contact with subsurface soil during excavation activities on site
		Air	Vapors in Air	Construction Worker	Adult	Inhalation	Quant	Indirect contact with subsurface soil contaminants that volatilize during excavation activities
	Groundwater	Groundwater	Tap Water	Resident	Adult / Child	Oral	Quant	Evaluate groundwater as hypothetical drinking water source
						Dermal	Quant	Evaluate groundwater as hypothetical drinking water source
		Air	Water Vapor at Showerhead	Resident	Adult	Inhalation	Quant	Evaluate groundwater as hypothetical drinking water source
			Indoor Air	Resident	Adult / Child	Inhalation	Quant	Evaluate groundwater as hypothetical vapor intrusion source
	Surface Water	Surface Water	Surface Water in Streams	Resident	Adolescent	Oral	Quant	Direct contact with surface water while wading in streams is insignificant
						Dermal	Quant	Direct contact with surface water while wading in streams is insignificant

Notes:

(1) Exposed surface soil (soil not covered by buildings or pavement) will be evaluated for the industrial worker.

Table 1-14
Exposure Point Concentration Summary — Shallow/Intermediate Groundwater
Shakespeare Composite Structures Site
Newberry, South Carolina

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic [1] Mean	95% UCL [1] (Distribution)		Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic [2]	Rationale
Groundwater (Shallow/ Intermediate)	***VOCs***									
	1,2-Dichloroethane	mg/L	NC	NC		0.00054 J//	0.00054	mg/L	Max	Footnote (4)
	Benzene	mg/L	0.000577	0.00072	95% Student's-t UCL	0.00066 J//	0.00066	mg/L	Max	Footnote (4)
	Chloroform	mg/L	0.002438	0.003561	95% Student's-t UCL	0.0057 J//	0.003561	mg/L	95% UCL	Footnote (3)
	cis-1,2-Dichloroethene	mg/L	0.06008	0.1192	Gamma Adjusted KM-UCL	0.53	0.1192	mg/L	95% UCL	Footnote (3)
	Tetrachloroethene	mg/L	0.0031	0.004682	95% Student's-t UCL	0.005	0.004682	mg/L	95% UCL	Footnote (3)
	Trichloroethene	mg/L	0.3909	0.4602	95% KM (t) UCL	1.4	0.4602	mg/L	95% UCL	Footnote (3)
	Vinyl chloride	mg/L	0.003233	0.01034	95% Student's-t UCL	0.0081	0.0081	mg/L	Max	Footnote (4)
	Metals									
	Iron	mg/L	4.404	9.291	95% Student's-t UCL	11	9.291	mg/L	95% UCL	Footnote (3)
	Manganese	mg/L	0.1363	0.2568	95% Student's-t UCL	0.2	0.2	mg/L	Max	Footnote (4)

Notes:

(1) Arithmetic mean and 95% Upper Confidence Limit (UCL) were calculated using USEPA's ProUCL Version 5.1.002 statistical software package. Method used to compute selected UCL is shown.

(2) Statistic: Maximum Detected Value (Max); 95% UCL (95% UCL).

(3) The 95% UCL is lower than the maximum concentration and is selected as the exposure point concentration.

(4) The 95% UCL either could not be calculated or exceeded the maximum concentration; the maximum value was selected as the exposure point concentration.

(5) In evaluating groundwater from Shallow/Intermediate wells, the following locations were identified as the core of the plume for calculating the 95% UCL:

Benzene — MW-4, -6, and -7I

Chloroform — MW-5, -8, -9I, -22, TMW-22, -23, -24, and -30

cis-1,2-Dichloroethene — MW-3, -3I, -4, -5, -5I, -6, -6I, -7, -7I, -8, -9, -9I, -22, -26, -27, -28, -29, TMW-21, -22, -23, -24, -25, -29, -30, -31, -32, and -33

Tetrachloroethene — MW-7I, -8, -9I, and -20I

Trichloroethene — MW-6, -6I, -7, -7I, -8, -9, -9I, -10, -10I, -26, -27, -28, -29, TMW-21, -22, -23, -24, -29, -30, -31, -32, and -33

Vinyl Chloride — MW-6, -7, and -8

Iron — MW-6, -7I, -9I, -20, and -20I

Manganese — MW-7I, -8, and -9I

mg/L - Milligrams per liter

NC - Not calculated

Table 1-15
Exposure Point Concentration Summary — Bedrock Groundwater and Drinking Water Wells
Shakespeare Composite Structures Site
Newberry, South Carolina

Scenario Timeframe: Future
Medium: Groundwater
Exposure Medium: Groundwater

Exposure Point	Chemical of Potential Concern	Units	Arithmetic Mean [1]	95% UCL [1]	(Distribution)	Maximum Concentration (Qualifier)	Exposure Point Concentration			
							Value	Units	Statistic [2]	Rationale
Groundwater - All Bedrock Wells [5]	***VOCs***									
	1,2-Dichloroethane	mg/L	NC	NC		0.00073 J//	0.00073	mg/L	Max	Footnote (4)
	Chloroform	mg/L	0.00101	0.002464	95% Student's-t UCL	0.002 J//	0.002	mg/L	Max	Footnote (4)
	cis-1,2-Dichloroethene	mg/L	NC	NC		0.011	0.011	mg/L	Max	Footnote (4)
	Trichloroethene	mg/L	0.08957	0.156	95% Student's-t UCL	0.16	0.156	mg/L	95% UCL	Footnote (3)
Groundwater - Boazman Well	***VOCs***									
	Trichloroethene	mg/L	NC	NC		0.0015	0.0015	mg/L	Max	Footnote (4)
Groundwater - PW-2	***VOCs***									
	Trichloroethene	mg/L	NC	NC		0.03833	0.03833	mg/L	Max	Footnote (4)
Groundwater - PW-4	***VOCs***									
	Trichloroethene	mg/L	NC	NC		0.0009	0.0009	mg/L	Max	Footnote (4)
Groundwater - PW-5	***VOCs***									
	Trichloroethene	mg/L	NC	NC		0.015	0.015	mg/L	Max	Footnote (4)
Groundwater - PW-8	***VOCs***									
	Trichloroethene	mg/L	NC	NC		0.04995	0.04995	mg/L	Max	Footnote (4)

Notes:

(1) Arithmetic mean and 95% Upper Confidence Limit (UCL) were calculated using USEPA's ProUCL Version 5.1.002 statistical software package. Method used to compute selected UCL is shown.

(2) Statistic: Maximum Detected Value (Max); 95% UCL (95% UCL).

(3) The 95% UCL is lower than the maximum concentration and is selected as the exposure point concentration.

(4) The 95% UCL either could not be calculated or exceeded the maximum concentration; the maximum value was selected as the exposure point concentration.

(5) In evaluating groundwater from all Bedrock wells, the following locations were identified as the core of the plume for calculating the 95% UCL:

Chloroform — MW-9D, MW-12D, and MW-17D; Trichloroethene — MW-6D, PW-2, PW-8, and RDW-1.

mg/L - Milligrams per liter

NC - Not calculated

Table 1-16
Cancer Toxicity Data — Oral/Dermal
Shakespeare Composite Structures Site
Newberry, South Carolina

Chemical of Potential Concern	Oral Cancer Slope Factor Value	Oral Cancer Slope Factor Units	Oral Absorption Efficiency for Dermal (1)	Absorbed Cancer Slope Factor for Dermal (2) Value	Absorbed Cancer Slope Factor for Dermal (2) Units	Weight of Evidence/ Cancer Guideline Description	Mutagen (3)	Oral Cancer Slope Factor Source(s) (4)	Oral Cancer Slope Factor Date(s) (5) (MM/DD/YYYY)
VOCs									
1,2-Dichloroethane	9.10E-02	$(mg/kg\text{-}day)^{-1}$	1	9.10E-02	$(mg/kg\text{-}day)^{-1}$	B2		IRIS	04/18/2018
Benzene	5.50E-02	$(mg/kg\text{-}day)^{-1}$	1	5.50E-02	$(mg/kg\text{-}day)^{-1}$	A		IRIS	04/18/2018
Chloroform	3.10E-02	$(mg/kg\text{-}day)^{-1}$	1	3.10E-02	$(mg/kg\text{-}day)^{-1}$	B2		CalEPA:IRIS	04/18/2018
cis-1,2-Dichloroethene	ND	ND	ND	ND	ND	Inadequate		IRIS	04/18/2018
Tetrachloroethene	2.10E-03	$(mg/kg\text{-}day)^{-1}$	1	2.10E-03	$(mg/kg\text{-}day)^{-1}$	Likely		IRIS	04/18/2018
Trichloroethene	4.60E-02	$(mg/kg\text{-}day)^{-1}$	1	4.60E-02	$(mg/kg\text{-}day)^{-1}$	Known	Yes	IRIS	04/18/2018
Vinyl chloride	7.20E-01	$(mg/kg\text{-}day)^{-1}$	1	7.20E-01	$(mg/kg\text{-}day)^{-1}$	A	Yes	IRIS	04/18/2018
Metals									
Iron	ND	ND	ND	ND	ND	Inadequate		PPRTV	06/16/2005
Manganese	NA	NA	NA	NA	NA	D		IRIS	04/18/2018

Notes:

(1) Oral to dermal adjustment factors (gastrointestinal absorption factors) are from USEPA (July 2004).
The vinyl chloride slope factor is for continous lifetime exposure during adulthood.
The vinyl chloride slope factor for continous lifetime exposure from birth is 1.5 $(mg/kg\text{-}day)^{-1}$.
(2) Absorbed Cancer Slope Factor for Dermal = (Oral SF) / (Oral Absorption Efficiency).
(3) Identified as having a mutagenic mode of action for carcinogenesis (USEPA, February 2013).
(4) Source of Slope Factor and Weight of Evidence/Cancer Guideline Description.
A colon separates different sources used for each.
(5) For CalEPA and IRIS values, the date CalEPA or IRIS was searched.
For PPRTV values, the issue date of the paper.

Weight of Evidence Classification, as per Guidelines for Carcinogen Risk Assessment (USEPA, September 1986):

A - Human carcinogen
B1 - Probable human carcinogen - based on limited evidence of carcinogenicity in humans
B2 - Probable human carcinogen
C - Possible human carcinogen
D - Not classifiable as a human carcinogen

Weight of Evidence Classification, as per Guidelines for Carcinogen Risk Assessment (USEPA, March 2005):

Known - carcinogenic to humans
Likely - likely to be carcinogenic to humans
Suggestive - suggestive evidence to be carcinogenic to animals
Inadequate - inadequate information to assess carcinogenic potential
Not likely to be carcinogenic to humans

Definitions:

CalEPA - California Environmental Protection Agency
IRIS - Integrated Risk Information System
NA - Not Applicable
ND - No Data
PPRTV - Provisional Peer-Reviewed Toxicity Value
USEPA - United States Environmental Protection Agency

Table 1-17
Cancer Toxicity Data — Inhalation
Shakespeare Composite Structures Site
Newberry, South Carolina

Chemical of Potential Concern	Unit Risk Value	Unit Risk Units	Weight of Evidence/ Cancer Guideline Description	Mutagen [1]	Unit Risk Source(s) [2]	Unit Risk Date(s) [3] (MM/DD/YYYY)
VOCs						
1,2-Dichloroethane	2.60E-05	$(\mu g/m3)^{-1}$	B2		IRIS	04/18/2018
Benzene	7.80E-06	$(\mu g/m3)^{-1}$	A		IRIS	04/18/2018
Chloroform	2.30E-05	$(\mu g/m3)^{-1}$	B2		IRIS	04/18/2018
cis-1,2-Dichloroethene	ND	ND	Inadequate		IRIS	04/18/2018
Tetrachloroethene	2.60E-07	$(\mu g/m3)^{-1}$	Likely		IRIS	04/18/2018
Trichloroethene	4.10E-06	$(\mu g/m3)^{-1}$	Known	Yes	IRIS	04/18/2018
Vinyl chloride	4.40E-06	$(\mu g/m3)^{-1}$	A	Yes	IRIS	04/18/2018
Metals						
Iron	ND	ND	Inadequate		PPRTV	06/16/2005
Manganese	NA	NA	D		IRIS	04/18/2018

Notes:

(1) Identified as having a mutagenic mode of action for carcinogenesis (USEPA, February 2013).
The vinyl chloride unit risk is for continous lifetime exposure during adulthood.
The vinyl chloride unit risk for continous lifetime exposure from birth is 8.8 x 10-6 (ug/m3)-1.
(2) Source of Unit Risk : source of Weight of Evidence/Cancer Guideline Description.
(3) For IRIS values, the date IRIS was searched.
For PPRTV values, the issue date of the paper.

Weight of Evidence Classification, as per Guidelines for Carcinogen Risk Assessment (USEPA, September 1986):

A - Human carcinogen
B1 - Probable human carcinogen - based on limited evidence of carcinogenicity in humans
B2 - Probable human carcinogen
C - Possible human carcinogen
D - Not classifiable as a human carcinogen

Weight of Evidence Classification, as per Guidelines for Carcinogen Risk Assessment (USEPA, March 2005):

Known - carcinogenic to humans
Likely - likely to be carcinogenic to humans
Suggestive - suggestive evidence to be carcinogenic to animals
Inadequate - inadequate information to assess carcinogenic potential
Not likely to be carcinogenic to humans

Definitions:

IRIS - Integrated Risk Information System
NA - Not Applicable
ND - No Data
PPRTV - Provisional Peer-Reviewed Toxicity Value
USEPA - United States Environmental Protection Agency

Table 1-18
Non-Cancer Toxicity Data — Oral/Dermal
Shakespeare Composite Structures Site
Newberry, South Carolina

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 (3)	RfD: Target Organ(s)	
		Value	Units		Value	Units			Source(s)	Date(s) (4) (MM/DD/YYYY)
VOCs										
1,2-Dichloroethane	Chronic	6.00E-03	mg/kg-day	1	6.00E-03	mg/kg-day	Kidney	10,000	PPRTV App	10/01/2010
Benzene	Chronic	4.00E-03	mg/kg-day	1	4.00E-03	mg/kg-day	Immune System	300	IRIS	04/18/2018
Chloroform	Chronic	1.00E-02	mg/kg-day	1	1.00E-02	mg/kg-day	Liver	100	IRIS	04/18/2018
cis-1,2-Dichloroethene	Chronic	2.00E-03	mg/kg-day	1	2.00E-03	mg/kg-day	Kidney	3000	IRIS	04/18/2018
Tetrachloroethene	Chronic	6.00E-03	mg/kg-day	1	6.00E-03	mg/kg-day	Nervous System, Eyes	1000	IRIS	04/18/2018
Trichloroethene	Chronic	5.00E-04	mg/kg-day	1	5.00E-04	mg/kg-day	Fetus, Thymus, Immune System	10; 100; 1000	IRIS	04/18/2018
Vinyl chloride	Chronic	3.00E-03	mg/kg-day	1	3.00E-03	mg/kg-day	Liver	30	IRIS	04/18/2018
Metals										
Iron	Chronic	7.00E-01	mg/kg-day	1	7.00E-01	mg/kg-day	Gastrointestinal	1.5	PPRTV	09/11/2006
Manganese	Chronic	2.40E-02	mg/kg-day	0.04	9.60E-04	mg/kg-day	Nervous System	3	IRIS	04/18/2018

Notes:

(1) Oral to dermal adjustment factors (GI absorption factors) are from USEPA, July 2004.

(2) Absorbed RfD for Dermal = (Oral RfD) x (Oral Absorption Efficiency).

(3) Represents Uncertainty Factor x Modifying Factor.

(4) For IRIS values, the date IRIS was searched.
For PPRTV values, the issue date of the paper.

Definitions:

IRIS - Integrated Risk Information System

ND - No data

PPRTV - Provisional Peer-Reviewed Toxicity Value

PPRTV App - Provisional Peer-Reviewed Appendix Toxicity Value

USEPA - United States Environmental Protection Agency

Table 1-19
Non-Cancer Toxicity Data — Inhalation
Shakespeare Composite Structures Site
Newberry, South Carolina

Chemical of Potential Concern	Chronic/ Subchronic	Inhalation RfC Value	Inhalation RfC Units	Primary Target Organ(s)	Combined Uncertainty/ Modifying Factors (2)	RfC: Target Organ(s) Source(s)	RfC: Target Organ(s) Date(s) (3) (MM/DD/YYYY)
VOCs							
1,2-Dichloroethane	Chronic	7.00E+00	µg/m3	Liver	3000	PPRTV	10/01/2010
Benzene	Chronic	3.00E+01	µg/m3	Immune System	300	IRIS	04/18/2018
Chloroform	Chronic	9.80E+01	µg/m3	Liver	100	ATSDR	09/1997
cis-1,2-Dichloroethene	Chronic	ND	ND	ND	ND	ND	ND
Tetrachloroethene	Chronic	4.00E+01	µg/m3	Nervous System, Eyes	1000	IRIS	04/18/2018
Trichloroethene	Chronic	2.00E+00	ug/m3	Fetus, Thymus	10; 100	IRIS	04/18/2018
Vinyl chloride	Chronic	1.00E+02	µg/m3	Liver	30	IRIS	04/18/2018
Metals							
Iron	Chronic	ND	ND	ND	ND	ND	ND
Manganese	Chronic	5.00E-02	µg/m3	Nervous System	1000	IRIS	04/18/2018

Notes:

(1) Represents Uncertainty Factor x Modifying Factor.

(2) For ATSDR and PPTRV values, the date of the ATSDR or PPRTV document.
For IRIS values, the date IRIS was searched.

Definitions

µg/m3 - Micrograms per cubic meter
ATSDR - Agency for Toxic Substances and Disease Registry
IRIS - Integrated Risk Information System
ND - No data
USEPA - United States Environmental Protection Agency

Table 1-20
Overall Summary of Risks and Hazards for COPCs
Shakespeare Composite Structures Site
Newberry, South Carolina

Groundwater Medium (1)	Adult Resident		Child Resident (2)
	Cancer Risk	Hazard Index	Hazard Index
Shallow/Intermediate Wells	9E-04	39	58
Bedrock Wells	2E-04	12	18
Individual Bedrock Wells			
Boazman Well	2E-06	0.1	0.2
PW-2	4E-05	3	4
PW-4	9E-07	0.07	0.1
PW-5	2E-05	1	2
PW-8	5E-05	4	6

Notes:

(1) No COPCs were identified in surface or subsurface soil; therefore, risk and hazard were not calculated for these media.

(2) Cancer risk is not calculated for a child separate from an adult because carcinogenic effects accumulate over the lifetime of the individual.

Risk values and hazard indices are taken from Tables I.5-1 through I.5-14.

Table 2-1
Identification of Preliminary COPECs in Surface Water
Ecological Risk Assessment
Philips Electronics Facility
Newberry, South Carolina

Chemical [(1)]	Frequency of Detection	Units	Minimum Reporting Limit	Maximum Reporting Limit	Minimum Concentration [(2)]	Maximum Concentration [(2)]	Sample Designation of Maximum Concentration	Ecological Screening Value [(3)]	Maximum Hazard Quotient (HQ) [(4)]	Preliminary COPEC (Yes/No) / Basis [(5)]	
VOCs											
Acetone	3 / 5	ug/L	20	20	2.6 J//	3.7 J//	SW-1	1700	0.002	No	A
Chloromethane	1 / 5	ug/L	5	5	0.24 J//	0.24 J//	SW-3	16	0.015	No	A
cis-1,2-Dichloroethene	2 / 5	ug/L	5	5	0.52 J//	6.3	SW-2	620	0.01	No	A
Toluene	1 / 5	ug/L	5	5	0.38 J//	0.38 J//	SW-2	62	0.006	No	A
Trichloroethene	2 / 5	ug/L	5	5	0.92 J//	0.93 J//	SW-5	220	0.004	No	A

Notes:

(1) Only detected chemicals are shown.

(2) Minimum/maximum detected concentration and associated qualifiers.

(3) Ecological screening values are Chronic Freshwater Screening Values from Table 1a of the Region 4 Ecological Risk Assessment Supplemental Guidance (USEPA, March 2018).

Note: Chloromethane lacks an ESV in Table 1a, so a surrogate value was selected based on bromomethane. Bromomethane has the lowest screening value of the chlorinated or brominated methanes with screening values in Table 1a and is expected to provide a reasonably conservative surrogate screening value for evaluating chloromethane.

(4) Maximum hazard quotient (HQ) = maximum detected concentration/ecological screening value

(5) Basis for identification as a preliminary COPEC:

A - Maximum detected concentration is less than the ESV; therefore, chemical not identified as a preliminary COPEC.

Bold font indicates selection as a preliminary COPEC.

Data Qualifiers:

The "/" separates the laboratory added data qualifiers from the validation data qualifiers. The laboratory added data qualifiers precede the "/," and the validation qualifiers follow the "/."

J/ - Estimated result less than the reporting limit and greater than or equal to the method detection limit.

Definitions:

COPEC - chemical of potential ecological concern

ESV - ecological screening value

USEPA - United States Environmental Protection Agency

Appendix IA.1 VISL Calculator and Johnson and Ettinger Model Output

Table I.1-1
VISL Calculator (Commercial Scenario)
Shakespeare Composite Structures Site
Newberry, South Carolina

Default VISL Results
Commercial Equation Inputs

Output generated 04APR2018:13:33:11

Variable	Value
Exposure Scenario	Commercial
Temperature for Groundwater Vapor Concentration C	17
THQ (target hazard quotient) unitless	0.1
TR (target risk) unitless	0.000001
AT_w (averaging time - composite worker)	365
EF_w (exposure frequency - composite worker) day/yr	250
ED_w (exposure duration - composite worker) yr	25
ET_w (exposure time - composite worker) hr	8
LT (lifetime) yr	70
AF_{gw} (Attenuation Factor Groundwater) unitless	0.001
AF_{ss} (Attenuation Factor Sub-Slab) unitless	0.03

Table I.1-1
VISL Calculator (Commercial Scenario)
Shakespeare Composite Structures Site
Newberry, South Carolina

Commercial Vapor Intrusion Screening Levels (VISL)

Output generated 04APR2018:13:33:11

Chemical	CAS Number	Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)	Does the chemical have inhalation toxicity data? (IUR and/or RfC)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? (C_{vp} > $C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? (C_{hc} > $C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-06 or THQ=0.1) MIN($C_{ia,c}$,$C_{ia,nc}$) (μg/m³)	Toxicity Basis	Target Sub-Slab and Exterior Soil Gas Concentration (TCR=1E-06 or THQ=0.1) C_{sg},Target (μg/m³)	Target Groundwater Concentration (TCR=1E-06 or THQ=0.1) C_{gw},Target (μg/L)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)	Pure Phase Vapor Concentration C_{vp} (17 °C) (μg/m³)	Maximum Groundwater Vapor Concentration C_{hc} (μg/m³)	Temperature for Maximum Groundwater Vapor Concentration (°C)	Lower Explosive Limit LEL (% by volume)	LEL Ref	Inhalation Unit Risk $(ug/m^3)^{-1}$	IUR Ref	Chronic RfC (mg/m³)	Chronic RfC Ref	Mutagenic Indicator	Carcinogenic VISL TCR=1E-06 $C_{ia,c}$ (μg/m³)	Noncarcinogenic VISL THQ=0.1 $C_{ia,nc}$ (μg/m³)
Benzene	71-43-2	Yes	Yes	Yes	Yes	1.57	CA	52.4	9.81	No (5)	398000000	287000000	17	1.2	CRC89	0.0000078	I	0.03	I		1.57	13.1
Cumene	98-82-8	Yes	Yes	Yes	Yes	175	NC	5840	650	--	29100000	16500000	17	0.9	CRC89	-		0.4	I		-	175
Dichloroethylene, 1,2-cis-	156-59-2	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		1040000000	767000000	17	3	CRC89	-		-			-	-
Dichloroethylene, 1,2-trans-	156-60-5	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		1730000000	1270000000	17	6	CRC89	-		-			-	-
Ethylbenzene	100-41-4	Yes	Yes	Yes	Yes	4.91	CA	164	23.7	Yes (700)	54800000	35000000	17	0.8	CRC89	0.0000025	C	1	I		4.91	438
Tetrachloroethylene	127-18-4	Yes	Yes	Yes	Yes	17.5	NC	584	36.6	No (5)	165000000	98500000	17	-		2.6E-07	I	0.04	I		47.2	17.5
Toluene	108-88-3	Yes	Yes	Yes	Yes	2190	NC	73000	12000	No (1000)	141000000	96200000	17	1.1	CRC89	-		5	I		-	2190
Trichloroethylene	79-01-6	Yes	Yes	Yes	Yes	0.876	NC	29.2	3.12	Yes (5)	488000000	360000000	17	8	CRC89	0.0000041	I	0.002	I	Mut	2.99	0.876
Trimethylbenzene, 1,2,4-	95-63-6	Yes	Yes	Yes	Yes	26.3	NC	876	174	--	13600000	8590000	17	0.9	CRC89	-		0.06	I		-	26.3
Vinyl Chloride	75-01-4	Yes	Yes	Yes	Yes	2.79	CA	92.9	2.96	No (2)	10000000000	8280000000	17	3.6	CRC89	0.0000044	I	0.1	I	Mut	2.79	43.8
Xylene, P-	106-42-3	Yes	Yes	Yes	Yes	43.8	NC	1460	243	--	50500000	29300000	17	1.1	CRC89	-		0.1	S		-	43.8
Xylene, m-	108-38-3	Yes	Yes	Yes	Yes	43.8	NC	1460	233	--	47300000	30200000	17	1.1	CRC89	-		0.1	S		-	43.8
Xylene, o-	95-47-6	Yes	Yes	Yes	Yes	43.8	NC	1460	325	--	37700000	24000000	17	0.9	CRC89	-		0.1	S		-	43.8

Table I.1-2
VISL Calculator (Residential Scenario)
Shakespeare Composite Structures Site
Newberry, South Carolina

Default VISL Results
Resident Equation Inputs

Output generated 02AUG2018:13:22:08

Variable	Value
Exposure Scenario	Resident
Temperature for Groundwater Vapor Concentration C	17
ED_{res} (exposure duration) years	26
TR (target risk) unitless	0.000001
THQ (target hazard quotient) unitless	0.1
LT (lifetime) years	70
EF_{res} (exposure frequency) days/year	350
ED_{0-2} (mutagenic exposure duration first phase) years	2
ED_{2-6} (mutagenic exposure duration second phase) years	4
ED_{6-16} (mutagenic exposure duration third phase) years	10
ED_{16-26} (mutagenic exposure duration fourth phase) years	10
EF_{0-2} (mutagenic exposure frequency first phase) days/year	350
EF_{2-6} (mutagenic exposure frequency second phase) days/year	350
EF_{6-16} (mutagenic exposure frequency third phase) days/year	350
EF_{16-26} (mutagenic exposure frequency fourth phase) days/year	350
ET_{res} (exposure time) hours/day	24
ET_{0-2} (mutagenic exposure time first phase) hours/day	24
ET_{2-6} (mutagenic exposure time second phase) hours/day	24
ET_{6-16} (mutagenic exposure time third phase) hours/day	24
ET_{16-26} (mutagenic exposure time fourth phase) hours/day	24
AF_{gw} (Attenuation Factor Groundwater) unitless	0.001
AF_{ss} (Attenuation Factor Sub-Slab) unitless	0.03

Table I.1-2
VISL Calculator (Residential Scenario)
Shakespeare Composite Structures Site
Newberry, South Carolina

Resident Vapor Intrusion Screening Levels (VISL)

Output generated 02AUG2018:13:22:08

Chemical	**CAS Number**	**Does the chemical meet the definition for volatility? (HLC>1E-5 or VP>1)**	**Does the chemical have inhalation toxicity data? (IUR and/or RfC)**	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Soil Source? (C_{vp} > $C_{i,a}$,Target?)	Is Chemical Sufficiently Volatile and Toxic to Pose Inhalation Risk Via Vapor Intrusion from Groundwater Source? (C_{hc} > $C_{i,a}$,Target?)	Target Indoor Air Concentration (TCR=1E-06 or THQ=0.1) MIN($C_{ia,c}$,$C_{ia,nc}$) (µg/m^3)	**Toxicity Basis**	Target Sub-Slab and Near-source Soil Gas Concentration (TCR=1E-06 or THQ=0.1) C_{sg},Target (µg/m^3)	Target Groundwater Concentration (TCR=1E-06 or THQ=0.1) C_{gw},Target (µg/L)	Is Target Groundwater Concentration < MCL? (C_{gw} < MCL?)	Pure Phase Vapor Concentration C_{vp} (17 °C) (µg/m^3)	Maximum Groundwater Vapor Concentration C_{hc} (µg/m^3)	**Temperature for Maximum Groundwater Vapor Concentration (°C)**	**Lower Explosive Limit LEL (% by volume)**	**LEL Ref**	Inhalation Unit Risk (ug/m^3)$^{-1}$	**IUR Ref**	RfC (mg/m^3)	**RfC Ref**	**Mutagenic Indicator**	Carcinogenic VISL TCR=1E-06 $C_{ia,c}$ (µg/m^3)	Noncarcinogenic VISL THQ=0.1 $C_{ia,nc}$ (µg/m^3)
Acetone	67-64-1	Yes	Yes	Yes	Yes	3220	NC	107000	3100000	--	723000000	1040000000	17	2.5	CRC89	-		30.9	A	No	-	3220
Benzene	71-43-2	Yes	Yes	Yes	Yes	0.36	CA	12	2.25	Yes (5)	398000000	287000000	17	1.2	CRC89	0.0000078	I	0.03	I	No	0.36	3.13
Carbon Disulfide	75-15-0	Yes	Yes	Yes	Yes	73	NC	2430	164	--	1470000000	960000000	17	1.3	CRC89	-		0.7	I	No	-	73
Chloroform	67-66-3	Yes	Yes	Yes	Yes	0.122	CA	4.07	1.12	Yes (80)	1260000000	865000000	17	-		0.000023	I	0.0977	A	No	0.122	10.2
Cumene	98-82-8	Yes	Yes	Yes	Yes	41.7	NC	1390	155	--	29100000	16500000	17	0.9	CRC89	-		0.4	I	No	-	41.7
Dichloroethane, 1,1-	75-34-3	Yes	Yes	Yes	Yes	1.75	CA	58.5	10.5	--	1210000000	844000000	17	5.4	CRC89	0.0000016	C	-		No	1.75	-
Dichloroethane, 1,2-	107-06-2	Yes	Yes	Yes	Yes	0.108	CA	3.6	3.23	Yes (5)	420000000	288000000	17	6.2	CRC89	0.000026	I	0.007	P	No	0.108	0.73
Dichloroethylene, 1,1-	75-35-4	Yes	Yes	Yes	Yes	20.9	NC	695	25.7	No (7)	3130000000	1970000000	17	6.5	CRC89	-		0.2	I	No	-	20.9
Dichloroethylene, 1,2-cis-	156-59-2	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		1040000000	767000000	17	3	CRC89	-		-		No	-	-
Dichloroethylene, 1,2-trans-	156-60-5	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		1730000000	1270000000	17	6	CRC89	-		-		No	-	-
Methyl Acetate	79-20-9	Yes	No	No Inhal. Tox. Info	No Inhal. Tox. Info	-		-	-		861000000	816000000	17	3.1	CRC89	-		-		No	-	-
Methyl Ethyl Ketone (2-Butanone)	78-93-3	Yes	Yes	Yes	Yes	521	NC	17400	322000	--	351000000	362000000	17	1.4	CRC89	-		5	I	No	-	521
Methylene Chloride	75-09-2	Yes	Yes	Yes	Yes	62.6	NC	2090	634	No (5)	1990000000	1280000000	17	13	CRC89	1E-08	I	0.6	I	Mut	101	62.6
Styrene	100-42-5	Yes	Yes	Yes	Yes	104	NC	3480	1460	No (100)	35800000	22100000	17	0.9	CRC89	-		1	I	No	-	104
Tetrachloroethylene	127-18-4	Yes	Yes	Yes	Yes	4.17	NC	139	8.72	No (5)	165000000	98500000	17	-		2.6E-07	I	0.04	I	No	10.8	4.17
Toluene	108-88-3	Yes	Yes	Yes	Yes	521	NC	17400	2850	No (1000)	141000000	96200000	17	1.1	CRC89	-		5	I	No	-	521
Trichloroethylene	79-01-6	Yes	Yes	Yes	Yes	0.209	NC	6.95	0.742	Yes (5)	488000000	360000000	17	8	CRC89	0.0000041	I	0.002	I	Mut	0.478	0.209
Vinyl Chloride	75-01-4	Yes	Yes	Yes	Yes	0.168	CA	5.59	0.178	Yes (2)	10000000000	8280000000	17	3.6	CRC89	0.0000044	I	0.1	I	Mut	0.168	10.4
Xylenes	1330-20-7	Yes	Yes	Yes	Yes	10.4	NC	348	60	Yes (10000)	45600000	18400000	17	-		-		0.1	I	No	-	10.4

Table I.1-3
Johnson and Ettinger Model Input and Output
Current and Future Industrial Scenario - Ethylbenzene (Pole Winder Building)
Shakespeare Composite Structures Site
Newberry, South Carolina

Preview	Unit	Value	Range	Default	Default Range
Soil gas to indoor air attenuation coefficient	(-)	3.0E-03	1.0E-04 - 5.0E-02	0.0030	1.0E-04 - 5.0E-02
Predicted indoor air concentration due to vapor intrusion	(ug/m3)	3.0E-01	9.8E-03 - 4.9E+00	3.0E-01	9.8E-03 - 4.9E+00
Please check WARNING or ERROR flags	(ppbv)	6.8E-02	2.3E-03 - 1.1E+00	6.8E-02	2.3E-03 - 1.1E+00

Model Input

Site Name/Run Number: Example, Run 1

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Source medium		Source	Sub-slab Soil Gas					
Soil gas concentration	(ug/m3)	Cmedium	98.37		NA			
Depth below grade to soil gas sample	(m)	Ls	0.30		Vary - 50	NA		
Average vadose zone temperature	(°C)	Ts	17	25	3-30			
Calc: Source vapor concentration	(ug/m3)	Cs	98					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.000%					

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Ethylbenzene					
CAS No.		CAS	100-41-4					
Toxicity Factors								
Unit risk factor	$(ug/m^3)^{-1}$	IUR	2.50E-06	2.50E-06	NA	NA		
Mutagenic compound		Mut	No	NA	NA	NA		
Reference concentration	(mg/m^3)	RfC	1.00E+00	1.00E+00	NA	NA		

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	1.69E+02	1.69E+02	NA	NA		
Henry's Law Constant @ 25°C	$(atm\text{-}m^3/mol)$	Hc	7.88E-03	7.88E-03	NA	NA		
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	3.22E-01	3.22E-01				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	2.07E-01	3.31E-01				
Diffusivity in air	(cm2/s)	Dair	6.85E-02	6.85E-02	NA	NA		
Diffusivity in water	(cm2/s)	Dwater	8.46E-06	8.46E-06	NA	NA		

Table I.1-3
Johnson and Ettinger Model Input and Output
Current and Future Industrial Scenario - Ethylbenzene (Pole Winder Building)
Shakespeare Composite Structures Site
Newberry, South Carolina

Building Characteristics:

Select Building Assumptions

- (●) Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
- ( ) Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Building setting		Bldg_Setting	Commercial	Commercial				
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade				
Depth below grade to base of foundation	(m)	Lb	0.20	0.20	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.20	0.20	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00		
Enclosed space floor area	(m2)	Abf	2600.00	1500.00	80-1000	NA	WARNING	Value is outside of reasonable range (80 - 200 m2).
Enclosed space mixing height	(m)	Hb	5.00	3.00	2.13 - 3.05	NA	WARNING	Value is outside of reasonable range (2.13 – 3.05 m).
Indoor air exchange rate	(1 / hr)	ach	1.50	1.50	.3-4.1	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24		
Calc: Building ventilation rate	(m3/hr)	Qb	19500.00	6750.00	NA	0.30		
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	58.50	20.25	NA	NA		

Table I.1-3
Johnson and Ettinger Model Input and Output
Current and Future Industrial Scenario - Ethylbenzene (Pole Winder Building)
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Input — **Site Name/Run Number:** Example, Run 1
Chemical Name: Ethylbenzene CAS No. 100-41-4
Depth below grade to soil gas sample: 0.30 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sandy Clay					
Stratum A thickness (from surface)	(m)	hSA	0.30					
Stratum A total porosity	(-)	nSA	0.385	0.385	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.197	0.197	0.117 - 0.28	0.25		
Stratum A bulk density	(g/cm^3)	rhoSA	1.630	1.630	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm^3)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA		
Stratum containing soil gas sample								
Stratum A, B, or C		src_soil	Stratum A					
					NA	NA		
					NA			
					NA			

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA		
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA		
Exposure Scenario		Scenario	Commercial	Commercial				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	25	25	NA	NA		
Exposure duration	(yrs)	ED	25	25	NA	NA		
Exposure frequency	(days/yr)	EF	250	250	NA	NA		
Exposure time	(hrs/24 hrs)	ET	8	8	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA	NOTE	MMOAF not relevant for non-mutagenic compounds

Table I.1-3
Johnson and Ettinger Model Input and Output
Current and Future Industrial Scenario - Ethylbenzene (Pole Winder Building)
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Output **Site Name/Run Number:** Example, Run 1

Chemical Name: Ethylbenzene CAS No. 100-41-4

Range is based on the reasonable range of Qsoil/Qbuilding values, as reported in the literature.

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Soil gas to indoor air attenuation coefficient	**(-)**	**alpha**	**3.0E-03**	1.0E-04 - 5.0E-02	**3.0E-03**	1.0E-04 - 5.0E-02	WARNING	Please review warning messages

Predicted Indoor Air Concentration	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Indoor air concentration due to vapor intrusion	(ug/m3)	**Cia**	**3.0E-01**	9.8E-03 - 4.9E+00	**3.0E-01**	9.8E-03 - 4.9E+00		
	(ppbv)		**6.8E-02**	2.3E-03 - 1.1E+00	**6.8E-02**	2.3E-03 - 1.1E+00	WARNING	Please review warning messages

Predicted Vapor Conc. Beneath Foundation	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Subslab vapor concentration	(ug/m3)	**Css**	**9.8E+01**	9.8E+01 - 9.8E+01	**9.8E+01**	9.8E+01 - 4.9E+04		
	(ppbv)		**2.3E+01**	2.3E+01 - 2.3E+01	**2.3E+01**	2.3E+01 - 1.1E+04		

Diffusive Transport Upward Through Vadose Zone	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	1.8E-03	-	1.8E-03	-		
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB		-		-		
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-		
				-		-		
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	1.8E-03	-	1.8E-03	-		

Critical Parameters		Symbol	Value	Range	Default	Default Range	Flag
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	8.6E-04	-	1.4E-03		
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	7.0E+03	2.3E+02 - 1.2E+05	4.2E+03	1.4E+02 - 6.9E+04	
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02	

Interpretation

Advection is the dominant mechanism across the foundation.
Diffusion through soil and advection through foundation both control intrusio

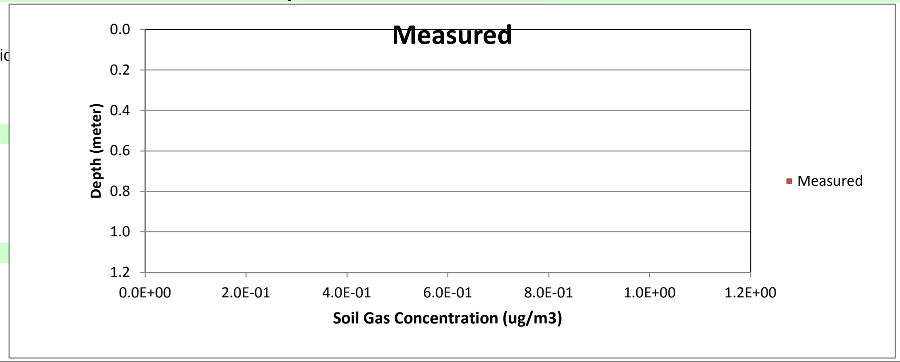
Critical Parameters

Hb, Ls, DeffT, ach, Qsoil_Qb

Non-Critical Parameters

Lf, DeffA, eta

Concentration versus Depth Profile



Please check WARNING or ERROR flags

Table I.1-3
Johnson and Ettinger Model Input and Output
Current and Future Industrial Scenario - Ethylbenzene (Pole Winder Building)
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Output

Site Name/Run Number: Example, Run 1

Chemical Name: Ethylbenzene CAS No. 100-41-4

Risk Calculations	Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels	**Scenario: Commercial**							
Target risk for carcinogens	(-)	Target_CR	1E-06	-	1E-06	-		
Target hazard quotient for noncarcinogens	(-)	Target_HQ	1	-	1	-		
Target indoor air concentration	**(ug/m3)**	**Target_IA**	**4.91E+00**	-	**4.91E+00**	-	Target indoor air concentration based on cancer risk (unit risk factor)	
	(ppbv)		**1.13E+00**	-	**1.13E+00**	-		
Target soil gas concentration	**(ug/m3)**	**Target_SV**	**1.64E+03**	**9.8E+01 - 4.9E+04**	**1.64E+03**	**9.8E+01 - 4.9E+04**		
Incremental Risk Estimates								
Incremental cancer risk from vapor intrusion	**(-)**	**Cancer_Risk**	**6.02E-08**	**2.0E-09 - 1.0E-06**	**6.02E-08**	**2.0E-09 - 1.0E-06**		
Hazard quotient from vapor intrusion	**(-)**	**HQ**	**6.74E-05**	**2.2E-06 - 1.1E-03**	**6.74E-05**	**2.2E-06 - 1.1E-03**		

Table I.1-4
Johnson and Ettinger Model Input and Output
Current and Future Industrial Scenario - Trichloroethene (Main Building)
Shakespeare Composite Structures Site
Newberry, South Carolina

Preview	Unit	Value	Range	Default	Default Range
Soil gas to indoor air attenuation coefficient	(-)	3.0E-03	1.0E-04 - 5.0E-02	0.0030	1.0E-04 - 5.0E-02
Predicted indoor air concentration due to vapor intrusion	(ug/m3)	6.9E-01	2.3E-02 - 1.2E+01	6.9E-01	2.3E-02 - 1.2E+01
Please check WARNING or ERROR flags	(ppbv)	1.3E-01	4.3E-03 - 2.2E+00	1.3E-01	4.3E-03 - 2.2E+00

Model Input

Site Name/Run Number: Example, Run 1

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Source medium		Source	Sub-slab Soil Gas					
Soil gas concentration	(ug/m3)	Cmedium	231.47		NA			
Depth below grade to soil gas sample	(m)	Ls	0.30		Vary - 50	NA		
Average vadose zone temperature	(^{o}C)	Ts	17	25	3-30			
Calc: Source vapor concentration	(ug/m3)	Cs	231					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.000%					

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Trichloroethylene					
CAS No.		CAS	79-01-6					
Toxicity Factors								
Unit risk factor	$(ug/m^3)^{-1}$	IUR	see note	see note	NA	NA		
Mutagenic compound		Mut	Yes	NA	NA	NA		
Reference concentration	(mg/m^3)	RfC	2.00E-03	2.00E-03	NA	NA		

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	1.28E+03	1.28E+03	NA	NA		
Henry's Law Constant @ 25^{o}C	(atm-m^3/mol)	Hc	9.85E-03	9.85E-03	NA	NA		
Calc: Henry's Law Constant @ 25^{o}C	(dimensionless)	Hr	4.03E-01	4.03E-01				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	2.79E-01	4.14E-01				
Diffusivity in air	(cm2/s)	Dair	6.87E-02	6.87E-02	NA	NA		
Diffusivity in water	(cm2/s)	Dwater	1.02E-05	1.02E-05	NA	NA		

Table I.1-4
Johnson and Ettinger Model Input and Output
Current and Future Industrial Scenario - Trichloroethene (Main Building)
Shakespeare Composite Structures Site
Newberry, South Carolina

Building Characteristics:

Select Building Assumptions

- (●) Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
- ( ) Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Building setting		Bldg_Setting	Commercial	Commercial				
Foundation type		Found_Type	Slab-on-grade	Slab-on-grade				
Depth below grade to base of foundation	(m)	Lb	0.20	0.20	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.20	0.20	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	0.001	0.001	0.00019-0.0019	1.00		
Enclosed space floor area	(m2)	Abf	7800.00	1500.00	80-1000	NA	WARNING	Value is outside of reasonable range (80 - 200 m2).
Enclosed space mixing height	(m)	Hb	5.00	3.00	2.13 - 3.05	NA	WARNING	Value is outside of reasonable range (2.13 – 3.05 m).
Indoor air exchange rate	(1 / hr)	ach	1.50	1.50	.3-4.1	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24		
Calc: Building ventilation rate	(m3/hr)	Qb	58500.00	6750.00	NA	0.30		
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	175.50	20.25	NA	NA		

Table I.1-4
Johnson and Ettinger Model Input and Output
Current and Future Industrial Scenario - Trichloroethene (Main Building)
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Input **Site Name/Run Number:** Example, Run 1
Chemical Name: Trichloroethylene CAS No. 79-01-6
Depth below grade to soil gas sample: 0.30 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sandy Clay					
Stratum A thickness (from surface)	(m)	hSA	0.30					
Stratum A total porosity	(-)	nSA	0.385	0.385	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.197	0.197	0.117 - 0.28	0.25		
Stratum A bulk density	(g/cm^3)	rhoSA	1.630	1.630	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm^3)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA		
Stratum containing soil gas sample								
Stratum A, B, or C		src_soil	Stratum A					
					NA	NA		
					NA			
					NA			

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA		
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA		
Exposure Scenario		Scenario	Commercial	Commercial				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	25	25	NA	NA		
Exposure duration	(yrs)	ED	25	25	NA	NA		
Exposure frequency	(days/yr)	EF	250	250	NA	NA		
Exposure time	(hrs/24 hrs)	ET	8	8	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA		MMOAF used in place of ED in risk calculations

Table I.1-4
Johnson and Ettinger Model Input and Output
Current and Future Industrial Scenario - Trichloroethene (Main Building)
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Output **Site Name/Run Number:** Example, Run 1

Chemical Name: Trichloroethylene **CAS No. 79-01-6**

Range is based on the reasonable range of Qsoil/Qbuilding values, as reported in the literature.

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Soil gas to indoor air attenuation coefficient	**(-)**	**alpha**	**3.0E-03**	1.0E-04 - 5.0E-02	**3.0E-03**	1.0E-04 - 5.0E-02	WARNING	Please review warning messages

Predicted Indoor Air Concentration	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Indoor air concentration due to vapor intrusion	(ug/m3)	**Cia**	**6.9E-01**	2.3E-02 - 1.2E+01	**6.9E-01**	2.3E-02 - 1.2E+01		
	(ppbv)		**1.3E-01**	4.3E-03 - 2.2E+00	**1.3E-01**	4.3E-03 - 2.2E+00	WARNING	Please review warning messages

Predicted Vapor Conc. Beneath Foundation	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Subslab vapor concentration	(ug/m3)	**Css**	**2.3E+02**	2.3E+02 - 2.3E+02	**2.3E+02**	2.3E+02 - 1.2E+05		
	(ppbv)		**4.3E+01**	4.3E+01 - 4.3E+01	**4.3E+01**	4.3E+01 - 2.2E+04		

Diffusive Transport Upward Through Vadose Zone	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	1.8E-03	-	1.8E-03	-		
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB		-		-		
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-		
				-		-		
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	1.8E-03	-	1.8E-03	-		

Critical Parameters		Symbol	Value	Range	Default	Default Range	Flag
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	8.6E-04	-	1.4E-03		
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	7.0E+03	2.3E+02 - 1.2E+05	4.1E+03	1.4E+02 - 6.9E+04	
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02	

Interpretation

Advection is the dominant mechanism across the foundation.
Diffusion through soil and advection through foundation both control intrusic

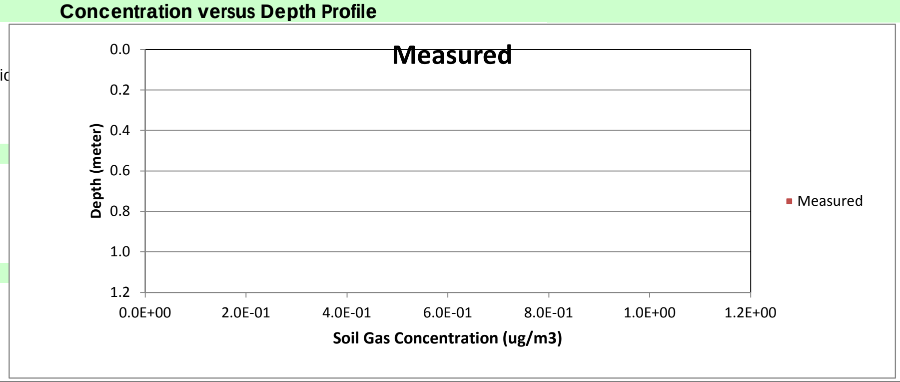
Critical Parameters

Hb, Ls, DeffT, ach, Qsoil_Qb

Non-Critical Parameters

Lf, DeffA, eta

Concentration versus Depth Profile



Please check WARNING or ERROR flags

Table I.1-4
Johnson and Ettinger Model Input and Output
Current and Future Industrial Scenario - Trichloroethene (Main Building)
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Output

Site Name/Run Number: Example, Run 1

Chemical Name: Trichloroethylene **CAS No. 79-01-6**

Risk Calculations	Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels	**Scenario: Commercial**							
Target risk for carcinogens	(-)	Target_CR	1E-06	-	1E-06	-		
Target hazard quotient for noncarcinogens	(-)	Target_HQ	1	-	1	-		
Target indoor air concentration	**(ug/m3)**	**Target_IA**	**2.05E+00**	-	**2.05E+00**	-	Target indoor air concentration based on both cancer risk and non-cancer toxicity	
	(ppbv)		**3.82E-01**	-	**3.82E-01**	-		
Target soil gas concentration	**(ug/m3)**	**Target_SV**	**6.84E+02**	**4.1E+01 - 2.1E+04**	**6.84E+02**	**4.1E+01 - 2.1E+04**		
Incremental Risk Estimates								
Incremental cancer risk from vapor intrusion	**(-)**	**Cancer_Risk**	**9.01E-07**	**3.0E-08 - 1.5E-05**	**9.01E-07**	**3.0E-08 - 1.5E-05**		
Hazard quotient from vapor intrusion	**(-)**	**HQ**	**7.93E-02**	**2.6E-03 - 1.3E+00**	**7.93E-02**	**2.6E-03 - 1.3E+00**		

Table I.1-5
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Chloroform
Shakespeare Composite Structures Site
Newberry, South Carolina

Preview	Unit	Value	Range	Default	Default Range
Groundwater to indoor air attenuation coefficient	(-)	3.6E-05	3.6E-05 - 3.6E-05	0.0001	5.1E-05 - 5.1E-05
Predicted indoor air concentration due to vapor intrusion	(ug/m3)	9.5E-03	9.5E-03 - 9.5E-03	1.4E-02	1.4E-02 - 1.4E-02
Please check WARNING or ERROR flags	(ppbv)	1.9E-03	1.9E-03 - 1.9E-03	2.8E-03	1.9E-03 - 1.9E-03

Model Input

Site Name/Run Number: Example, Run 1

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Source medium		Source	Groundwater					
Groundwater concentration	(ug/L)	Cmedium	2.438		NA			
Depth below grade to water table	(m)	Ls	2.44		Vary - 50	NA		
Average groundwater temperature	(°C)	Ts	17	25	3 - 25			
Calc: Source vapor concentration	(ug/m3)	Cs	265					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.000%					

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Chloroform					
CAS No.		CAS	67-66-3					
Toxicity Factors								
Unit risk factor	$(ug/m^3)^{-1}$	IUR	2.30E-05	2.30E-05	NA	NA		
Mutagenic compound		Mut	No	NA	NA	NA		
Reference concentration	(mg/m^3)	RfC	9.80E-02	9.80E-02	NA	NA		

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	7.95E+03	7.95E+03	NA	NA		
Henry's Law Constant @ 25°C	$(atm\text{-}m^3/mol)$	Hc	3.67E-03	3.67E-03	NA	NA		
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	1.50E-01	1.50E-01				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	1.09E-01	1.54E-01				
Diffusivity in air	(cm2/s)	Dair	7.69E-02	7.69E-02	NA	NA		
Diffusivity in water	(cm2/s)	Dwater	1.09E-05	1.09E-05	NA	NA		

Table I.1-5
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Chloroform
Shakespeare Composite Structures Site
Newberry, South Carolina

Building Characteristics:

Select Building Assumptions

- (●) Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
- ( ) Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Building setting		Bldg_Setting	Residential	Residential				
Foundation type		Found_Type	Closed crawl space w/ dirt floor	Closed crawl space w/ dirt floor				
Depth below grade to base of foundation	(m)	Lb	1.00	1.00	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.00	0.00	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	1.000	1.000	NA	1.00		
Enclosed space floor area	(m2)	Abf	150.00	150.00	80 - 200	NA		
Enclosed space mixing height	(m)	Hb	2.44	1.30	0.5 - 1.30	NA	WARNING	Value is different from default value; please justify.
Indoor air exchange rate	(1 / hr)	ach	0.45	0.45	.15-1.26	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24		
Calc: Building ventilation rate	(m3/hr)	Qb	164.70	87.75	NA	0.30		
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	NA	NA	NA	NA		

Table I.1-5
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Chloroform
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Input   **Site Name/Run Number:** Example, Run 1
Chemical Name: Chloroform CAS No. 67-66-3
Depth below grade to water table: 2.44 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sandy Clay					
Stratum A thickness (from surface)	(m)	hSA	2.44					
Stratum A total porosity	(-)	nSA	0.385	0.385	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.197	0.197	0.117 - 0.28	0.25		
Stratum A bulk density	(g/cm^3)	rhoSA	1.630	1.630	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm^3)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA		
Stratum directly above the water table								
Stratum A, B, or C		src_soil	Stratum A					
Height of capillary fringe	(m)	hcz	0.300	0.300	NA	NA		
Capillary zone total porosity	(-)	ncz	0.385	0.385	NA	0.20		
Capillary zone water filled porosity	(-)	nwcz	0.355	0.355	NA	0.13		

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA		
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA		
Exposure Scenario		Scenario	Residential	Residential				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	26	26	NA	NA		
Exposure duration	(yrs)	ED	26	26	NA	NA		
Exposure frequency	(days/yr)	EF	350	350	NA	NA		
Exposure time	(hrs/24 hrs)	ET	24	24	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA	NOTE	MMOAF not relevant for non-mutagenic compounds

Table I.1-5
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Chloroform
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Output

Site Name/Run Number: Example, Run 1

Range is based on the reasonable range of Qsoil/Qbuilding values, as reported in the literature.

Chemical Name: Chloroform CAS No. 67-66-3

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Groundwater to indoor air attenuation coefficient	**(-)**	**alpha**	**3.6E-05**	3.6E-05 - 3.6E-05	**5.1E-05**	5.1E-05 - 5.1E-05	WARNING	Please review warning messages

Predicted Indoor Air Concentration	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Indoor air concentration due to vapor intrusion	(ug/m3)	**Cia**	**9.5E-03**	9.5E-03 - 9.5E-03	**1.4E-02**	1.4E-02 - 1.4E-02		
	(ppbv)		**1.9E-03**	1.9E-03 - 1.9E-03	**2.8E-03**	2.8E-03 - 2.8E-03	WARNING	Please review warning messages

Predicted Vapor Conc. Beneath Foundation	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Subslab vapor concentration	(ug/m3)	**Css**	**NA**	NA - NA	**NA**	NA - NA		
	(ppbv)		**0.0E+00**	0.0E+00 - 0.0E+00	**0.0E+00**	0.0E+00 - 0.0E+00		

Diffusive Transport Upward Through Vadose Zone	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	2.0E-03	-	2.0E-03	-		
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB		-		-		
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-		
Effective diffusion coefficient through capillary zone	(cm2/sec)	DeffCZ	2.6E-05	-	2.0E-05	-		
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	1.2E-04	-	9.1E-05	-		

Critical Parameters		Symbol	Value	Range	Default	Default Range	Flag
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	3.6E-05	-	5.1E-05		
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	0.0E+00	0.0E+00 - 0.0E+00	0.0E+00	0.0E+00 - 0.0E+00	
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02	

Interpretation

Diffusion is the dominant mechanism across the foundation.

Diffusion through soil is the overall rate limiting process.

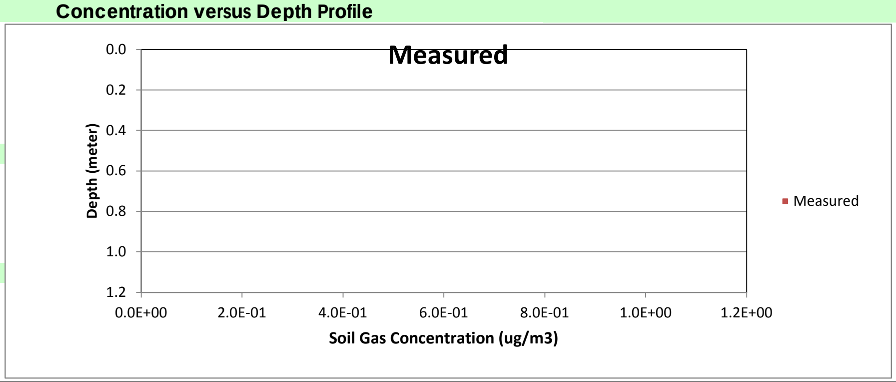
Critical Parameters

Hb, Ls, DeffT, ach

Non-Critical Parameters

Qsoil_Qb, Lf, DeffA, eta

Concentration versus Depth Profile



Please check WARNING or ERROR flags

Table I.1-5
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Chloroform
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Output Site Name/Run Number: Example, Run 1

Chemical Name: Chloroform CAS No. 67-66-3

Risk Calculations	Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels — Scenario: Residential								
Target risk for carcinogens	(-)	Target_CR	1E-06	-	1E-06	-		
Target hazard quotient for noncarcinogens	(-)	Target_HQ	1	-	1	-		
Target indoor air concentration	(ug/m3)	Target_IA	1.22E-01	-	1.22E-01	-	Target indoor air concentration based on cancer risk (unit risk factor)	
	(ppbv)		2.50E-02	-	2.50E-02	-		
Target groundwater concentration	(ug/L)	Target_GW	3.13E+01	3.1E+01 - 3.1E+01	1.54E+01	2.2E+01 - 2.2E+01		
Incremental Risk Estimates								
Incremental cancer risk from vapor intrusion	(-)	Cancer_Risk	7.79E-08	7.8E-08 - 7.8E-08	1.12E-07	1.1E-07 - 1.1E-07		
Hazard quotient from vapor intrusion	(-)	HQ	9.30E-05	9.3E-05 - 9.3E-05	1.34E-04	1.3E-04 - 1.3E-04		

Table I.1-6
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Trichloroethene
Shakespeare Composite Structures Site
Newberry, South Carolina

Preview	Unit	Value	Range	Default	Default Range
Groundwater to indoor air attenuation coefficient	(-)	1.7E-05	1.7E-05 - 1.7E-05	0.0000	2.5E-05 - 2.5E-05
Predicted indoor air concentration due to vapor intrusion	(ug/m3)	1.8E+00	1.8E+00 - 1.8E+00	2.7E+00	2.7E+00 - 2.7E+00
Please check WARNING or ERROR flags	(ppbv)	3.4E-01	3.4E-01 - 3.4E-01	5.0E-01	3.4E-01 - 3.4E-01

Model Input

Site Name/Run Number: Example, Run 1

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Source medium		Source	Groundwater					
Groundwater concentration	(ug/L)	Cmedium	390.9		NA			
Depth below grade to water table	(m)	Ls	2.44		Vary - 50	NA		
Average groundwater temperature	(°C)	Ts	17	25	3 - 25			
Calc: Source vapor concentration	(ug/m3)	Cs	109058					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.022%					

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Trichloroethylene					
CAS No.		CAS	79-01-6					
Toxicity Factors								
Unit risk factor	$(ug/m^3)^{-1}$	IUR	see note	see note	NA	NA		
Mutagenic compound		Mut	Yes	NA	NA	NA		
Reference concentration	(mg/m^3)	RfC	2.00E-03	2.00E-03	NA	NA		

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	1.28E+03	1.28E+03	NA	NA		
Henry's Law Constant @ 25°C	$(atm\text{-}m^3/mol)$	Hc	9.85E-03	9.85E-03	NA	NA		
Calc: Henry's Law Constant @ 25°C	(dimensionless)	Hr	4.03E-01	4.03E-01				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	2.79E-01	4.14E-01				
Diffusivity in air	(cm2/s)	Dair	6.87E-02	6.87E-02	NA	NA		
Diffusivity in water	(cm2/s)	Dwater	1.02E-05	1.02E-05	NA	NA		

Table I.1-6
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Trichloroethene
Shakespeare Composite Structures Site
Newberry, South Carolina

Building Characteristics:

Select Building Assumptions
- (●) Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
- (○) Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Building setting		Bldg_Setting	Residential	Residential				
Foundation type		Found_Type	Closed crawl space w/ dirt floor	Closed crawl space w/ dirt floor				
Depth below grade to base of foundation	(m)	Lb	1.00	1.00	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.00	0.00	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	1.000	1.000	NA	1.00		
Enclosed space floor area	(m2)	Abf	150.00	150.00	80 - 200	NA		
Enclosed space mixing height	(m)	Hb	2.44	1.30	0.5 - 1.30	NA	WARNING	Value is different from default value; please justify.
Indoor air exchange rate	(1 / hr)	ach	0.45	0.45	.15-1.26	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24		
Calc: Building ventilation rate	(m3/hr)	Qb	164.70	87.75	NA	0.30		
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	NA	NA	NA	NA		

Table I.1-6
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Trichloroethene
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Input **Site Name/Run Number:** Example, Run 1
Chemical Name: Trichloroethylene CAS No. 79-01-6
Depth below grade to water table: 2.44 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sandy Clay					
Stratum A thickness (from surface)	(m)	hSA	2.44					
Stratum A total porosity	(-)	nSA	0.385	0.385	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.197	0.197	0.117 - 0.28	0.25		
Stratum A bulk density	(g/cm^3)	rhoSA	1.630	1.630	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm^3)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA		
Stratum directly above the water table								
Stratum A, B, or C		src_soil	Stratum A					
Height of capillary fringe	(m)	hcz	0.300	0.300	NA	NA		
Capillary zone total porosity	(-)	ncz	0.385	0.385	NA	0.20		
Capillary zone water filled porosity	(-)	nwcz	0.355	0.355	NA	0.13		

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA		
Target hazard quotient for non-carcinogens	(-)	Target_HQ	0.1	1	NA	NA	WARNING	Value is different from default value; please justify.
Exposure Scenario		Scenario	Residential	Residential				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	26	26	NA	NA		
Exposure duration	(yrs)	ED	26	26	NA	NA		
Exposure frequency	(days/yr)	EF	350	350	NA	NA		
Exposure time	(hrs/24 hrs)	ET	24	24	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA		MMOAF used in place of ED in risk calculations

Table I.1-6
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Trichloroethene
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Output — **Site Name/Run Number:** Example, Run 1

Range is based on the reasonable range of Qsoil/Qbuilding values, as reported in the literature.

Chemical Name: Trichloroethylene **CAS No. 79-01-6**

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Groundwater to indoor air attenuation coefficient	**(-)**	**alpha**	**1.7E-05**	1.7E-05 - 1.7E-05	**2.5E-05**	2.5E-05 - 2.5E-05	WARNING	Please review warning messages

Predicted Indoor Air Concentration	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Indoor air concentration due to vapor intrusion	(ug/m3)	**Cia**	**1.8E+00**	1.8E+00 - 1.8E+00	**2.7E+00**	2.7E+00 - 2.7E+00		
	(ppbv)		**3.4E-01**	3.4E-01 - 3.4E-01	**5.0E-01**	5.0E-01 - 5.0E-01	WARNING	Please review warning messages

Predicted Vapor Conc. Beneath Foundation	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Subslab vapor concentration	(ug/m3)	**Css**	**NA**	NA - NA	**NA**	NA - NA		
	(ppbv)		**0.0E+00**	0.0E+00 - 0.0E+00	**0.0E+00**	0.0E+00 - 0.0E+00		

Diffusive Transport Upward Through Vadose Zone	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	1.8E-03	-	1.8E-03	-		
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB		-		-		
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-		
Effective diffusion coefficient through capillary zone	(cm2/sec)	DeffCZ	1.2E-05	-	9.3E-06	-		
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	5.5E-05	-	4.4E-05	-		

Critical Parameters		Symbol	Value	Range	Default	Default Range	Flag
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	1.7E-05	-	2.5E-05		
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	0.0E+00	0.0E+00 - 0.0E+00	0.0E+00	0.0E+00 - 0.0E+00	
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02	

Interpretation

Diffusion is the dominant mechanism across the foundation.

Diffusion through soil is the overall rate limiting process.

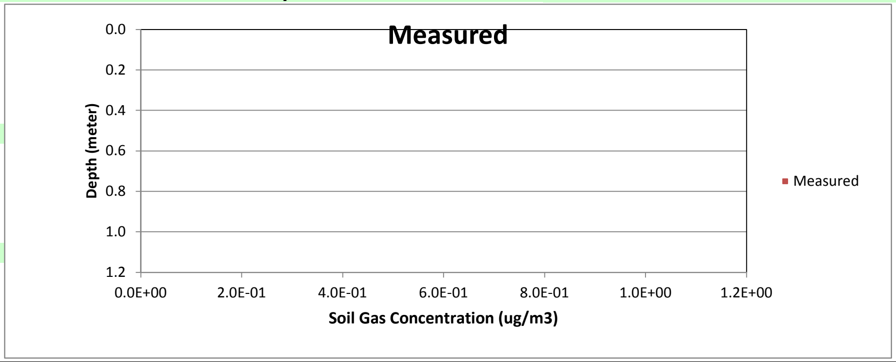
Critical Parameters

Hb, Ls, DeffT, ach

Non-Critical Parameters

Qsoil_Qb, Lf, DeffA, eta

Concentration versus Depth Profile



Please check WARNING or ERROR flags

Table I.1-6
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Trichloroethene
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Output

Site Name/Run Number: Example, Run 1

Chemical Name: Trichloroethylene **CAS No. 79-01-6**

Risk Calculations	Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels	**Scenario: Residential**							
Target risk for carcinogens	(-)	Target_CR	1E-06	-	1E-06	-		
Target hazard quotient for noncarcinogens	(-)	Target_HQ	0.1	-	1	-		
Target indoor air concentration	**(ug/m3)**	**Target_IA**	**4.78E-01**	-	**4.78E-01**	-	Target indoor air concentration based on both cancer risk and non-cancer toxicity	
	(ppbv)		**8.91E-02**	-	**8.91E-02**	-		
Target groundwater concentration	**(ug/L)**	**Target_GW**	**1.03E+02**	**1.0E+02 - 1.0E+02**	**4.67E+01**	**6.9E+01 - 6.9E+01**		
Incremental Risk Estimates								
Incremental cancer risk from vapor intrusion	**(-)**	**Cancer_Risk**	**3.81E-06**	**3.8E-06 - 3.8E-06**	**5.64E-06**	**5.6E-06 - 5.6E-06**		
Hazard quotient from vapor intrusion	**(-)**	**HQ**	**8.75E-01**	**8.7E-01 - 8.7E-01**	**1.29E+00**	**1.3E+00 - 1.3E+00**		

Table I.1-7
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Vinyl Chloride
Shakespeare Composite Structures Site
Newberry, South Carolina

Preview	Unit	Value	Range	Default	Default Range
Groundwater to indoor air attenuation coefficient	(-)	1.3E-05	1.3E-05 - 1.3E-05	0.0000	2.3E-05 - 2.3E-05
Predicted indoor air concentration due to vapor intrusion	(ug/m3)	3.9E-02	3.9E-02 - 3.9E-02	6.8E-02	6.8E-02 - 6.8E-02
Please check WARNING or ERROR flags	(ppbv)	1.5E-02	1.5E-02 - 1.5E-02	2.7E-02	1.5E-02 - 1.5E-02

Model Input

Site Name/Run Number: Example, Run 1

Note:
-Yellow highlighted cells indicate parameters that typically are changed or must be inputted by the user.
-Dotted outline cells indicate default values that may be changed with justification.
-Toxicity values are taken from Regional Screening Level tables. These tables are updated semi-annually and may not reflect the most current toxicity information.

Use English / Metric Converter

Source Characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Source medium		Source	Groundwater					
Groundwater concentration	(ug/L)	Cmedium	3.233		NA			
Depth below grade to water table	(m)	Ls	2.44		Vary - 50	NA		
Average groundwater temperature	(^{o}C)	Ts	17	25	3 - 25			
Calc: Source vapor concentration	(ug/m3)	Cs	3002					
Calc: % of pure component saturated vapor concentration	(%)	%Sat	0.000%					

Chemical:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Chemical Name		Chem	Vinyl Chloride					
CAS No.		CAS	75-01-4					
Toxicity Factors								
Unit risk factor	(ug/m^3)$^{-1}$	IUR	4.40E-06	4.40E-06	NA	NA		
Mutagenic compound		Mut	VC	NA	NA	NA		
Reference concentration	(mg/m^3)	RfC	1.00E-01	1.00E-01	NA	NA		

Chemical Properties:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Pure component water solubility	(mg/L)	S	8.80E+03	8.80E+03	NA	NA		
Henry's Law Constant @ 25^{o}C	(atm-m^3/mol)	Hc	2.78E-02	2.78E-02	NA	NA		
Calc: Henry's Law Constant @ 25^{o}C	(dimensionless)	Hr	1.14E+00	1.14E+00				
Calc: Henry's Law Constant @ system temperature	(dimensionless)	Hs	9.29E-01	1.17E+00				
Diffusivity in air	(cm2/s)	Dair	1.07E-01	1.07E-01	NA	NA		
Diffusivity in water	(cm2/s)	Dwater	1.20E-05	1.20E-05	NA	NA		

Table I.1-7
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Vinyl Chloride
Shakespeare Composite Structures Site
Newberry, South Carolina

Building Characteristics:

Select Building Assumptions

- (●) Use ratio for Qsoil/Qbuilding (recommended if no site specific data available)
- ( ) Specify Qsoil and Qbuilding separately; calculate ratio

	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Building setting		Bldg_Setting	Residential	Residential				
Foundation type		Found_Type	Closed crawl space w/ dirt floor	Closed crawl space w/ dirt floor				
Depth below grade to base of foundation	(m)	Lb	1.00	1.00	0.1 - 2.44	NA		
Foundation thickness	(m)	Lf	0.00	0.00	0.1 - 0.25	NA		
Fraction of foundation area with cracks	(-)	eta	1.000	1.000	NA	1.00		
Enclosed space floor area	(m2)	Abf	150.00	150.00	80 - 200	NA		
Enclosed space mixing height	(m)	Hb	2.44	1.30	0.5 - 1.30	NA	WARNING	Value is different from default value; please justify.
Indoor air exchange rate	(1 / hr)	ach	0.45	0.45	.15-1.26	NA		
Qsoil/Qbuilding	(-)	Qsoil_Qb	0.0030	0.0030	0.0001 - 0.05	1.24		
Calc: Building ventilation rate	(m3/hr)	Qb	164.70	87.75	NA	0.30		
Calc: Average vapor flow rate into building	(m3/hr)	Qsoil	NA	NA	NA	NA		

Table I.1-7
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Vinyl Chloride
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Input — **Site Name/Run Number:** Example, Run 1

Chemical Name: Vinyl Chloride CAS No. 75-01-4

Depth below grade to water table: 2.44 meters

Vadose zone characteristics:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Stratum A (Top of soil profile):								
Stratum A SCS soil type		SCS_A	Sandy Clay					
Stratum A thickness (from surface)	(m)	hSA	2.44					
Stratum A total porosity	(-)	nSA	0.385	0.385	NA	0.20		
Stratum A water-filled porosity	(-)	nwSA	0.197	0.197	0.117 - 0.28	0.25		
Stratum A bulk density	(g/cm^3)	rhoSA	1.630	1.630	NA	0.05		
Stratum B (Soil layer below Stratum A):								
Stratum B SCS soil type		SCS_B	Not Present					
Stratum B thickness	(m)	hSB	0.00					
Stratum B total porosity	(-)	nSB			NA	NA		
Stratum B water-filled porosity	(-)	nwSB			NA	NA		
Stratum B bulk density	(g/cm^3)	rhoSB			NA	NA		
Stratum C (Soil layer below Stratum B):								
Stratum C SCS soil type		SCS_C	Not Present					
Stratum C thickness	(m)	hSC	0.00					
Stratum C total porosity	(-)	nSC			NA	NA		
Stratum C water-filled porosity	(-)	nwSC			NA	NA		
Stratum C bulk density	(g/cm^3)	rhoSC			NA	NA		
Stratum directly above the water table								
Stratum A, B, or C		src_soil	Stratum A					
Height of capillary fringe	(m)	hcz	0.300	0.300	NA	NA		
Capillary zone total porosity	(-)	ncz	0.385	0.385	NA	0.20		
Capillary zone water filled porosity	(-)	nwcz	0.355	0.355	NA	0.13		

Exposure Parameters:	Units	Symbol	Value	Default	Potential Span	CV	Flag	Comment
Target risk for carcinogens	(-)	Target_CR	1.00E-06	1.00E-06	NA	NA		
Target hazard quotient for non-carcinogens	(-)	Target_HQ	1	1	NA	NA		
Exposure Scenario		Scenario	Residential	Residential				
Averaging time for carcinogens	(yrs)	ATc	70	70	NA	NA		
Averaging time for non-carcinogens	(yrs)	ATnc	26	26	NA	NA		
Exposure duration	(yrs)	ED	26	26	NA	NA		
Exposure frequency	(days/yr)	EF	350	350	NA	NA		
Exposure time	(hrs/24 hrs)	ET	24	24	NA	NA		
Mutagenic mode-of-action factor	(yrs)	MMOAF	72	72	NA	NA		MMOAF used in place of ED in risk calculations

Table I.1-7
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Vinyl Chloride
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Output **Site Name/Run Number:** Example, Run 1

Range is based on the reasonable range of Qsoil/Qbuilding values, as reported in the literature.

Chemical Name: Vinyl Chloride CAS No. 75-01-4

Source to Indoor Air Attenuation Factor	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Groundwater to indoor air attenuation coefficient	**(-)**	**alpha**	**1.3E-05**	1.3E-05 - 1.3E-05	**2.3E-05**	2.3E-05 - 2.3E-05	WARNING	Please review warning messages

Predicted Indoor Air Concentration	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Indoor air concentration due to vapor intrusion	(ug/m3)	**Cia**	**3.9E-02**	3.9E-02 - 3.9E-02	**6.8E-02**	6.8E-02 - 6.8E-02		
	(ppbv)		**1.5E-02**	1.5E-02 - 1.5E-02	**2.7E-02**	2.7E-02 - 2.7E-02	WARNING	Please review warning messages

Predicted Vapor Conc. Beneath Foundation	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Subslab vapor concentration	(ug/m3)	**Css**	**NA**	NA - NA	**NA**	NA - NA		
	(ppbv)		**0.0E+00**	0.0E+00 - 0.0E+00	**0.0E+00**	0.0E+00 - 0.0E+00		

Diffusive Transport Upward Through Vadose Zone	Units	Symbol	Value	Range	Default	Default Range	Flag	Comment
Effective diffusion coefficient through Stratum A	(cm2/sec)	DeffA	2.8E-03	-	2.8E-03	-		
Effective diffusion coefficient through Stratum B	(cm2/sec)	DeffB		-		-		
Effective diffusion coefficient through Stratum C	(cm2/sec)	DeffC		-		-		
Effective diffusion coefficient through capillary zone	(cm2/sec)	DeffCZ	9.0E-06	-	8.4E-06	-		
Effective diffusion coefficient through unsaturated zone	(cm2/sec)	DeffT	4.3E-05	-	4.0E-05	-		

Critical Parameters		Symbol	Value	Range	Default	Default Range	Flag
α for diffusive transport from source to building with dirt floor foundation	(-)	A_Param	1.3E-05	-	2.3E-05		
Pe (Peclet Number) for transport through the foundation (advection / diffusion)	(-)	B_Param	0.0E+00	0.0E+00 - 0.0E+00	0.0E+00	0.0E+00 - 0.0E+00	
α for convective transport from subslab to building	(-)	C_Param	3.0E-03	1.0E-04 - 5.0E-02	3.0E-03	1.0E-04 - 5.0E-02	

Interpretation

Diffusion is the dominant mechanism across the foundation.

Diffusion through soil is the overall rate limiting process.

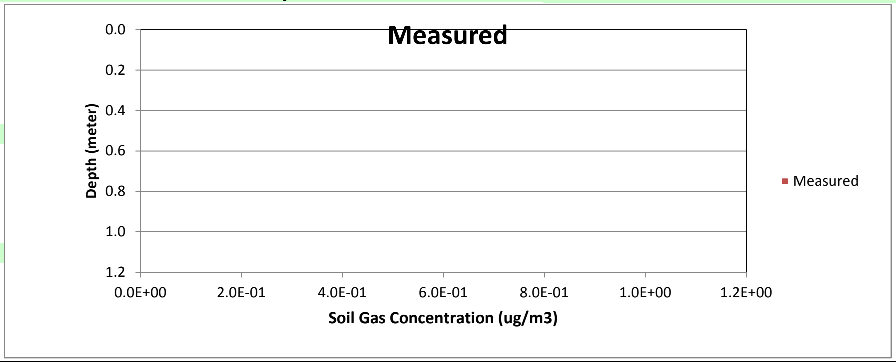
Critical Parameters

Hb, Ls, DeffT, ach

Non-Critical Parameters

Qsoil_Qb, Lf, DeffA, eta

Concentration versus Depth Profile



Please check WARNING or ERROR flags

Table I.1-7
Johnson and Ettinger Model Input and Output
Future Residential Scenario - Vinyl Chloride
Shakespeare Composite Structures Site
Newberry, South Carolina

Model Output Site Name/Run Number: Example, Run 1

Chemical Name: Vinyl Chloride CAS No. 75-01-4

Risk Calculations	Units	Symbol	Value	Range	Default	Range	Flag	Comment
Risk-Based Target Screening Levels Scenario: Residential								
Target risk for carcinogens	(-)	Target_CR	1E-06	-	1E-06	-		
Target hazard quotient for noncarcinogens	(-)	Target_HQ	1	-	1	-		
Target indoor air concentration	**(ug/m3)**	**Target_IA**	**1.68E-01**	-	**1.68E-01**	-	Target indoor air concentration based on cancer risk (unit risk factor)	
	(ppbv)		**6.56E-02**	-	**6.56E-02**	-		
Target groundwater concentration	**(ug/L)**	**Target_GW**	**1.40E+01**	**1.4E+01 - 1.4E+01**	**6.32E+00**	**7.9E+00 - 7.9E+00**		
Incremental Risk Estimates								
Incremental cancer risk from vapor intrusion	**(-)**	**Cancer_Risk**	**2.31E-07**	**2.3E-07 - 2.3E-07**	**4.07E-07**	**4.1E-07 - 4.1E-07**		
Hazard quotient from vapor intrusion	**(-)**	**HQ**	**3.71E-04**	**3.7E-04 - 3.7E-04**	**6.54E-04**	**6.5E-04 - 6.5E-04**		

Appendix IA.2 ProUCL Output

Appendix I.2
Human Health ProUCL Output
Shallow/Intermediate Groundwater
Shakespeare Composite Structures Site
Newberry, South Carolina

UCL Statistics for Data Sets with Non-Detects

User Selected Options	
Date/Time of Computation	ProUCL 5.15/17/2018 4:42:30 PM
From File	For ProUCL Shallow.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Benzene

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	0.49	Mean	0.577
Maximum	0.66	Median	0.58
SD	0.085	Std. Error of Mean	0.0491
Coefficient of Variation	0.147	Skewness	-0.176

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.999	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.182	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	0.72	95% Adjusted-CLT UCL (Chen-1995)	0.652
		95% Modified-t UCL (Johnson-1978)	0.719

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	67.98	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.00848	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	407.9	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.994	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.202	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.713	Mean of logged Data	-0.558
Maximum of Logged Data	-0.416	SD of logged Data	0.149

Assuming Lognormal Distribution

95% H-UCL	0.793	90% Chebyshev (MVUE) UCL	0.725
95% Chebyshev (MVUE) UCL	0.793	97.5% Chebyshev (MVUE) UCL	0.886
99% Chebyshev (MVUE) UCL	1.07		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	0.657	95% Jackknife UCL	0.72
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	0.724	95% Chebyshev(Mean, Sd) UCL	0.791
97.5% Chebyshev(Mean, Sd) UCL	0.883	99% Chebyshev(Mean, Sd) UCL	1.065

Suggested UCL to Use

95% Student's-t UCL	0.72

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

Chloroform

General Statistics

Total Number of Observations	8	Number of Distinct Observations	8
		Number of Missing Observations	0
Minimum	0.54	Mean	2.438
Maximum	5.7	Median	2.1
SD	1.677	Std. Error of Mean	0.593
Coefficient of Variation	0.688	Skewness	0.971

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.925	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.818	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.181	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.283	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		95% UCLs (Adjusted for Skewness)	
95% Student's-t UCL	3.561	95% Adjusted-CLT UCL (Chen-1995)	3.63
		95% Modified-t UCL (Johnson-1978)	3.594

Gamma GOF Test

A-D Test Statistic	0.204	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.723	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.14	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.297	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	2.248	k star (bias corrected MLE)	1.489
Theta hat (MLE)	1.084	Theta star (bias corrected MLE)	1.638
nu hat (MLE)	35.97	nu star (bias corrected)	23.82
MLE Mean (bias corrected)	2.438	MLE Sd (bias corrected)	1.998
		Approximate Chi Square Value (0.05)	13.71
Adjusted Level of Significance	0.0195	Adjusted Chi Square Value	11.81

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	4.235	95% Adjusted Gamma UCL (use when n<50)	4.913

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.954	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.818	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.158	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.283	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.616	Mean of logged Data	0.652
Maximum of Logged Data	1.74	SD of logged Data	0.786

Assuming Lognormal Distribution

95% H-UCL	6.229	90% Chebyshev (MVUE) UCL	4.617
95% Chebyshev (MVUE) UCL	5.578	97.5% Chebyshev (MVUE) UCL	6.91
99% Chebyshev (MVUE) UCL	9.529		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	3.413	95% Jackknife UCL	3.561
95% Standard Bootstrap UCL	3.386	95% Bootstrap-t UCL	3.892
95% Hall's Bootstrap UCL	4.084	95% Percentile Bootstrap UCL	3.413
95% BCA Bootstrap UCL	3.57		
90% Chebyshev(Mean, Sd) UCL	4.216	95% Chebyshev(Mean, Sd) UCL	5.021
97.5% Chebyshev(Mean, Sd) UCL	6.139	99% Chebyshev(Mean, Sd) UCL	8.336

Suggested UCL to Use

95% Student's-t UCL	3.561

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

cis-1,2-Dichloroethene

General Statistics

Total Number of Observations	27	Number of Distinct Observations	18
Number of Detects	16	Number of Non-Detects	11
Number of Distinct Detects	16	Number of Distinct Non-Detects	2
Minimum Detect	1.2	Minimum Non-Detect	5
Maximum Detect	530	Maximum Non-Detect	25
Variance Detects	17013	Percent Non-Detects	40.74%
Mean Detects	60.08	SD Detects	130.4
Median Detects	11.5	CV Detects	2.171
Skewness Detects	3.531	Kurtosis Detects	13.12
Mean of Logged Detects	2.845	SD of Logged Detects	1.563

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.474	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.343	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data Not Normal at 5% Significance Level

Detected Data Not Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	36.98	KM Standard Error of Mean	20.11
KM SD	101.1	95% KM (BCA) UCL	74.4
95% KM (t) UCL	71.28	95% KM (Percentile Bootstrap) UCL	73.56
95% KM (z) UCL	70.06	95% KM Bootstrap t UCL	192.3
90% KM Chebyshev UCL	97.3	95% KM Chebyshev UCL	124.6
97.5% KM Chebyshev UCL	162.5	99% KM Chebyshev UCL	237

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.96	**Anderson-Darling GOF Test**
5% A-D Critical Value	0.796	Detected Data Not Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.221	**Kolmogorov-Smirnov GOF**
5% K-S Critical Value	0.227	Detected data appear Gamma Distributed at 5% Significance Level

Detected data follow Appr. Gamma Distribution at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.507	k star (bias corrected MLE)	0.454
Theta hat (MLE)	118.5	Theta star (bias corrected MLE)	132.5
nu hat (MLE)	16.22	nu star (bias corrected)	14.51
Mean (detects)	60.08		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs

GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)

For such situations, GROS method may yield incorrect values of UCLs and BTVs

This is especially true when the sample size is small.

For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	35.61
Maximum	530	Median	4.2
SD	103.5	CV	2.908
k hat (MLE)	0.196	k star (bias corrected MLE)	0.199
Theta hat (MLE)	181.5	Theta star (bias corrected MLE)	178.9
nu hat (MLE)	10.59	nu star (bias corrected)	10.75
Adjusted Level of Significance (β)	0.0401		
Approximate Chi Square Value (10.75, α)	4.416	Adjusted Chi Square Value (10.75, β)	4.158
95% Gamma Approximate UCL (use when n>=50)	86.69	95% Gamma Adjusted UCL (use when n<50)	92.05

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	36.98	SD (KM)	101.1
Variance (KM)	10229	SE of Mean (KM)	20.11
k hat (KM)	0.134	k star (KM)	0.144
nu hat (KM)	7.22	nu star (KM)	7.752
theta hat (KM)	276.6	theta star (KM)	257.6
80% gamma percentile (KM)	38.79	90% gamma percentile (KM)	108.9
95% gamma percentile (KM)	205.2	99% gamma percentile (KM)	487.3

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (7.75, α)	2.592	Adjusted Chi Square Value (7.75, β)	2.405
95% Gamma Approximate KM-UCL (use when n>=50)	110.6	95% Gamma Adjusted KM-UCL (use when n<50)	119.2

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.968	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.887	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.154	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.213	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	36.64	Mean in Log Scale	1.93
SD in Original Scale	103.2	SD in Log Scale	1.736
95% t UCL (assumes normality of ROS data)	70.51	95% Percentile Bootstrap UCL	72.17
95% BCA Bootstrap UCL	98.11	95% Bootstrap t UCL	188
95% H-UCL (Log ROS)	106.3		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	2.114	KM Geo Mean	8.281
KM SD (logged)	1.513	95% Critical H Value (KM-Log)	3.258
KM Standard Error of Mean (logged)	0.336	95% H-UCL (KM -Log)	68.38
KM SD (logged)	1.513	95% Critical H Value (KM-Log)	3.258
KM Standard Error of Mean (logged)	0.336		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	37.36	Mean in Log Scale	2.179
SD in Original Scale	103	SD in Log Scale	1.498
95% t UCL (Assumes normality)	71.16	95% H-Stat UCL	70.16

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Gamma Distributed at 5% Significance Level

Suggested UCL to Use

Gamma Adjusted KM-UCL (use when k<=1 and 15 < n < 50 but k<=1)	119.2

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Tetrachloroethene

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	2.1	Mean	3.1
Maximum	5	Median	2.65
SD	1.344	Std. Error of Mean	0.672
Coefficient of Variation	0.434	Skewness	1.408

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.848	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.25	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	4.682	95% Adjusted-CLT UCL (Chen-1995)	4.711
		95% Modified-t UCL (Johnson-1978)	4.76

Gamma GOF Test

A-D Test Statistic	0.404	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.658	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.288	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.395	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	8.025	k star (bias corrected MLE)	2.173
Theta hat (MLE)	0.386	Theta star (bias corrected MLE)	1.427
nu hat (MLE)	64.2	nu star (bias corrected)	17.38
MLE Mean (bias corrected)	3.1	MLE Sd (bias corrected)	2.103
		Approximate Chi Square Value (0.05)	8.947
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	6.023	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.887	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.257	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.375	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	0.742	Mean of logged Data	1.068
Maximum of Logged Data	1.609	SD of logged Data	0.401

Assuming Lognormal Distribution

95% H-UCL	6.575	90% Chebyshev (MVUE) UCL	4.921
95% Chebyshev (MVUE) UCL	5.751	97.5% Chebyshev (MVUE) UCL	6.904
99% Chebyshev (MVUE) UCL	9.168		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	4.205	95% Jackknife UCL	4.682
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	5.116	95% Chebyshev(Mean, Sd) UCL	6.029
97.5% Chebyshev(Mean, Sd) UCL	7.297	99% Chebyshev(Mean, Sd) UCL	9.787

Suggested UCL to Use

95% Student's-t UCL	4.682

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix I.2
Human Health ProUCL Output
Shallow/Intermediate Groundwater
Shakespeare Composite Structures Site
Newberry, South Carolina

Trichloroethene

General Statistics

Total Number of Observations	22	Number of Distinct Observations	18
Number of Detects	18	Number of Non-Detects	4
Number of Distinct Detects	17	Number of Distinct Non-Detects	1
Minimum Detect	10	Minimum Non-Detect	5
Maximum Detect	1400	Maximum Non-Detect	5
Variance Detects	148096	Percent Non-Detects	18.18%
Mean Detects	390.9	SD Detects	384.8
Median Detects	250	CV Detects	0.985
Skewness Detects	1.349	Kurtosis Detects	1.439
Mean of Logged Detects	5.347	SD of Logged Detects	1.359

Normal GOF Test on Detects Only

Shapiro Wilk Test Statistic	0.861	Shapiro Wilk GOF Test
5% Shapiro Wilk Critical Value	0.897	Detected Data Not Normal at 5% Significance Level
Lilliefors Test Statistic	0.184	Lilliefors GOF Test
5% Lilliefors Critical Value	0.202	Detected Data appear Normal at 5% Significance Level

Detected Data appear Approximate Normal at 5% Significance Level

Kaplan-Meier (KM) Statistics using Normal Critical Values and other Nonparametric UCLs

KM Mean	320.7	KM Standard Error of Mean	81.08
KM SD	369.6	95% KM (BCA) UCL	457.5
95% KM (t) UCL	460.2	95% KM (Percentile Bootstrap) UCL	446
95% KM (z) UCL	454.1	95% KM Bootstrap t UCL	512.9
90% KM Chebyshev UCL	564	95% KM Chebyshev UCL	674.1
97.5% KM Chebyshev UCL	827.1	99% KM Chebyshev UCL	1127

Gamma GOF Tests on Detected Observations Only

A-D Test Statistic	0.143	Anderson-Darling GOF Test
5% A-D Critical Value	0.769	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.0901	Kolmogorov-Smirnov GOF
5% K-S Critical Value	0.21	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics on Detected Data Only

k hat (MLE)	0.937	k star (bias corrected MLE)	0.817
Theta hat (MLE)	417.4	Theta star (bias corrected MLE)	478.2
nu hat (MLE)	33.72	nu star (bias corrected)	29.43
Mean (detects)	390.9		

Gamma ROS Statistics using Imputed Non-Detects

GROS may not be used when data set has > 50% NDs with many tied observations at multiple DLs
GROS may not be used when kstar of detects is small such as <1.0, especially when the sample size is small (e.g., <15-20)
For such situations, GROS method may yield incorrect values of UCLs and BTVs
This is especially true when the sample size is small.
For gamma distributed detected data, BTVs and UCLs may be computed using gamma distribution on KM estimates

Minimum	0.01	Mean	319.8
Maximum	1400	Median	180
SD	379.1	CV	1.185
k hat (MLE)	0.308	k star (bias corrected MLE)	0.296
Theta hat (MLE)	1039	Theta star (bias corrected MLE)	1080
nu hat (MLE)	13.55	nu star (bias corrected)	13.03
Adjusted Level of Significance (β)	0.0386		
Approximate Chi Square Value (13.03, α)	5.915	Adjusted Chi Square Value (13.03, β)	5.56
95% Gamma Approximate UCL (use when n>=50)	704.7	95% Gamma Adjusted UCL (use when n<50)	749.7

Estimates of Gamma Parameters using KM Estimates

Mean (KM)	320.7	SD (KM)	369.6
Variance (KM)	136590	SE of Mean (KM)	81.08
k hat (KM)	0.753	k star (KM)	0.681
nu hat (KM)	33.14	nu star (KM)	29.95
theta hat (KM)	425.9	theta star (KM)	471.2
80% gamma percentile (KM)	527.6	90% gamma percentile (KM)	810.4
95% gamma percentile (KM)	1103	99% gamma percentile (KM)	1802

Gamma Kaplan-Meier (KM) Statistics

Approximate Chi Square Value (29.95, α)	18.45	Adjusted Chi Square Value (29.95, β)	17.78
95% Gamma Approximate KM-UCL (use when n>=50)	520.5	95% Gamma Adjusted KM-UCL (use when n<50)	540.2

Lognormal GOF Test on Detected Observations Only

Shapiro Wilk Test Statistic	0.939	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.897	Detected Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.16	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.202	Detected Data appear Lognormal at 5% Significance Level

Detected Data appear Lognormal at 5% Significance Level

Lognormal ROS Statistics Using Imputed Non-Detects

Mean in Original Scale	321.8	Mean in Log Scale	4.793
SD in Original Scale	377.3	SD in Log Scale	1.73
95% t UCL (assumes normality of ROS data)	460.3	95% Percentile Bootstrap UCL	461.8
95% BCA Bootstrap UCL	477.4	95% Bootstrap t UCL	501.2
95% H-UCL (Log ROS)	2194		

Statistics using KM estimates on Logged Data and Assuming Lognormal Distribution

KM Mean (logged)	4.668	KM Geo Mean	106.4
KM SD (logged)	1.872	95% Critical H Value (KM-Log)	3.965
KM Standard Error of Mean (logged)	0.411	95% H-UCL (KM -Log)	3103
KM SD (logged)	1.872	95% Critical H Value (KM-Log)	3.965
KM Standard Error of Mean (logged)	0.411		

DL/2 Statistics

DL/2 Normal		**DL/2 Log-Transformed**	
Mean in Original Scale	320.3	Mean in Log Scale	4.542
SD in Original Scale	378.7	SD in Log Scale	2.134
95% t UCL (Assumes normality)	459.2	95% H-Stat UCL	7166

DL/2 is not a recommended method, provided for comparisons and historical reasons

Nonparametric Distribution Free UCL Statistics

Detected Data appear Approximate Normal Distributed at 5% Significance Level

Suggested UCL to Use

95% KM (t) UCL	460.2

When a data set follows an approximate (e.g., normal) distribution passing one of the GOF test
When applicable, it is suggested to use a UCL based upon a distribution (e.g., gamma) passing both GOF tests in ProUCL

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Vinyl chloride

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	0.68	Mean	3.233
Maximum	8.1	Median	0.92
SD	4.216	Std. Error of Mean	2.434
Coefficient of Variation	1.304	Skewness	1.726

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.774	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.375	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	10.34	95% Adjusted-CLT UCL (Chen-1995)	9.829
		95% Modified-t UCL (Johnson-1978)	10.75

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	0.921	k star (bias corrected MLE)	N/A
Theta hat (MLE)	3.509	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	5.529	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.84	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.345	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.386	Mean of logged Data	0.541
Maximum of Logged Data	2.092	SD of logged Data	1.352

Assuming Lognormal Distribution

95% H-UCL	91608134	90% Chebyshev (MVUE) UCL	8.601
95% Chebyshev (MVUE) UCL	11.17	97.5% Chebyshev (MVUE) UCL	14.73
99% Chebyshev (MVUE) UCL	21.73		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	7.237	95% Jackknife UCL	10.34
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	10.54	95% Chebyshev(Mean, Sd) UCL	13.84
97.5% Chebyshev(Mean, Sd) UCL	18.44	99% Chebyshev(Mean, Sd) UCL	27.45

Suggested UCL to Use

95% Student's-t UCL	10.34

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Iron

General Statistics

Total Number of Observations	5	Number of Distinct Observations	5
		Number of Missing Observations	0
Minimum	350	Mean	4404
Maximum	11000	Median	1200
SD	5126	Std. Error of Mean	2293
Coefficient of Variation	1.164	Skewness	0.687

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.786	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.334	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.343	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	9291	95% Adjusted-CLT UCL (Chen-1995)	8927
		95% Modified-t UCL (Johnson-1978)	9409

Gamma GOF Test

A-D Test Statistic	0.503	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.7	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.283	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.367	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	0.708	k star (bias corrected MLE)	0.417
Theta hat (MLE)	6217	Theta star (bias corrected MLE)	10569
nu hat (MLE)	7.084	nu star (bias corrected)	4.167
MLE Mean (bias corrected)	4404	MLE Sd (bias corrected)	6822
		Approximate Chi Square Value (0.05)	0.789
Adjusted Level of Significance	0.0086	Adjusted Chi Square Value	0.332

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	23266	95% Adjusted Gamma UCL (use when n<50)	55286

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.874	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.762	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.237	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.343	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	5.858	Mean of logged Data	7.539
Maximum of Logged Data	9.306	SD of logged Data	1.58

Assuming Lognormal Distribution

95% H-UCL	2420562	90% Chebyshev (MVUE) UCL	12975
95% Chebyshev (MVUE) UCL	16815	97.5% Chebyshev (MVUE) UCL	22145
99% Chebyshev (MVUE) UCL	32615		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	8175	95% Jackknife UCL	9291
95% Standard Bootstrap UCL	7777	95% Bootstrap-t UCL	51396
95% Hall's Bootstrap UCL	93696	95% Percentile Bootstrap UCL	8074
95% BCA Bootstrap UCL	8200		
90% Chebyshev(Mean, Sd) UCL	11282	95% Chebyshev(Mean, Sd) UCL	14397
97.5% Chebyshev(Mean, Sd) UCL	18721	99% Chebyshev(Mean, Sd) UCL	27215

Suggested UCL to Use

95% Student's-t UCL	9291

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Manganese

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	59	Mean	136.3
Maximum	200	Median	150
SD	71.49	Std. Error of Mean	41.27
Coefficient of Variation	0.524	Skewness	-0.829

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.973	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.242	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	256.8	95% Adjusted-CLT UCL (Chen-1995)	183.1
		95% Modified-t UCL (Johnson-1978)	253.6

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	4.34	k star (bias corrected MLE)	N/A
Theta hat (MLE)	31.41	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	26.04	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.915	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.299	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	4.078	Mean of logged Data	4.795
Maximum of Logged Data	5.298	SD of logged Data	0.638

Assuming Lognormal Distribution

95% H-UCL	6301	90% Chebyshev (MVUE) UCL	283.2
95% Chebyshev (MVUE) UCL	349	97.5% Chebyshev (MVUE) UCL	440.3
99% Chebyshev (MVUE) UCL	619.6		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	204.2	95% Jackknife UCL	256.8
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	260.2	95% Chebyshev(Mean, Sd) UCL	316.2
97.5% Chebyshev(Mean, Sd) UCL	394.1	99% Chebyshev(Mean, Sd) UCL	547

Suggested UCL to Use

95% Student's-t UCL	256.8

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Note: For highly negatively-skewed data, confidence limits (e.g., Chen, Johnson, Lognormal, and Gamma) may not be reliable. Chen's and Johnson's methods provide adjustments for positvely skewed data sets.

UCL Statistics for Uncensored Full Data Sets

User Selected Options	
Date/Time of Computation	ProUCL 5.15/17/2018 3:06:42 PM
From File	For ProUCL Bedrock.xls
Full Precision	OFF
Confidence Coefficient	95%
Number of Bootstrap Operations	2000

Chloroform

General Statistics

Total Number of Observations	3	Number of Distinct Observations	3
		Number of Missing Observations	0
Minimum	0.42	Mean	1.01
Maximum	2	Median	0.61
SD	0.863	Std. Error of Mean	0.498
Coefficient of Variation	0.854	Skewness	1.638

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use
guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest.
For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012).
Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.839	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.345	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	2.464	95% Adjusted-CLT UCL (Chen-1995)	2.332
		95% Modified-t UCL (Johnson-1978)	2.543

Gamma GOF Test

Not Enough Data to Perform GOF Test

Gamma Statistics

k hat (MLE)	2.3	k star (bias corrected MLE)	N/A
Theta hat (MLE)	0.439	Theta star (bias corrected MLE)	N/A
nu hat (MLE)	13.8	nu star (bias corrected)	N/A
MLE Mean (bias corrected)	N/A	MLE Sd (bias corrected)	N/A
		Approximate Chi Square Value (0.05)	N/A
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	N/A	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.917	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.767	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.297	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.425	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	-0.868	Mean of logged Data	-0.223
Maximum of Logged Data	0.693	SD of logged Data	0.815

Assuming Lognormal Distribution

95% H-UCL	509	90% Chebyshev (MVUE) UCL	2.277
95% Chebyshev (MVUE) UCL	2.861	97.5% Chebyshev (MVUE) UCL	3.672
99% Chebyshev (MVUE) UCL	5.265		

Nonparametric Distribution Free UCL Statistics
Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	1.829	95% Jackknife UCL	2.464
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	2.504	95% Chebyshev(Mean, Sd) UCL	3.181
97.5% Chebyshev(Mean, Sd) UCL	4.12	99% Chebyshev(Mean, Sd) UCL	5.965

Suggested UCL to Use

95% Student's-t UCL	2.464

Recommended UCL exceeds the maximum observation

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Trichloroethene

General Statistics

Total Number of Observations	4	Number of Distinct Observations	4
		Number of Missing Observations	0
Minimum	38.33	Mean	89.57
Maximum	160	Median	79.98
SD	56.49	Std. Error of Mean	28.24
Coefficient of Variation	0.631	Skewness	0.596

Note: Sample size is small (e.g., <10), if data are collected using ISM approach, you should use guidance provided in ITRC Tech Reg Guide on ISM (ITRC, 2012) to compute statistics of interest. For example, you may want to use Chebyshev UCL to estimate EPC (ITRC, 2012). Chebyshev UCL can be computed using the Nonparametric and All UCL Options of ProUCL 5.1

Normal GOF Test

Shapiro Wilk Test Statistic	0.917	**Shapiro Wilk GOF Test**
5% Shapiro Wilk Critical Value	0.748	Data appear Normal at 5% Significance Level
Lilliefors Test Statistic	0.258	**Lilliefors GOF Test**
5% Lilliefors Critical Value	0.375	Data appear Normal at 5% Significance Level

Data appear Normal at 5% Significance Level

Assuming Normal Distribution

95% Normal UCL		**95% UCLs (Adjusted for Skewness)**	
95% Student's-t UCL	156	95% Adjusted-CLT UCL (Chen-1995)	145
		95% Modified-t UCL (Johnson-1978)	157.4

Gamma GOF Test

A-D Test Statistic	0.323	**Anderson-Darling Gamma GOF Test**
5% A-D Critical Value	0.659	Detected data appear Gamma Distributed at 5% Significance Level
K-S Test Statistic	0.278	**Kolmogorov-Smirnov Gamma GOF Test**
5% K-S Critical Value	0.396	Detected data appear Gamma Distributed at 5% Significance Level

Detected data appear Gamma Distributed at 5% Significance Level

Gamma Statistics

k hat (MLE)	3.248	k star (bias corrected MLE)	0.979
Theta hat (MLE)	27.58	Theta star (bias corrected MLE)	91.53
nu hat (MLE)	25.98	nu star (bias corrected)	7.828
MLE Mean (bias corrected)	89.57	MLE Sd (bias corrected)	90.55
		Approximate Chi Square Value (0.05)	2.636
Adjusted Level of Significance	N/A	Adjusted Chi Square Value	N/A

Assuming Gamma Distribution

95% Approximate Gamma UCL (use when n>=50))	266	95% Adjusted Gamma UCL (use when n<50)	N/A

Lognormal GOF Test

Shapiro Wilk Test Statistic	0.93	**Shapiro Wilk Lognormal GOF Test**
5% Shapiro Wilk Critical Value	0.748	Data appear Lognormal at 5% Significance Level
Lilliefors Test Statistic	0.237	**Lilliefors Lognormal GOF Test**
5% Lilliefors Critical Value	0.375	Data appear Lognormal at 5% Significance Level

Data appear Lognormal at 5% Significance Level

Lognormal Statistics

Minimum of Logged Data	3.646	Mean of logged Data	4.333
Maximum of Logged Data	5.075	SD of logged Data	0.667

Assuming Lognormal Distribution

95% H-UCL	560.5	90% Chebyshev (MVUE) UCL	176.3
95% Chebyshev (MVUE) UCL	215.5	97.5% Chebyshev (MVUE) UCL	270
99% Chebyshev (MVUE) UCL	377.1		

Nonparametric Distribution Free UCL Statistics

Data appear to follow a Discernible Distribution at 5% Significance Level

Nonparametric Distribution Free UCLs

95% CLT UCL	136	95% Jackknife UCL	156
95% Standard Bootstrap UCL	N/A	95% Bootstrap-t UCL	N/A
95% Hall's Bootstrap UCL	N/A	95% Percentile Bootstrap UCL	N/A
95% BCA Bootstrap UCL	N/A		
90% Chebyshev(Mean, Sd) UCL	174.3	95% Chebyshev(Mean, Sd) UCL	212.7
97.5% Chebyshev(Mean, Sd) UCL	266	99% Chebyshev(Mean, Sd) UCL	370.6

Suggested UCL to Use

95% Student's-t UCL	156

Note: Suggestions regarding the selection of a 95% UCL are provided to help the user to select the most appropriate 95% UCL.
Recommendations are based upon data size, data distribution, and skewness.
These recommendations are based upon the results of the simulation studies summarized in Singh, Maichle, and Lee (2006).
However, simulations results will not cover all Real World data sets; for additional insight the user may want to consult a statistician.

Appendix IA.3 Exposure Factors

Table I.3-1
Values Used For Daily Intake Calculations - Groundwater (Future - Oral and Dermal)
Shakespeare Composite Structures Site
Newberry, South Carolina

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
Oral	Resident	Adult	Tap Water	CW	Chemical Concentration in Groundwater	--	mg/L	(1)	
				IR-Wa	Ingestion Rate of Groundwater - adult	2.5	L/day	USEPA, Sep 2011; USEPA, May 2018	Chronic Daily Intake (mg/kg-day) for carcinogens =
				IR-Wc	Ingestion Rate of Groundwater - child	0.78	L/day	USEPA, Sep 2011; USEPA, May 2018	CW x IR-Wa x EFa x EDa x 1/BWa x 1/AT-C +
				EFa	Exposure Frequency - adult	350	day/yr	USEPA, Mar 1991; USEPA, May 2018	CW x IR-Wc x EFc x EDc x 1/BWc x 1/AT-C
				EFc	Exposure Frequency - child	350	day/yr	USEPA, Mar 1991; USEPA, May 2018	
				EDa	Exposure Duration - adult	20	years	USEPA, May 2018	Chronic Daily Intake (mg/kg-day) for noncarcinogens =
				EDc	Exposure Duration - child	6	years	USEPA, Mar 1991; USEPA, May 2018	CW x IR-Wa x EFa x EDres x 1/BWa x 1/AT-N
				EDres	Exposure Duration - resident	26	years	USEPA, Sep 2011; USEPA, May 2018	
				BWa	Body Weight - adult	80	kg	USEPA, Sep 2011; USEPA, May 2018	
				BWc	Body Weight - child	15	kg	USEPA, Mar 1991; USEPA, May 2018	
				AT-C	Averaging Time (Cancer)	25550	days	USEPA, Dec 1989 (70 y x 365 d/y)	
				AT-N	Averaging Time (Non-Cancer)	9490	days	USEPA, Dec 1989 (ED x 365 d/y)	
		Child	Tap Water	CW	Chemical Concentration in Groundwater	--	mg/L	(1)	
				IR-Wc	Ingestion Rate of Groundwater - child	0.78	L/day	USEPA, Sep 2011; USEPA, May 2018	Chronic Daily Intake (mg/kg-day) for noncarcinogens =
				EFc	Exposure Frequency - child	350	day/yr	USEPA, Mar 1991; USEPA, May 2018	CW x IR-Wc x EFc x EDc x 1/BWc x 1/AT-N
				EDc	Exposure Duration - child	6	years	USEPA, Mar 1991; USEPA, May 2018	
				BWc	Body Weight - child	15	kg	USEPA, Mar 1991; USEPA, May 2018	
				AT-N	Averaging Time (Non-Cancer)	2190	days	USEPA, Dec 1989 (ED x 365 d/y)	

Table I.3-1
Values Used For Daily Intake Calculations - Groundwater (Future - Oral and Dermal)
Shakespeare Composite Structures Site
Newberry, South Carolina

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
Dermal	Resident	Adult	Tap Water	CW	Chemical Concentration in Groundwater	--	mg/L	(1)	
				FA	Fraction Absorbed Water	chemical-specific	unitless	USEPA, July 2004	Chronic Daily Intake (mg/kg-day) for carcinogens =
				Kp	Dermal Permeability Coefficient	chemical-specific	cm/hr	USEPA, July 2004	DA-event x EVa x EDa x EFa x SAa x 1/BWa x 1/AT-C + DA-event x EVc x EDc x EFc x SAc x 1/BWc x 1/AT-C
				SAa	Body Area Available for Contact - adult	20900	cm2	USEPA, Sep 2011; USEPA, Apr 2014 (2)	Chronic Daily Intake (mg/kg-day) for noncarcinogens =
				SAc	Body Area Available for Contact - child	6378	cm2	USEPA, Sep 2011; USEPA, Apr 2014 (2)	DA-event x EVa x EDres x EFa x SAa x 1/BWa x 1/AT-N
				tau-event	Lag Time per Event	chemical-specific	hours/event	USEPA, July 2004	Where:
				t-eventa	Event Duration - adult	0.71	hours/event	USEPA, Sep 2011; USEPA, May 2018	For organic compounds in which t-event is
				t-eventc	Event Duration - child	0.54	hours/event	USEPA, Sep 2011; USEPA, May 2018	less than or equal to t-tau:
				B	Ratio of Kp of a Compound through the Stratum Corneum Relative to Its Kp across the Viable Epidermis	chemical-specific	unitless	USEPA, July 2004	DA-event (Absorbed Dose per Event [mg/cm2-event]) = 2 x FA x Kp x CW x CF x SQRT([6 x tau-event x t-event] / p)
				EVa	Event Frequency - adult	1	event/day	USEPA, July 2004	For organics where t-event is greater than t-tau:
				EVc	Event Frequency - child	1	event/day	USEPA, July 2004	
				EFa	Exposure Frequency - adult	350	days/year	USEPA, Mar 1991; USEPA, May 2018	DA-event = FA x Kp x CW x CF x {[t-event/(1+B)] +
				EFc	Exposure Frequency - child	350	days/year	USEPA, Mar 1991; USEPA, May 2018	
				EDa	Exposure Duration - adult	20	years	USEPA, May 2018	2 x tau-event x [(1+3B + 3B 2) / (1 + B)2] }
				EDc	Exposure Duration - child	6	years	USEPA, Mar 1991; USEPA, May 2018	
				EDres	Exposure Duration - resident	26	years	USEPA, Sep 2011; USEPA, May 2018	
				CF	Conversion Factor	0.001	L/cm3	--	
				BWa	Body Weight - adult	80	kg	USEPA, Sep 2011; USEPA, May 2018	For inorganic compounds,
				BWc	Body Weight - child	15	kg	USEPA, Mar 1991; USEPA, May 2018	
				AT-C	Averaging Time, carcinogens	25,550	days	USEPA, Dec 1989 (70 y x 365 d/y)	DA-event = Kp x CW x CF x t-event
				AT-N	Averaging Time, noncarcinogens	9490	days	USEPA, Dec 1989 (ED x 365 d/y)	

Table I.3-1
Values Used For Daily Intake Calculations - Groundwater (Future - Oral and Dermal)
Shakespeare Composite Structures Site
Newberry, South Carolina

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
Dermal	Resident	Child	Tap Water	CW	Chemical Concentration in Groundwater	--	mg/L	(1)	
				FA	Fraction Absorbed Water	chemical-specific	unitless	USEPA, July 2004	Chronic Daily Intake (mg/kg-day) for noncarcinogens =
				Kp	Dermal Permeability Coefficient	chemical-specific	cm/hr	USEPA, July 2004	DA-event x EVc x EDc x EFc x SAc x 1/BWc x 1/AT-N
				SAc	Body Area Available for Contact - child	6378	cm2	USEPA, Sep 2011; USEPA, Apr 2014 [(2)]	Where:
				tau-event	Lag Time per Event	chemical-specific	hours/event	USEPA, July 2004	For organic compounds in which t-event is
				t-eventc	Event Duration - child	0.54	hours/event	USEPA, Sep 2011; USEPA, May 2018	less than or equal to t-tau:
				B	Ratio of Kp of a Compound through the Stratum Corneum Relative to Its Kp across the Viable Epidermis	chemical-specific	unitless	USEPA, July 2004	DA-event (Absorbed Dose per Event [mg/cm2-event]) = 2 x FA x Kp x CW x CF x SQRT([6 x tau-event x t-event] / p)
				EVc	Event Frequency - child	1	event/day	USEPA, July 2004	For organics where t-event is greater than t-tau:
				EFc	Exposure Frequency - child	350	days/year	USEPA, Mar 1991; USEPA, May 2018	DA-event = FA x Kp x CW x CF x {[t-event/(1+B)] +
				EDc	Exposure Duration - child	6	years	USEPA, Mar 1991; USEPA, May 2018	2 x tau-event x [(1+3B + 3B 2) / (1 + B)2] }
				CF	Conversion Factor	0.001	L/cm3	--	
				BWc	Body Weight - child	15	kg	USEPA, Mar 1991; USEPA, May 2018	For inorganic compounds,
				AT-N	Averaging Time, noncarcinogens	2190	days	USEPA, Dec 1989 (ED x 365 d/y)	DA-event = Kp x CW x CF x t-event

Notes:

(1) Based on groundwater sampling data.

(2) Represents whole body.

USEPA, December 1989. Risk Assessment Guidance for Superfund - Volume I - Human Health Evaluation Manual (Part A), Office of Emergency and Remedial Response. EPA/540/1-89/002.

USEPA, March 1991. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Supplemental Guidance, Standard Default Exposure Factors). OSWER Directive 9285.6-03.

USEPA, July 2004. Risk Assessment Guidance for Superfund - Volume I - Human Health Evaluation Manual (Part E), Office of Emergency and Remedial Response. EPA/540/R99/005.

USEPA, September 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-09/052F.

USEPA April 2014. Human Health Evaluation Manual, Supplemental Guidance: Update of Standard Default Exposure Factors. OSWER Directive 9200.1-120.

USEPA, May 2018. Regional Screening Table User's Guide (May 2018). Table 1. Standard Default Factors.

Table I.3-2
Values Used For Daily Intake Calculations - Groundwater (Future - Inhalation via Showering and Vapor Intrusion)
Shakespeare Composite Structures Site
Newberry, South Carolina

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	Resident	Adult	Vapors from Volatilization (Showering)	CW	Chemical Concentration in Groundwater	--	ug/L	(1)	
				CA	Chemical Concentration in Air	Modeled	ug/m3	CW x K	Exposure Concentration (ug/m3) for carcinogens =
				K	Andelman Volatilization Factor	0.5	L/m3	USEPA, Dec 1991	CA x ET x EF x ED x 1/AT-C
				ET	Exposure Time (Indoor Air)	0.71	hr/day	USEPA, Sep 2011; USEPA, May 2018	
				EF	Exposure Frequency	350	day/yr	USEPA, Mar 1991; USEPA, May 2018	Exposure Concentration (ug/m3) for noncarcinogens =
				ED	Exposure Duration	26	years	USEPA, Sep 2011; USEPA, May 2018	CA x ET x EF x ED x 1/AT-N
				AT-C	Averaging Time (Cancer)	613,200	hours	70 yr [lifetime]x 365 d/yr x 24 hrs/day	
				AT-N	Averaging Time (Non-Cancer)	227,760	hours	ED x 365 d/yr x 24 hrs/day	
	Resident	Adult and Child	Indoor Air via Vapor Intrusion	CW	Chemical Concentration in Groundwater	--	ug/L	(1)	
				CA	Chemical Concentration in Air	Modeled	ug/m3	(2)	Exposure Concentration for carcinogens =
				ET	Exposure Time (Indoor Air)	24	hr/day	USEPA, May 2018	CA x ET x EF x ED x 1/AT-C
				EF	Exposure Frequency	350	day/yr	USEPA, Mar 1991; USEPA, May 2018	
				ED	Exposure Duration	26	years	USEPA, Sep 2011; USEPA, May 2018	Exposure Concentration for noncarcinogens =
				AT-C	Averaging Time (Cancer)	613,200	hours	70 yr [lifetime]x 365 d/yr x 24 hrs/day	CA x ET x EF x ED x 1/AT-N
				AT-N	Averaging Time (Non-Cancer)	227,760	hours	ED x 365 d/yr x 24 hrs/day	

Notes:

(1) Based on groundwater sampling data.

(2) Calculated using Johnson and Ettinger Indoor Air model.

USEPA, March 1991. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Supplemental Guidance, Standard Default Exposure Factors). OSWER Directive 9285.6-03.

USEPA, December1991. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluaion Manual (Part B, Development of Risk-Based Preliminary Remediation Goals). EPA/540/R-92/003.

USEPA, September 2011. Exposure Factors Handbook: 2011 Edition. EPA/600/R-09/052F.

USEPA, May 2018. Regional Screening Table User's Guide (May 2018). Table 1. Standard Default Factors.

Table I.3-3
DA_{event} Equations for Groundwater
Shakespeare Composite Structures Site
Newberry, South Carolina

For organics,

$$If\ t_{event} \le t^*,\ then: DA_{event} = 2FA \times K_p \times C_w \sqrt{\frac{6\tau_{event} \times t_{event}}{\pi}}$$

$$If\ t_{event} > t^*,\ then: DA_{event} = FA \times K_p \times C_w \left[\frac{t_{event}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$$

Parameter	Definition (Units)	Value	Source
Organics			
DA_{event}	Dose absorbed per event (mg/cm^2-event)	Chemical-specific	Calculated using Equations 3.2 or 3.3 (USEPA, July 2004).
FA	Fraction absorbed water (dimensionless)	Chemical-specific	Obtained from Appendix B, Exhibit B-3 (USEPA, July 2004).
K_p	Dermal permeability coefficient (cm/hr)	Chemical-specific	Obtained from Appendix B, Exhibit B-2 (USEPA, July 2004).
C_w	Chemical concentration in water (mg/cm^3)	Chemical-specific	Refer to Tables 6-6 and 6-7 for groundwater concentration.
τ_{event}	Lag time per event (hr/event)	Chemical-specific	Calculated using Equation A.4 (USEPA, July 2004).
t_{event}	Event duration (hr/event)	Resident Child: 0.54	Obtained from USEPA, Sep 2011; USEPA, May 2018
		Age-Adjusted Resident Adult: 0.67	Age Adjusted, based on tevent of 0.54 for child and 0.71 for adult from USEPA 2014: ((0.54*6) + (0.71*20)) / 26
t^*	Time to reach steady-state (hr)	Chemical-specific	Calculated using Equations A.5 or A.6 (USEPA, July 2004).
B	Kp stratum corneum: Kp viable epidermis (dimensionless)	Chemical-specific	Calculated using Equation A.1 (USEPA, July 2004).

Table I.3-4
Estimation of DA_{event} - Lag Time per Event (τ_{event}) for Dermal Contact with Groundwater
Shakespeare Composite Structures Site
Newberry, South Carolina

$$\tau_{event} = \frac{l_{sc}^{2}}{6 * D_{sc}} = 0.105 * 10^{(0.0056*MW)}$$

Used in calculation for t_{event} (Equation A.4 in USEPA 2004)	Molecular Weight [1] (g/mole)	EDC for stratum corneum/ Apparent thickness of stratum corneum (cm/hr)	EDC for stratum corneum/ Apparent thickness of stratum corneum (cm/hr)	Apparent thickness of stratum corneum (cm)	Effective Diffusion Coefficient through Stratum Corneum (cm2/hr)	Lag Time per Event (hr/event)
Chemical	MW	Log *Dsc/lsc*	*Dsc / lsc*	*lsc*	*Dsc*	τ_{event}
Groundwater (Shallow/Intermediate)						
VOCs						
1,2-Dichloroethane	9.90E+01	-3.36E+00	4.36E-04	1.00E-03	4.36E-07	3.82E-01
Benzene	7.81E+01	-3.24E+00	5.71E-04	1.00E-03	5.71E-07	2.92E-01
Chloroform	1.19E+02	-3.47E+00	3.35E-04	1.00E-03	3.35E-07	4.98E-01
cis-1,2-Dichloroethene	9.69E+01	-3.35E+00	4.48E-04	1.00E-03	4.48E-07	3.72E-01
Tetrachloroethene	1.66E+02	-3.74E+00	1.84E-04	1.00E-03	1.84E-07	9.07E-01
Trichloroethene	1.31E+02	-3.54E+00	2.87E-04	1.00E-03	2.87E-07	5.81E-01
Vinyl chloride	6.25E+01	-3.16E+00	6.99E-04	1.00E-03	6.99E-07	2.39E-01
Metals						
Iron	5.58E+01	-3.12E+00	7.61E-04	1.00E-03	7.61E-07	2.19E-01
Manganese	5.49E+01	-3.11E+00	7.70E-04	1.00E-03	7.70E-07	2.16E-01
Groundwater (Bedrock)						
All Bedrock Wells						
VOCs						
1,2-Dichloroethane	9.90E+01	-3.36E+00	4.36E-04	1.00E-03	4.36E-07	3.82E-01
Chloroform	1.19E+02	-3.47E+00	3.35E-04	1.00E-03	3.35E-07	4.98E-01
cis-1,2-Dichloroethene	9.69E+01	-3.35E+00	4.48E-04	1.00E-03	4.48E-07	3.72E-01
Trichloroethene	1.31E+02	-3.54E+00	2.87E-04	1.00E-03	2.87E-07	5.81E-01
Boazman Well						
VOCs						
Trichloroethene	1.31E+02	-3.54E+00	2.87E-04	1.00E-03	2.87E-07	5.81E-01
PW-2						
VOCs						
Trichloroethene	1.31E+02	-3.54E+00	2.87E-04	1.00E-03	2.87E-07	5.81E-01
PW-4						
VOCs						
Trichloroethene	1.31E+02	-3.54E+00	2.87E-04	1.00E-03	2.87E-07	5.81E-01
PW-5						
VOCs						
Trichloroethene	1.31E+02	-3.54E+00	2.87E-04	1.00E-03	2.87E-07	5.81E-01
PW-8						
VOCs						
Trichloroethene	1.31E+02	-3.54E+00	2.87E-04	1.00E-03	2.87E-07	5.81E-01

Note:
[1] Value obtained from the RSL Chemical-Specific Parameters Supporting Table (USEPA, May 2018).

Table I.3-5
Estimation of DA_{event} - Time to Reach Steady State for Dermal Contact with Groundwater
Shakespeare Composite Structures Site
Newberry, South Carolina

If $B \leq 0.6$, then $t^* = 2.4 * \tau_{event}$

If $B > 0.6$, then $t^* = 6 * \tau_{event} (b - \sqrt{b^2 - c^2})$

$b = \frac{2 * (1+B)^2}{\pi} - c$ $\quad$ $c = \frac{1 + 3B + 3B^2}{3 * (1 + B)}$

Used in calculation for t* (Equation A.5 or A.6 in USEPA 2004). Also uses Equations A.7 and A.8 for b and c in USEPA 2004.	Permeability Constant [1] (cm/hr)	Molecular Weight [1] (g/mole)	Kp Stratum Corneum: Kp Viable Epidermis (unitless)	Lag Time per Event (hr/event)	Formula Used	Time to reach steady state (hr)	Correlation Coefficients (unitless)	Correlation Coefficients (unitless)
Chemical	Kp	MW	B	τ_{event}	Formula	t*	b	c
Groundwater (Shallow/Intermediate)								
VOCs								
1,2-Dichloroethane	4.20E-03	9.90E+01	1.61E-02	3.82E-01	Eq. A.5	9.17E-01	3.13E-01	3.44E-01
Benzene	1.49E-02	7.81E+01	5.07E-02	2.92E-01	Eq. A.5	7.01E-01	3.35E-01	3.68E-01
Chloroform	6.83E-03	1.19E+02	2.87E-02	4.98E-01	Eq. A.5	1.19E+00	3.21E-01	3.53E-01
cis-1,2-Dichloroethene	1.10E-02	9.69E+01	4.17E-02	3.72E-01	Eq. A.5	8.94E-01	3.29E-01	3.62E-01
Tetrachloroethene	3.34E-02	1.66E+02	1.65E-01	9.07E-01	Eq. A.5	2.18E+00	4.13E-01	4.51E-01
Trichloroethene	1.16E-02	1.31E+02	5.11E-02	5.81E-01	Eq. A.5	1.39E+00	3.35E-01	3.68E-01
Vinyl chloride	8.38E-03	6.25E+01	2.55E-02	2.39E-01	Eq. A.5	5.73E-01	3.19E-01	3.51E-01
Metals								
Iron	1.00E-03	5.58E+01	2.87E-03	2.19E-01	Eq. A.5	5.25E-01	3.05E-01	3.35E-01
Manganese	1.00E-03	5.49E+01	2.85E-03	2.16E-01	Eq. A.5	5.19E-01	3.05E-01	3.35E-01
Groundwater (Bedrock)								
All Bedrock Wells								
VOCs								
1,2-Dichloroethane	4.20E-03	9.90E+01	1.61E-02	3.82E-01	Eq. A.5	9.17E-01	3.13E-01	3.44E-01
Chloroform	6.83E-03	1.19E+02	2.87E-02	4.98E-01	Eq. A.5	1.19E+00	3.21E-01	3.53E-01
cis-1,2-Dichloroethene	1.10E-02	9.69E+01	4.17E-02	3.72E-01	Eq. A.5	8.94E-01	3.29E-01	3.62E-01
Trichloroethene	1.16E-02	1.31E+02	5.11E-02	5.81E-01	Eq. A.5	1.39E+00	3.35E-01	3.68E-01
Boazman Well								
VOCs								
Trichloroethene	1.16E-02	1.31E+02	5.11E-02	5.81E-01	Eq. A.5	1.39E+00	3.35E-01	3.68E-01
PW-2								
VOCs								
Trichloroethene	1.16E-02	1.31E+02	5.11E-02	5.81E-01	Eq. A.5	1.39E+00	3.35E-01	3.68E-01
PW-4								
VOCs								
Trichloroethene	1.16E-02	1.31E+02	5.11E-02	5.81E-01	Eq. A.5	1.39E+00	3.35E-01	3.68E-01
PW-5								
VOCs								
Trichloroethene	1.16E-02	1.31E+02	5.11E-02	5.81E-01	Eq. A.5	1.39E+00	3.35E-01	3.68E-01
PW-8								
VOCs								
Trichloroethene	1.16E-02	1.31E+02	5.11E-02	5.81E-01	Eq. A.5	1.39E+00	3.35E-01	3.68E-01

Note:
[1] Value obtained from the RSL Chemical-Specific Parameters Supporting Table (USEPA, May 2018).

Table I.3-6

Estimation of DA_{event} for Dermal Contact with Organics in Groundwater (Age-Adjusted Resident Adult)

Shakespeare Composite Structures Site

Newberry, South Carolina

For organics,

$$If\ t_{event} \leq t^*,\ then: DA_{event} = 2FA \times K_p \times C_w \sqrt{\frac{6\tau_{event} \times t_{event}}{\pi}}$$

$$If\ t_{event} > t^*,\ then: DA_{event} = FA \times K_p \times C_w \left[\frac{t_{event}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$$

Parameter	**Fraction absorbed water**[1] (unitless)	**Permeability Constant**[2] (cm/hr)	**Concentration in Water**[3] (mg/L)	**Concentration in Water** (mg/cm3)	**Lag Time per Event**[4] (hr/event)	**Time to reach steady state**[5] (hr)	**Event Duration**[6] (hr/event)	**Molecular Weight**[2] (g/mole)	**Kp Stratum Corneum: Kp Viable Epidermis**[7] (unitless)	**Formula Used**[8, 9]	**Absorbed Dose per Event**[8] (mg/cm3-event)	**Absorbed Dose per Event**[9] (mg/cm3-event)	**Absorbed Dose per Event**[10] (mg/cm3-event)
Chemical (Organics)	FA	Kp	Cw (mg/L)	Cw (mg/cm ^{3})	τ_{event}	t*	t_{event}	MW	B	Formula	DA_{event} (Eq. 3.2)	DA_{event} (Eq. 3.3)	Final DA_{event} Adult
Groundwater (Shallow/Intermediate)													
VOCs													
1,2-Dichloroethane	1.00E+00	4.20E-03	5.40E-04	5.40E-07	3.82E-01	9.17E-01	6.70E-01	9.90E+01	1.61E-02	Eq. 3.2	3.17E-09	-	3.17E-09
Benzene	1.00E+00	1.49E-02	6.60E-04	6.60E-07	2.92E-01	7.01E-01	6.70E-01	7.81E+01	5.07E-02	Eq. 3.2	1.20E-08	-	1.20E-08
Chloroform	1.00E+00	6.83E-03	3.56E-03	3.56E-06	4.98E-01	1.19E+00	6.70E-01	1.19E+02	2.87E-02	Eq. 3.2	3.88E-08	-	3.88E-08
cis-1,2-Dichloroethene	1.00E+00	1.10E-02	1.19E-01	1.19E-04	3.72E-01	8.94E-01	6.70E-01	9.69E+01	4.17E-02	Eq. 3.2	1.81E-06	-	1.81E-06
Tetrachloroethene	1.00E+00	3.34E-02	4.68E-03	4.68E-06	9.07E-01	2.18E+00	6.70E-01	1.66E+02	1.65E-01	Eq. 3.2	3.37E-07	-	3.37E-07
Trichloroethene	1.00E+00	1.16E-02	4.60E-01	4.60E-04	5.81E-01	1.39E+00	6.70E-01	1.31E+02	5.11E-02	Eq. 3.2	9.21E-06	-	9.21E-06
Vinyl chloride	1.00E+00	8.38E-03	8.10E-03	8.10E-06	2.39E-01	5.73E-01	6.70E-01	6.25E+01	2.55E-02	Eq. 3.3	-	7.76E-08	7.76E-08
Groundwater (Bedrock)													
All Bedrock Wells													
VOCs													
1,2-Dichloroethane	1.00E+00	4.20E-03	7.30E-04	7.30E-07	3.82E-01	9.17E-01	6.70E-01	9.90E+01	1.61E-02	Eq. 3.2	4.29E-09	-	4.29E-09
Chloroform	1.00E+00	6.83E-03	2.00E-03	2.00E-06	4.98E-01	1.19E+00	6.70E-01	1.19E+02	2.87E-02	Eq. 3.2	2.18E-08	-	2.18E-08
cis-1,2-Dichloroethene	1.00E+00	1.10E-02	1.10E-02	1.10E-05	3.72E-01	8.94E-01	6.70E-01	9.69E+01	4.17E-02	Eq. 3.2	1.67E-07	-	1.67E-07
Trichloroethene	1.00E+00	1.16E-02	1.56E-01	1.56E-04	5.81E-01	1.39E+00	6.70E-01	1.31E+02	5.11E-02	Eq. 3.2	3.12E-06	-	3.12E-06
Boazman Well													
VOCs													
Trichloroethene	1.00E+00	1.16E-02	1.50E-03	1.50E-06	5.81E-01	1.39E+00	6.70E-01	1.31E+02	5.11E-02	Eq. 3.2	3.00E-08	-	3.00E-08
PW-2													
VOCs													
Trichloroethene	1.00E+00	1.16E-02	3.83E-02	3.83E-05	5.81E-01	1.39E+00	6.70E-01	1.31E+02	5.11E-02	Eq. 3.2	7.67E-07	-	7.67E-07
PW-4													
VOCs													
Trichloroethene	1.00E+00	1.16E-02	9.00E-04	9.00E-07	5.81E-01	1.39E+00	6.70E-01	1.31E+02	5.11E-02	Eq. 3.2	1.80E-08	-	1.80E-08
PW-5													
VOCs													
Trichloroethene	1.00E+00	1.16E-02	1.50E-02	1.50E-05	5.81E-01	1.39E+00	6.70E-01	1.31E+02	5.11E-02	Eq. 3.2	3.00E-07	-	3.00E-07
PW-8													
VOCs													
Trichloroethene	1.00E+00	1.16E-02	5.00E-02	5.00E-05	5.81E-01	1.39E+00	6.70E-01	1.31E+02	5.11E-02	Eq. 3.2	9.99E-07	-	9.99E-07

Notes:

1 Value obtained from Appendix B, Exhibit B-3 (USEPA, July 2004).
A default value of 1.0 was used for cis-1,2-dichloroethene, which is not listed in Exhibit B-3.

2 Value obtained from the RSL Chemical-Specific Parameters Supporting Table (USEPA, May 2018).

3 Refer to Tables 6-6 and 6-7 for groundwater concentration.

4 Refer to Table I.3-4.

5 Refer to Table I.3-5.

6 Refer to Table I.3-3.

7 Value estimated using Equation A-1 (USEPA 2004).

8 Estimated using Equation 3-2 when $t_{event} \leq t^*$ (USEPA 2004).

9 Estimated Using Equation 3-3 when $t_{event} > t^*$ (USEPA 2004).

10 DA_{event} from either Equation 3-2 or 3-3 depending on t_{event} (USEPA 2004).

Table I.3-7

Estimation of DA_{event} for Dermal Contact with Inorganics in Groundwater (Age-AdjustedResident Adult)

Shakespeare Composite Structures Site

Newberry, South Carolina

$$\text{For inorganics,}$$
$$DA_{event} = K_p \times C_w \times CF \times t_{event}$$

Parameter	**Permeability Constant**[1] (cm/hr)	**Concentration in Water**[2] (mg/L)	**Conversion Factor** (L/cm3)	**Event Duration** (hr/event)	**Absorbed Dose per Event**[3] (mg/cm^2-event)
Chemical (Inorganics)	Kp	CW	CF	t_{event}	Final DA_{event}
Groundwater (Shallow/Intermediate)					
Metals					
Iron	1.00E-03	9.29E+00	1.00E-03	6.70E-01	6.22E-06
Manganese	1.00E-03	2.00E-01	1.00E-03	6.70E-01	1.34E-07

Notes:

[1] Value obtained from the RSL Chemical-Specific Parameters Supporting Table (USEPA, May 2018).

[2] Refer to Tables 6-6 for groundwater concentration.

[3] DA_{event} from Equation 3-4 (USEPA, July 2004).

Table I.3-8

Estimation of DA_{event} for Dermal Contact with Organics in Groundwater (Resident Child)

Shakespeare Composite Structures Site

Newberry, South Carolina

For organics,

$$If\ t_{event} \le t^*, then: DA_{event} = 2FA \times K_p \times C_w \sqrt{\frac{6\tau_{event} \times t_{event}}{\pi}}$$

$$If\ t_{event} > t^*, then: DA_{event} = FA \times K_p \times C_w \left[\frac{t_{event}}{1+B} + 2\tau_{event}\left(\frac{1+3B+3B^2}{(1+B)^2}\right)\right]$$

Parameter	**Fraction absorbed water**[1] (unitless)	**Permeability Constant**[2] (cm/hr)	**Concentration in Water**[3] (mg/L)	**Concentration in Water** (mg/cm3)	**Lag Time per Event**[4] (hr/event)	**Time to reach steady state**[5] (hr)	**Event Duration**[6] (hr/event)	**Molecular Weight**[2] (g/mole)	**Kp Stratum Corneum: Kp Viable Epidermis**[7] (unitless)	**Formula Used**[8, 9]	**Absorbed Dose per Event**[8] (mg/cm3-event)	**Absorbed Dose per Event**[9] (mg/cm3-event)	**Absorbed Dose per Event**[10] (mg/cm3-event)
Chemical (Organics)	FA	Kp	Cw (mg/L)	Cw (mg/cm ^{3})	τ_{event}	t*	t_{event}	MW	B	Formula	DA_{event} (Eq. 3.2)	DA_{event} (Eq. 3.3)	Final DA_{event} Adult
Groundwater (Shallow/Intermediate)													
VOCs													
1,2-Dichloroethane	1.00E+00	4.20E-03	5.40E-04	5.40E-07	3.82E-01	9.17E-01	5.40E-01	9.90E+01	1.61E-02	Eq. 3.2	2.85E-09	-	2.85E-09
Benzene	1.00E+00	1.49E-02	6.60E-04	6.60E-07	2.92E-01	7.01E-01	5.40E-01	7.81E+01	5.07E-02	Eq. 3.2	1.08E-08	-	1.08E-08
Chloroform	1.00E+00	6.83E-03	3.56E-03	3.56E-06	4.98E-01	1.19E+00	5.40E-01	1.19E+02	2.87E-02	Eq. 3.2	3.48E-08	-	3.48E-08
cis-1,2-Dichloroethene	1.00E+00	1.10E-02	1.19E-01	1.19E-04	3.72E-01	8.94E-01	5.40E-01	9.69E+01	4.17E-02	Eq. 3.2	1.63E-06	-	1.63E-06
Tetrachloroethene	1.00E+00	3.34E-02	4.68E-03	4.68E-06	9.07E-01	2.18E+00	5.40E-01	1.66E+02	1.65E-01	Eq. 3.2	3.02E-07	-	3.02E-07
Trichloroethene	1.00E+00	1.16E-02	4.60E-01	4.60E-04	5.81E-01	1.39E+00	5.40E-01	1.31E+02	5.11E-02	Eq. 3.2	8.27E-06	-	8.27E-06
Vinyl chloride	1.00E+00	8.38E-03	8.10E-03	8.10E-06	2.39E-01	5.73E-01	5.40E-01	6.25E+01	2.55E-02	Eq. 3.2	6.73E-08	-	6.73E-08
Groundwater (Bedrock)													
All Bedrock Wells													
VOCs													
1,2-Dichloroethane	1.00E+00	4.20E-03	7.30E-04	7.30E-07	3.82E-01	9.17E-01	5.40E-01	9.90E+01	1.61E-02	Eq. 3.2	3.85E-09	-	3.85E-09
Chloroform	1.00E+00	6.83E-03	2.00E-03	2.00E-06	4.98E-01	1.19E+00	5.40E-01	1.19E+02	2.87E-02	Eq. 3.2	1.96E-08	-	1.96E-08
cis-1,2-Dichloroethene	1.00E+00	1.10E-02	1.10E-02	1.10E-05	3.72E-01	8.94E-01	5.40E-01	9.69E+01	4.17E-02	Eq. 3.2	1.50E-07	-	1.50E-07
Trichloroethene	1.00E+00	1.16E-02	1.56E-01	1.56E-04	5.81E-01	1.39E+00	5.40E-01	1.31E+02	5.11E-02	Eq. 3.2	2.80E-06	-	2.80E-06
Boazman Well													
VOCs													
Trichloroethene	1.00E+00	1.16E-02	1.50E-03	1.50E-06	5.81E-01	1.39E+00	5.40E-01	1.31E+02	5.11E-02	Eq. 3.2	2.69E-08	-	2.69E-08
PW-2													
VOCs													
Trichloroethene	1.00E+00	1.16E-02	3.83E-02	3.83E-05	5.81E-01	1.39E+00	5.40E-01	1.31E+02	5.11E-02	Eq. 3.2	6.88E-07	-	6.88E-07
PW-4													
VOCs													
Trichloroethene	1.00E+00	1.16E-02	9.00E-04	9.00E-07	5.81E-01	1.39E+00	5.40E-01	1.31E+02	5.11E-02	Eq. 3.2	1.62E-08	-	1.62E-08
PW-5													
VOCs													
Trichloroethene	1.00E+00	1.16E-02	1.50E-02	1.50E-05	5.81E-01	1.39E+00	5.40E-01	1.31E+02	5.11E-02	Eq. 3.2	2.69E-07	-	2.69E-07
PW-8													
VOCs													
Trichloroethene	1.00E+00	1.16E-02	5.00E-02	5.00E-05	5.81E-01	1.39E+00	5.40E-01	1.31E+02	5.11E-02	Eq. 3.2	8.97E-07	-	8.97E-07

Notes:

[1] Value obtained from Appendix B, Exhibit B-3 (USEPA, July 2004).

A default value of 1.0 was used for cis-1,2-dichloroethene, which is not listed in Exhibit B-3.

[2] Value obtained from the RSL Chemical-Specific Parameters Supporting Table (USEPA, May 2018).

[3] Refer to Tables 6-6 and 6-7 for groundwater concentration.

[4] Refer to Table I.3-4.

[5] Refer to Table I.3-5.

[6] Refer to Table I.3-3.

[7] Value estimated using Equation A-1 (USEPA 2004).

[8] Estimated using Equation 3-2 when $t_{event} \le t^*$ (USEPA 2004).

[9] Estimated Using Equation 3-3 when $t_{event} > t^*$ (USEPA 2004).

[10] DA_{event} from either Equation 3-2 or 3-3 depending on t_{event} (USEPA 2004).

Table I.3-9

Estimation of DA_{event} for Dermal Contact with Inorganics in Groundwater (Resident Child)

Shakespeare Composite Structures Site

Newberry, South Carolina

$$For\ inorganics,$$
$$DA_{event} = K_p \times C_w \times CF \times t_{event}$$

Parameter	**Permeability Constant**[1] (cm/hr)	**Concentration in Water**[2] (mg/L)	**Conversion Factor** (L/cm3)	**Event Duration** (hr/event)	**Absorbed Dose per Event**[3] (mg/cm^2-event)
Chemical (Inorganics)	Kp	CW	CF	t_{event}	Final DA_{event}
Groundwater (Shallow/Intermediate)					
Metals					
Iron	1.00E-03	9.29E+00	1.00E-03	5.40E-01	5.02E-06
Manganese	1.00E-03	2.00E-01	1.00E-03	5.40E-01	1.08E-07

Notes:

[1] Value obtained from the RSL Chemical-Specific Parameters Supporting Table (USEPA, May 2018).

[2] Refer to Tables 6-6 for groundwater concentration.

[3] DA_{event} from Equation 3-4 (USEPA, July 2004).

Appendix IA.4 Chemicals of Specific Concern

Table I.4-5
Calculation of Risks to Future Residents from Ingestion of Groundwater for Vinyl Chloride
Shakespeare Composite Structures Site
Newberry, South Carolina

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	26-year Resident (Adult/Child)

Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Route:	Ingestion

Age	IRGW [1] (L/day)	EF [2] (days/yr)	ED [2] (years)	BW [1] (kg)	AT-C (days) (70 years x 365 days/year)
Early Life	0.78	NA	NA	15	NA
0 to 6 years	0.78	350	6	15	25550
6 to 26 years	2.5	350	20	80	25550

DI = (CGW x IRGWc x 1/BWc) + (CGW x IRGW c x EFc x EDc x 1/BWc x 1/AT-C) + (CGW x IRGWa x EFa x EDa x 1/BWa x 1/AT-C)

Risk (Early Life) = DI (Early Life) x SF_{EL}
Risk (0 to 6 years) = DI (0 to 6 years) x SF_{LL}
Risk (6 to 26 years) = DI (6 to 26 years) x SF_{LL}

Chemical	CGW (mg/L)	DI (Early Life) (mg/kg-day)	DI (0 to 6 years) (mg/kg-day)	DI (6 to 20 years) (mg/kg-day)	SF_{EL} (Early Life Risk) $(mg/kg\text{-}day)^{-1}$	SF_{LL} (Later Life Risk) $(mg/kg\text{-}day)^{-1}$	Risk (Early Life)	Risk (0 to 6 years)	Risk (6 to 26 years)	Total Risk
VOCs										
Vinyl Chloride (Shallow/Intermediate)	8.10E-03	4.21E-04	3.46E-05	6.93E-05	7.80E-01	7.20E-01	3.29E-04	2.49E-05	4.99E-05	4.03E-04

Where:

AT-C (days) = (70 [lifetime in years] x 365 days/year)
CGW (mg/L) = Concentration in groundwater
BWa (kg) = Body Weight - adult
BWc (kg) = Body Weight - child
DI (mg/kg-day) = Daily Intake

EDa (years) = Exposure Duration - adult
EDc (years) = Exposure Duration - child
EFa (days/year) = Exposure Frequency - adult
EFc (days/year) = Exposure Frequency - child

IRGWa (L/day) = Ingestion Rate, groundwater - adult
IRGWc (L/day) = Ingestion Rate, groundwater - child
NA = Not Applicable
SF_{EL} $(mg/kg\text{-}day)^{-1}$ = Oral Slope Factor for Early Lifetime Exposure
SF_{LL} $(mg/kg\text{-}day)^{-1}$ = Oral Slope Factor for Later Lifetime Exposure

SF_{EL} = SF for Lifetime exposure from birth - SF for Lifetime exposure during adulthood
= 1.5 $(mg/kg\text{-}day)^{-1}$ - 0.72 $(mg/kg\text{-}day)^{-1}$ = 0.78 $(mg/kg\text{-}day)^{-1}$

Sources:

[1] USEPA, 2018. Regional Screening Level User's Guide. May 2018.
[2] USEPA, 2014. OSWER Directive 9200.1-120. April 2014.

Table I.4-6
Calculation of Risks to Future Residents from Dermal Contact with Groundwater for Vinyl Chloride
Shakespeare Composite Structures Site
Newberry, South Carolina

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	26-year Resident (Adult/Child)

Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Route:	Dermal Contact

Age	EV [1] (events/day)	EF [2] (days/yr)	ED [2] (years)	SA [3] (cm^2)	BW [3, 4] (kg)	AT-C (days) (70 years x 365 days/year)
Early Life	1	NA	NA	4646	10	NA
0 to 6 years	1	350	6	6378	15	25550
6 to 26 years	1	350	20	20900	80	25550

DAD (Early Life) = DA-Event x EVc x SAc x 1/BWc
DAD (0 to 6 years) = DA-Event x EVc x EFc x EDc x SAc x 1/BWc x 1/AT-C
DAD (6 to 26 years) = DA-Event x EVa x EFa x EDa x SAa x 1/BWa x 1/AT-C

Risk (Early Life) = DAD (Early Life) x SF_{EL}
Risk (0 to 6 years) = DAD (0 to 6 years) x SF_{LL}
Risk (6 to 26 years) = DAD (6 to 26 years) x SF_{LL}

Chemical	CGW (mg/L)	DA-Event [5] (Early Life) (mg/cm^2-event)	DA-Event [5] (0 to 6 years) (mg/cm^2-event)	DA-Event [6] (6 to 26 years) (mg/cm^2-event)	DAD (Early Life) (mg/kg-day)	DAD (0 to 6 years) (mg/kg-day)	DAD (6 to 20 years) (mg/kg-day)	SF_{EL} (Early Life Risk) $(mg/kg\text{-}day)^{-1}$	SF_{LL} (Later Life Risk) $(mg/kg\text{-}day)^{-1}$	Risk (Early Life)	Risk (0 to 6 years)	Risk (6 to 26 years)	Total Risk
VOCs													
Vinyl Chloride (Shallow/Intermediate)	8.10E-03	6.73E-08	6.73E-08	7.76E-08	3.13E-05	2.35E-06	5.55E-06	7.80E-01	7.20E-01	2.44E-05	1.69E-06	4.00E-06	3.01E-05

Where:

AT-C (days) = (70 [lifetime in years] x 365 days/year)
BWa (kg) = Body Weight - adult
BWc (kg) = Body Weight - child
CGW (mg/L) = Concentration in groundwater
DAD (mg/kg-day) = Dermally Absorbed Dose
DA-Event (mg/cm2-event) = Absorbed dose per event

EDa (years) = Exposure Duration - adult
EDc (years) = Exposure Duration - child
EFa (days/year) = Exposure Frequency - adult
EFc (days/year) = Exposure Frequency - child
EVa (events/day) = Event Frequency - adult
EVc (events/day) = Event Frequency - child

NA = Not Applicable
SAa (cm2) = Skin Surface Area available for contact - adult
SAc (cm2) = Skin Surface Area available for contact - child
SF_{EL} $(mg/kg\text{-}day)^{-1}$ = Dermal Slope Factor for Early Lifetime Exposure
SF_{LL} $(mg/kg\text{-}day)^{-1}$ = Dermal Slope Factor for Later Lifetime Exposure

SF_{EL} = SF for Lifetime exposure from birth - SF for Lifetime exposure during adulthood
= 1.5 $(mg/kg\text{-}day)^{-1}$ - 0.72 $(mg/kg\text{-}day)^{-1}$ = 0.78 $(mg/kg\text{-}day)^{-1}$

Sources:

[1] USEPA, 2004. Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final, July 2004.
[2] USEPA, 2014. OSWER Directive 9200.1-120. April 2014.
[3] USEPA, 2011. Exposure Factors Handbook: 2011 Edition. EPA/ 600/ R 090/052F. September 2011.
[4] USEPA, 2018. Regional Screening Level User's Guide. May 2018.
[5] DA-Event calculations are shown on Table I.3-8.
[6] DA-Event calculations are shown on Table I.3-6.

Table I.4-7
Calculation of Risks to Future Residents from Inhalation of Vinyl Chloride while Showering with Groundwater
Shakespeare Composite Structures Site
Newberry, South Carolina

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	26-year Resident (Adult/Child)

Medium:	Groundwater
Exposure Medium:	Air
Exposure Route:	Inhalation - Showering

Age	ET [1] (hours/day)	EF [1] (days/yr)	ED [1] (years)	AT-C (hours) (70 years x 365 days/year x 24 hours/day)
Early Life	NA	NA	NA	NA
0 to 26 years	0.71	350	26	613200

EC (Early Life) = CA
EC (0 to 26 years) = (CA x ET x EF x ED) / AT-C

Risk (Early Life) = EC (Early Life) x IUR_{EL}
Risk (0 to 26 years) = EC (0 to 26 years) x IUR_{LL}

Chemical	CA (ug/m3)	EC (Early Life) (ug/m3)	EC (0 to 26 years) (ug/m3)	IUR_{EL} (Early Life Risk) $(ug/m^3)^{-1}$	IUR_{LL} (Later Life Risk) $(ug/m^3)^{-1}$	Risk (Early Life)	Risk (0 to 26 years)	Total Risk
VOCs								
Vinyl Chloride (Shallow/Intermediate)	4.05E+00	4.05E+00	4.27E-02	4.40E-06	4.40E-06	1.78E-05	1.88E-07	1.80E-05

Where:

AT-C (hours) = (70 [lifetime in years] x 365 days/year x 24 hours/day)
CA (ug/m3) = Contaminant concentration in air (calculated using USEPA Andelman Model):
(CW mg/L x 0.5 L/m3 x 1000 ug/mg)
EC (ug/m3) = Exposure concentration for estimating cancer risk

ED (years) = Exposure Duration
EF (days/year) = Exposure Frequency
IUR_{EL} $(ug/m3)^{-1}$ = Inhalation Unit Risk for Early Lifetime Exposure
IUR_{LL} $(ug/m3)^{-1}$ = Inhalation Unit Risk for Later Lifetime Exposure

IUR_{EL} = IUR for Lifetime exposure from birth - IUR for Lifetime exposure during adulthood
= 8.8E-6 $(ug/m^3)^{-1}$ - 4.4E-6 $(ug/m^3)^{-1}$ = 4.4E-6 $(ug/m^3)^{-1}$

Sources:
[1] USEPA, 2014. OSWER Directive 9200.1-120. April 2014.

Table I.4-1
Calculation of Risks to Future Residents from Ingestion of Groundwater for Trichloroethylene
Shakespeare Composite Structures Site
Newberry, South Carolina

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	26-year Resident (Adult/Child)

Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Route:	Ingestion

Age	ED [1,2] (years)	EF [2] (days/yr)	IRGW [3, 4] (L/day)	BW [3, 4] (kg)	AT-C (days) (70 years x 365 days/year)	Age-Dependent [4] Adjustment Factors
0 to 2 years	2	350	0.73	10	25550	10
2 to 6 years	4	350	0.76	17	25550	3
6 to 16 years	10	350	1.3	44	25550	3
16 to 26 years	10	350	2.2	80	25550	1
0 to 6 years (Child)	6	350	0.78	15	25550	NA
6 to 26 years (Adult)	20	350	2.5	80	25550	NA

DI = $(CGW \times [(CAF \times IFW_{res\text{-}adj}) + (MAF \times IFWM_{res\text{-}adj})] / AT\text{-}C)$

Where:

IFWres-adj = $ED_c \times EF_c \times IRGW_c \times 1/BW_c + ED_a \times EF_a \times IRGW_a \times 1/BW_a$

IFWMres-adj = $(ED_{0-2} \times EF_{0-2} \times IRGW_{0-2} \times 1/BW_{0-2} \times 10) + (ED_{2-6} \times EF_{2-6} \times IRGW_{2-6} \times 1/BW_{2-6} \times 3) + (ED_{6-16} \times EF_{6-16} \times IRGW_{6-16} \times 1/BW_{6-16} \times 3) + (ED_{16-26} \times EF_{16-26} \times IRGW_{16-26} \times 1/BW_{16-26} \times 1)$

CAF = $SF_{\text{Non-Hodgkins and Liver}} / SF_{\text{Adult}} =$ 3.72E-2 (mg/kg-day)$^{-1}$ / 4.6E-2 (mg/kg-day)$^{-1}$ = 0.804

MAF = $SF_{\text{Kidney}} / SF_{\text{Adult}} =$ 9.3E-3 (mg/kg-day)$^{-1}$ / 4.6E-2 (mg/kg-day)$^{-1}$ = 0.202

Risk = DI x SF

Chemical	CGW (mg/L)	IFWres-adj (L/kg)	IFWMres-adj (L/kg)	DI (0 to 26 years) (mg/kg-day)	SF (mg/kg-day)$^{-1}$	Risk (0 to 26 years)	Total Risk
Trichloroethylene (Shallow/Intermediate)	4.60E-01	3.28E+02	1.11E+03	8.77E-03	4.60E-02	4.03E-04	4.03E-04
Trichloroethylene (All Bedrock Wells)	1.56E-01	3.28E+02	1.11E+03	2.97E-03	4.60E-02	1.37E-04	1.37E-04
Trichloroethylene (Boazman Well)	1.50E-03	3.28E+02	1.11E+03	2.86E-05	4.60E-02	1.31E-06	1.31E-06
Trichloroethylene (PW-2)	3.83E-02	3.28E+02	1.11E+03	7.30E-04	4.60E-02	3.36E-05	3.36E-05
Trichloroethylene (PW-4)	9.00E-04	3.28E+02	1.11E+03	1.72E-05	4.60E-02	7.89E-07	7.89E-07
Trichloroethylene (PW-5)	1.50E-02	3.28E+02	1.11E+03	2.86E-04	4.60E-02	1.31E-05	1.31E-05
Trichloroethylene (PW-8)	5.00E-02	3.28E+02	1.11E+03	9.52E-04	4.60E-02	4.38E-05	4.38E-05

Where:

AT-C (days) = (70 [lifetime in years] x 365 days/year)
BW (kg) = Body Weight
CAF (unitless) = Carcinogenic Adjustment Factor
CGW (mg/L) = Concentration in groundwater
DI (mg/kg-day) = Daily Intake
ED (years) = Exposure Duration
EF (days/year) = Exposure Frequency
IFWres-adj (L/kg) = Resident Drinking Water Ingestion Rate (Age-Adjusted)
IFWMres-adj (L/kg) = Resident Mutagenic Drinking Water Ingestion Rate (Age-Adjusted)
IRGW (L/day) = Ingestion Rate, groundwater
MAF (unitless) = Mutagenic Adjustment Factor
SF (mg/kg-day)$^{-1}$ = Oral Slope Factor

Sources:

[1] USEPA, 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. March 2005.
[2] USEPA, 2014. OSWER Directive 9200.1-120. April 2014.
[3] USEPA, 2011. Exposure Factors Handbook: 2011 Edition. EPA/ 600/ R 090/052F. September 2011.
[4] USEPA, 2018. Regional Screening Level User's Guide. May 2018.

Table I.4-2
Calculation of Risks to Future Residents from Dermal Contact with Groundwater for Trichloroethylene
Shakespeare Composite Structures Site
Newberry, South Carolina

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	26-year Resident (Adult/Child)

Medium:	Groundwater
Exposure Medium:	Groundwater
Exposure Route:	Dermal Contact

Age	EV [1] (events/day)	EF [2] (days/yr)	ED [2, 3] (years)	SA [4] (cm^2)	BW [4, 5] (kg)	AT-C (days) (70 years x 365 days/year)	Age-Dependent [5] Adjustment Factors
0 to 2 years	1	350	2	4646	10	25550	10
2 to 6 years	1	350	4	7225	17	25550	3
6 to 16 years	1	350	10	13350	44	25550	3
16 to 26 years	1	350	10	19450	80	25550	1
0 to 6 years (Child)	1	350	6	6378	15	25550	NA
6 to 26 years (Adult)	1	350	20	20900	80	25550	NA

DAD = ([(CAF x DFWres-adj) + (MAF x DFWMres-adj)] /AT-C)

Where:

$DFWres\text{-}adj = DA\text{-}Event_c \times EV_c \times ED_c \times EF_c \times SA_c \times 1/BW_c + DA\text{-}Event_a \times EV_a \times ED_a \times EF_a \times SA_a \times 1/BW_a$

$DFWMres\text{-}adj = (DA\text{-}Event_{0\text{-}2} \times EV_{0\text{-}2} \times ED_{0\text{-}2} \times EF_{0\text{-}2} \times SA_{0\text{-}2} \times 1/BW_{0\text{-}2} \times 10) + (DA\text{-}Event_{2\text{-}6} \times EV_{2\text{-}6} \times ED_{2\text{-}6} \times EF_{2\text{-}6} \times SA_{2\text{-}6} \times 1/BW_{2\text{-}6} \times 3) +$
$(DA\text{-}Event_{6\text{-}16} \times EV_{6\text{-}16} \times ED_{6\text{-}16} \times EF_{6\text{-}16} \times SA_{6\text{-}16} \times 1/BW_{6\text{-}16} \times 3) + (DA\text{-}Event_{16\text{-}26} \times EV_{16\text{-}26} \times ED_{16\text{-}26} \times EF_{16\text{-}26} \times SA_{16\text{-}26} \times 1/BW_{16\text{-}26} \times 1)$

$CAF = SF_{Non\text{-}Hodgkins\ and\ Liver} / SF_{Adult}$ = 3.72E-2 $(mg/kg\text{-}day)^{-1}$ / 4.6E-2 $(mg/kg\text{-}day)^{-1}$ = 0.804

$MAF = SF_{Kidney} / SF_{Adult}$ = 9.3E-3 $(mg/kg\text{-}day)^{-1}$ / 4.6E-2 $(mg/kg\text{-}day)^{-1}$ = 0.202

Risk = DAD x SF

Chemical	CGW (mg/L)	DA-Event [6] (0 to 2 years) (2 to 6 years) (mg/cm^2-event)	DA-Event [7] (6 to 16 years) (16 to 26 years) (mg/cm^2-event)	DA-Event [6] (0 to 6 years) (mg/cm^2-event)	DA-Event [7] (6 to 26 years) (mg/cm^2-event)	DFWres-adj (L/kg)	DFWMres-adj (L/kg)	DAD (mg/kg-day)	SF $(mg/kg\text{-}day)^{-1}$	Risk (0 to 26 years)	Total Risk
Trichloroethylene (Shallow/Intermediate)	4.60E-01	8.27E-06	9.21E-06	8.27E-06	9.21E-06	2.42E+01	7.88E+01	1.39E-03	4.60E-02	6.37E-05	6.37E-05
Trichloroethylene (All Bedrock Wells)	1.56E-01	2.80E-06	3.12E-06	2.80E-06	3.12E-06	8.21E+00	2.67E+01	4.69E-04	4.60E-02	2.16E-05	2.16E-05
Trichloroethylene (Boazman Well)	1.50E-03	2.69E-08	3.00E-08	2.69E-08	3.00E-08	7.89E-02	2.57E-01	4.51E-06	4.60E-02	2.08E-07	2.08E-07
Trichloroethylene (PW-2)	3.83E-02	6.88E-07	7.67E-07	6.88E-07	7.67E-07	2.02E+00	6.56E+00	1.15E-04	4.60E-02	5.31E-06	5.31E-06
Trichloroethylene (PW-4)	9.00E-04	1.62E-08	1.80E-08	1.62E-08	1.80E-08	4.74E-02	1.54E-01	2.71E-06	4.60E-02	1.25E-07	1.25E-07
Trichloroethylene (PW-5)	1.50E-02	2.69E-07	3.00E-07	2.69E-07	3.00E-07	7.89E-01	2.57E+00	4.51E-05	4.60E-02	2.08E-06	2.08E-06
Trichloroethylene (PW-8)	5.00E-02	8.97E-07	9.99E-07	8.97E-07	9.99E-07	2.63E+00	8.55E+00	1.50E-04	4.60E-02	6.92E-06	6.92E-06

Where:

AT-C (days) = (70 [lifetime in years] x 365 days/year)
BW (kg) = Body Weight
CAF (unitless) = Carcinogenic Adjustment Factor
CGW (mg/L) = Concentration in groundwater
DAD (mg/kg-day) = Dermally Absorbed Dose
DA-Event (mg/cm2-event) = Absorbed dose per event
DFWres-adj (L/kg) = Resident Water Dermal Contact Rate (Age-Adjusted)
DFWMres-adj (mg/kg) = Resident Mutagenic Water Dermal Contact Rate (Age-Adjusted)
ED (years) = Exposure Duration
EF (days/year) = Exposure Frequency
EV (events/day) = Event Frequency
MAF (unitless) = Mutagenic Adjustment Factor
SA (cm2) = Skin Surface Area available for contact
SF $(mg/kg\text{-}day)^{-1}$ = Dermal Slope Factor

Sources:

[1] USEPA, 2004. Risk Assessment Guidance for Superfund Volume 1: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), Final, July 2004.
[2] USEPA, 2014. OSWER Directive 9200.1-120. April 2014.
[3] USEPA, 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. March 2005.
[4] USEPA, 2011. Exposure Factors Handbook: 2011 Edition. EPA/ 600/ R 090/052F. September 2011.
[5] USEPA, 2018. Regional Screening Level User's Guide. May 2018.
[6] DA-Event calculations are shown on Table I.3-8.
[7] DA-Event calculations are shown on Table I.3-6.

Table I.4-3
Calculation of Risks to Future Residents from Inhalation of Trichloroethylene while Showering with Groundwater
Shakespeare Composite Structures Site
Newberry, South Carolina

Scenario Timeframe:	Future	Medium:	Groundwater
Receptor Population:	Resident	Exposure Medium:	Air
Receptor Age:	26-year Resident (Adult/Child)	Exposure Route:	Inhalation - Showering

Age	ET [1] (hours/day)	EF [1] (days/yr)	ED [1,2] (years)	AT-C (hours) (70 years x 365 days/year x 24 hours/day)	Age-Dependent [3] Adjustment Factors
0 to 2 years	0	350	2	613200	10
2 to 6 years	0	350	4	613200	3
6 to 16 years	0.71	350	10	613200	3
16 to 26 years	0.71	350	10	613200	1
26 years	0.71	350	26	613200	NA

EC = CA x [(ET_{res} x EF_{res} x ED_{res} x CAF_{res}) + (ET_{0-2} x EF_{0-2} x ED_{0-2} x MAF x 10) + (ET_{2-6} x EF_{2-6} x ED_{2-6} x MAF x 3) +
(ET_{6-16} x EF_{6-16} x ED_{6-16} x MAF x 3) + (ET_{16-26} x EF_{16-26} x ED_{16-26} x MAF x 1)] / AT-C

Where:

CAF = $IUR_{Non-Hodgkins\ and\ Liver}$ / IUR_{Adult} = 3.1E-6 $(ug/m^3)^{-1}$ / 4.1E-6 $(ug/m^3)^{-1}$ = 0.756

MAF = IUR_{Kidney} / IUR_{Adult} = 1E-6 $(ug/m^3)^{-1}$ / 4.1E-6 $(ug/m^3)^{-1}$ = 0.244

Risk (0 to 26 years) = EC x IUR

Risk (0 to 26 years) = EC x IUR	CA (ug/m3)	EC (0 to 26 years) (ug/m3)	IUR $(ug/m^3)^{-1}$	Risk (0 to 26 years)	Total Risk
Trichloroethylene (Shallow/Intermediate)	2.30E+02	2.74E+00	4.10E-06	1.12E-05	1.12E-05
Trichloroethylene (All Bedrock Wells)	7.80E+01	9.30E-01	4.10E-06	3.81E-06	3.81E-06
Trichloroethylene (Boazman Well)	7.50E-01	8.94E-03	4.10E-06	3.67E-08	3.67E-08
Trichloroethylene (PW-2)	1.92E+01	2.28E-01	4.10E-06	9.37E-07	9.37E-07
Trichloroethylene (PW-4)	4.50E-01	5.36E-03	4.10E-06	2.20E-08	2.20E-08
Trichloroethylene (PW-5)	7.50E+00	8.94E-02	4.10E-06	3.67E-07	3.67E-07
Trichloroethylene (PW-8)	2.50E+01	2.98E-01	4.10E-06	1.22E-06	1.22E-06

Where:

AT-C (hours) = (70 [lifetime in years] x 365 days/year x 24 hours/day)
CA (ug/m3) = Contaminant concentration in air (calculated using USEPA Andelman Model):
(CW mg/L x 0.5 L/m3 x 1000 ug/mg)
CAF (unitless) = Carcinogenic Adjustment Factor
EC (ug/m3) = Exposure concentration for estimating cancer risk

ED (years) = Exposure Duration
EF (days/year) = Exposure Frequency
ET (hours/day) = Exposure Time
IUR $(ug/m3)^{-1}$ = Inhalation Unit Risk
MAF (unitless) = Mutagenic Adjustment Factor

Sources:

[1] USEPA, 2014. OSWER Directive 9200.1-120. April 2014.
[2] USEPA, 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. March 2005.
[3] USEPA, 2018. Regional Screening Level User's Guide. May 2018.

Table I.4-4
Calculation of Risks to Future Residents from Inhalation of VOCs via Vapor Intrusion for Trichloroethylene
Shakespeare Composite Structures Site
Newberry, South Carolina

Scenario Timeframe:	Future
Receptor Population:	Resident
Receptor Age:	26-year Resident (Adult/Child)

Medium:	Groundwater
Exposure Medium:	Air
Exposure Route:	Inhalation - Indoor Air

Age	ET [1] (hours/day)	EF [1] (days/yr)	ED [1,2] (years)	AT-C (hours) (70 years x 365 days/year x 24 hours/day)	Age-Dependent [3] Adjustment Factors
0 to 2 years	24	350	2	613200	10
2 to 6 years	24	350	4	613200	3
6 to 16 years	24	350	10	613200	3
16 to 26 years	24	350	10	613200	1
26 years	24	350	26	613200	NA

EC = CA x [(ET_{res} x EF_{res} x ED_{res} x CAF_{res}) + ($ET_{0\text{-}2}$ x $EF_{0\text{-}2}$ x $ED_{0\text{-}2}$ x MAF x 10) + ($ET_{2\text{-}6}$ x $EF_{2\text{-}6}$ x $ED_{2\text{-}6}$ x MAF x 3) +
($ET_{6\text{-}16}$ x $EF_{6\text{-}16}$ x $ED_{6\text{-}16}$ x MAF x 3) + ($ET_{16\text{-}26}$ x $EF_{16\text{-}26}$ x $ED_{16\text{-}26}$ x MAF x 1)] / AT-C

Where:

CAF = $IUR_{\text{Non-Hodgkins and Liver}}$ / IUR_{Adult} = 3.1E-6 $(ug/m^3)^{-1}$ / 4.1E-6 $(ug/m^3)^{-1}$ = 0.756
MAF = IUR_{Kidney} / IUR_{Adult} = 1E-6 $(ug/m^3)^{-1}$ / 4.1E-6 $(ug/m^3)^{-1}$ = 0.244

Risk (0 to 26 years) = EC x IUR

Chemical	CA (ug/m3)	EC (0 to 26 years) (ug/m3)	IUR $(ug/m^3)^{-1}$	Risk (0 to 26 years)	Total Risk
Trichloroethylene (Shallow/Intermediate)	1.82E+00	9.30E-01	4.10E-06	3.81E-06	3.81E-06

Where:
AT-C (hours) = (70 [lifetime in years] x 365 days/year x 24 hours/day)
CA (ug/m3) = Contaminant concentration in air (calculated using Johnson and Ettinger Model)
CAF (unitless) = Carcinogenic Adjustment Factor
EC (ug/m3) = Exposure concentration for estimating cancer risk
ED (years) = Exposure Duration
EF (days/year) = Exposure Frequency
ET (hours/day) = Exposure Time
IUR $(ug/m3)^{-1}$ = Inhalation Unit Risk
MAF (unitless) = Mutagenic Adjustment Factor

Sources:
[1] USEPA, 2014. OSWER Directive 9200.1-120. April 2014.
[2] USEPA, 2005. Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens. March 2005.
[3] USEPA, 2018. Regional Screening Level User's Guide. May 2018.

Appendix IA.5 Risk Calculations

Table I.5-1
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Adult (Shallow/Intermediate Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC		Cancer Risk Calculations					Noncancer Hazard Calculations				
							Intake/Exposure Concentration		CSF/Unit Risk		Cancer Risk	Intake/Exposure Concentration		RfD/RfC		Hazard Quotient
					Value	Units	Value	Units	Value	Units		Value	Units	Value	Units	
Groundwater	Groundwater	Groundwater (Shallow/ Intermediate)	Ingestion	***VOCs***												
				1,2-Dichloroethane	5.40E-04	mg/L	6.9E-06	mg/kg-day	9.1E-02	kg-day/mg	6E-07	1.6E-05	mg/kg-day	6.0E-03	mg/kg-day	0.003
				Benzene	6.60E-04	mg/L	8.5E-06	mg/kg-day	5.5E-02	kg-day/mg	5E-07	2.0E-05	mg/kg-day	4.0E-03	mg/kg-day	0.005
				Chloroform	3.56E-03	mg/L	4.6E-05	mg/kg-day	3.1E-02	kg-day/mg	1E-06	1.1E-04	mg/kg-day	1.0E-02	mg/kg-day	0.01
				cis-1,2-Dichloroethene	1.19E-01	mg/L	1.5E-03	mg/kg-day	NA	kg-day/mg	NA	3.6E-03	mg/kg-day	2.0E-03	mg/kg-day	2
				Tetrachloroethene	4.68E-03	mg/L	6.0E-05	mg/kg-day	2.1E-03	kg-day/mg	1E-07	1.4E-04	mg/kg-day	6.0E-03	mg/kg-day	0.02
				Trichloroethene	4.60E-01	mg/L	(1)	(1)	(1)	(1)	4E-04	1.4E-02	mg/kg-day	5.0E-04	mg/kg-day	28
				Vinyl chloride	8.10E-03	mg/L	(1)	(1)	(1)	(1)	4E-04	2.4E-04	mg/kg-day	3.0E-03	mg/kg-day	0.08
				Metals												
				Iron	9.29E+00	mg/L	1.2E-01	mg/kg-day	NA	kg-day/mg	NA	2.8E-01	mg/kg-day	7.0E-01	mg/kg-day	0.4
				Manganese	2.00E-01	mg/L	2.6E-03	mg/kg-day	NA	kg-day/mg	NA	6.0E-03	mg/kg-day	2.4E-02	mg/kg-day	0.2
			Exp. Route Total								8E-04					30
			Dermal	***VOCs***												
				1,2-Dichloroethane	5.40E-04	mg/L	3.4E-07	mg/kg-day	9.1E-02	kg-day/mg	3E-08	7.9E-07	mg/kg-day	6.0E-03	mg/kg-day	0.0001
				Benzene	6.60E-04	mg/L	1.3E-06	mg/kg-day	5.5E-02	kg-day/mg	7E-08	3.0E-06	mg/kg-day	4.0E-03	mg/kg-day	0.0008
				Chloroform	3.56E-03	mg/L	4.1E-06	mg/kg-day	3.1E-02	kg-day/mg	1E-07	9.7E-06	mg/kg-day	1.0E-02	mg/kg-day	0.001
				cis-1,2-Dichloroethene	1.19E-01	mg/L	1.9E-04	mg/kg-day	NA	kg-day/mg	NA	4.5E-04	mg/kg-day	2.0E-03	mg/kg-day	0.2
				Tetrachloroethene	4.68E-03	mg/L	3.6E-05	mg/kg-day	2.1E-03	kg-day/mg	8E-08	8.4E-05	mg/kg-day	6.0E-03	mg/kg-day	0.01
				Trichloroethene	4.60E-01	mg/L	(1)	(1)	(1)	(1)	6E-05	2.3E-03	mg/kg-day	5.0E-04	mg/kg-day	5
				Vinyl chloride	8.10E-03	mg/L	(1)	(1)	(1)	(1)	3E-05	1.9E-05	mg/kg-day	3.0E-03	mg/kg-day	0.006
				Metals												
				Iron	9.29E+00	mg/L	6.6E-04	mg/kg-day	NA	kg-day/mg	NA	1.6E-03	mg/kg-day	7.0E-01	mg/kg-day	0.002
				Manganese	2.00E-01	mg/L	1.4E-05	mg/kg-day	NA	kg-day/mg	NA	3.4E-05	mg/kg-day	9.6E-04	mg/kg-day	0.03
			Exp. Route Total								9E-05					5
		Exposure Point Total									9E-04					35
	Exposure Medium Total										9E-04					35
	Vapors from Groundwater	Water Vapors at Showerhead (2)	Inhalation	***VOCs***												
				1,2-Dichloroethane	2.70E-01	ug/m3	2.84E-03	ug/m3	2.6E-05	$(ug/m3)^{-1}$	7E-08	7.7E-03	ug/m3	7.0E+00	ug/m3	0.001
				Benzene	3.30E-01	ug/m3	3.48E-03	ug/m3	7.8E-06	$(ug/m3)^{-1}$	3E-08	9.4E-03	ug/m3	3.0E+01	ug/m3	0.0003
				Chloroform	1.78E+00	ug/m3	1.88E-02	ug/m3	2.3E-05	$(ug/m3)^{-1}$	4E-07	5.1E-02	ug/m3	9.8E+01	ug/m3	0.0005
				cis-1,2-Dichloroethene	5.96E+01	ug/m3	6.28E-01	ug/m3	NA	$(ug/m3)^{-1}$	NA	1.7E+00	ug/m3	NA	ug/m3	NA
				Tetrachloroethene	2.34E+00	ug/m3	2.47E-02	ug/m3	2.6E-07	$(ug/m3)^{-1}$	6E-09	6.6E-02	ug/m3	4.0E+01	ug/m3	0.002
				Trichloroethene	2.30E+02	ug/m3	(1)	(1)	(1)	(1)	1E-05	6.5E+00	ug/m3	2.0E+00	ug/m3	3
				Vinyl chloride	4.05E+00	ug/m3	(1)	(1)	(1)	(1)	2E-05	1.1E-01	ug/m3	1.0E+02	ug/m3	0.001
			Exp. Route Total								3E-05					3
		Exposure Point Total									3E-05					3
		Indoor Air Via Vapor Intrusion	Inhalation	***VOCs***												
				Trichloroethene	1.82E+00	ug/m3	(1)	(1)	(1)	(1)	4E-06	1.7E+00	ug/m3	2.0E+00	ug/m3	0.9
			Exp. Route Total								4E-06					0.9
		Exposure Point Total									4E-06					0.9
	Exposure Medium Total										3E-05					4
Groundwater Total											9E-04					39
Total Receptor Risk							Total of Receptor Risks Across Shallow/Intermediate Groundwater				9E-04	Total of Receptor Hazards Across Shallow/Intermediate GW				39

(1) Refer to Appendix I.4 Tables for the risk estimates for Trichloroethene and Vinyl Chloride.
(2) Only Groundwater COPCs considered volatile are evaluated for inhalation while showering.
NA - Not Applicable.

Table I.5-2
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Child (Shallow/Intermediate Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Shallow/ Intermediate)	Ingestion	***VOCs***												
				1,2-Dichloroethane	5.40E-04	mg/L	NA	NA	NA	NA	NA	2.7E-05	mg/kg-day	6.0E-03	mg/kg-day	0.004
				Benzene	6.60E-04	mg/L	NA	NA	NA	NA	NA	3.3E-05	mg/kg-day	4.0E-03	mg/kg-day	0.008
				Chloroform	3.56E-03	mg/L	NA	NA	NA	NA	NA	1.8E-04	mg/kg-day	1.0E-02	mg/kg-day	0.02
				cis-1,2-Dichloroethene	1.19E-01	mg/L	NA	NA	NA	NA	NA	5.9E-03	mg/kg-day	2.0E-03	mg/kg-day	3
				Tetrachloroethene	4.68E-03	mg/L	NA	NA	NA	NA	NA	2.3E-04	mg/kg-day	6.0E-03	mg/kg-day	0.04
				Trichloroethene	4.60E-01	mg/L	NA	NA	NA	NA	NA	2.3E-02	mg/kg-day	5.0E-04	mg/kg-day	46
				Vinyl chloride	8.10E-03	mg/L	NA	NA	NA	NA	NA	4.0E-04	mg/kg-day	3.0E-03	mg/kg-day	0.1
				Metals												
				Iron	9.29E+00	mg/L	NA	NA	NA	NA	NA	4.6E-01	mg/kg-day	7.0E-01	mg/kg-day	0.7
				Manganese	2.00E-01	mg/L	NA	NA	NA	NA	NA	1.0E-02	mg/kg-day	2.4E-02	mg/kg-day	0.4
			Exp. Route Total								NA					50
			Dermal	***VOCs***												
				1,2-Dichloroethane	5.40E-04	mg/L	NA	NA	NA	NA	NA	1.2E-06	mg/kg-day	6.0E-03	mg/kg-day	0.0002
				Benzene	6.60E-04	mg/L	NA	NA	NA	NA	NA	4.4E-06	mg/kg-day	4.0E-03	mg/kg-day	0.001
				Chloroform	3.56E-03	mg/L	NA	NA	NA	NA	NA	1.4E-05	mg/kg-day	1.0E-02	mg/kg-day	0.001
				cis-1,2-Dichloroethene	1.19E-01	mg/L	NA	NA	NA	NA	NA	6.6E-04	mg/kg-day	2.0E-03	mg/kg-day	0.3
				Tetrachloroethene	4.68E-03	mg/L	NA	NA	NA	NA	NA	1.2E-04	mg/kg-day	6.0E-03	mg/kg-day	0.02
				Trichloroethene	4.60E-01	mg/L	NA	NA	NA	NA	NA	3.4E-03	mg/kg-day	5.0E-04	mg/kg-day	7
				Vinyl chloride	8.10E-03	mg/L	NA	NA	NA	NA	NA	2.7E-05	mg/kg-day	3.0E-03	mg/kg-day	0.009
				Metals												
				Iron	9.29E+00	mg/L	NA	NA	NA	NA	NA	2.0E-03	mg/kg-day	7.0E-01	mg/kg-day	0.003
				Manganese	2.00E-01	mg/L	NA	NA	NA	NA	NA	4.4E-05	mg/kg-day	9.6E-04	mg/kg-day	0.05
			Exp. Route Total								NA					7
		Exposure Point Total									NA					57
	Exposure Medium Total										NA					57
	Vapors from Groundwater	Indoor Air Via Vapor Intrusion	Inhalation	***VOCs***												
				Trichloroethene	1.82E+00	ug/m3	NA	NA	NA	NA	NA	1.7E+00	ug/m3	2.0E+00	ug/m3	0.9
			Exp. Route Total								NA					0.9
		Exposure Point Total									NA					0.9
	Exposure Medium Total										NA					0.9
Groundwater Total											NA					58
Total Receptor Risk							Total of Receptor Risks Across Shallow/Intermediate Groundwater				NA	Total of Receptor Hazards Across Shallow/Intermediate GW				58

NA - Not Applicable.

Table I.5-3
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Adult (Bedrock Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock)	Ingestion	***VOCs***												
				1,2-Dichloroethane	7.30E-04	mg/L	9.4E-06	mg/kg-day	9.1E-02	kg-day/mg	9E-07	2.2E-05	mg/kg-day	6.0E-03	mg/kg-day	0.004
				Chloroform	2.00E-03	mg/L	2.6E-05	mg/kg-day	3.1E-02	kg-day/mg	8E-07	6.0E-05	mg/kg-day	1.0E-02	mg/kg-day	0.006
				cis-1,2-Dichloroethene	1.10E-02	mg/L	1.4E-04	mg/kg-day	NA	kg-day/mg	NA	3.3E-04	mg/kg-day	2.0E-03	mg/kg-day	0.2
				Trichloroethene	1.56E-01	mg/L	(1)	(1)	(1)	(1)	1E-04	4.7E-03	mg/kg-day	5.0E-04	mg/kg-day	9
			Exp. Route Total								1E-04					10
			Dermal	***VOCs***												
				1,2-Dichloroethane	7.30E-04	mg/L	4.6E-07	mg/kg-day	9.1E-02	kg-day/mg	4E-08	1.1E-06	mg/kg-day	6.0E-03	mg/kg-day	0.0002
				Chloroform	2.00E-03	mg/L	2.3E-06	mg/kg-day	3.1E-02	kg-day/mg	7E-08	5.5E-06	mg/kg-day	1.0E-02	mg/kg-day	0.0005
				cis-1,2-Dichloroethene	1.10E-02	mg/L	1.8E-05	mg/kg-day	NA	kg-day/mg	NA	4.2E-05	mg/kg-day	2.0E-03	mg/kg-day	0.02
				Trichloroethene	1.56E-01	mg/L	(1)	(1)	(1)	(1)	2E-05	7.8E-04	mg/kg-day	5.0E-04	mg/kg-day	2
			Exp. Route Total								2E-05					2
		Exposure Point Total									2E-04					11
	Exposure Medium Total										2E-04					11
	Vapors from Groundwater	Water Vapors at Showerhead [2]	Inhalation	***VOCs***												
				1,2-Dichloroethane	3.65E-01	ug/m3	3.85E-03	ug/m3	2.6E-05	$(ug/m3)^{-1}$	1E-07	1.0E-02	ug/m3	7.0E+00	ug/m3	0.001
				Chloroform	1.00E+00	ug/m3	1.05E-02	ug/m3	2.3E-05	$(ug/m3)^{-1}$	2E-07	2.8E-02	ug/m3	9.8E+01	ug/m3	0.0003
				cis-1,2-Dichloroethene	5.50E+00	ug/m3	5.80E-02	ug/m3	NA	$(ug/m3)^{-1}$	NA	1.6E-01	ug/m3	NA	ug/m3	NA
				Trichloroethene	7.80E+01	ug/m3	(1)	(1)	(1)	(1)	4E-06	2.2E+00	ug/m3	2.0E+00	ug/m3	1
			Exp. Route Total								4E-06					1
		Exposure Point Total									4E-06					1
	Exposure Medium Total										4E-06					1
Groundwater Total											2E-04					12
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater				2E-04	Total of Receptor Hazards Across Bedrock GW				12

(1) Refer to Appendix I.4 Tables for the risk estimates for Trichloroethene.

(2) Only Groundwater COPCs considered volatile are evaluated for inhalation while showering.

NA - Not Applicable.

Table I.5-4
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Child (Bedrock Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock)	Ingestion	***VOCs***												
				1,2-Dichloroethane	7.30E-04	mg/L	NA	NA	NA	NA	NA	3.6E-05	mg/kg-day	6.0E-03	mg/kg-day	0.006
				Chloroform	2.00E-03	mg/L	NA	NA	NA	NA	NA	1.0E-04	mg/kg-day	1.0E-02	mg/kg-day	0.01
				cis-1,2-Dichloroethene	1.10E-02	mg/L	NA	NA	NA	NA	NA	5.5E-04	mg/kg-day	2.0E-03	mg/kg-day	0.3
				Trichloroethene	1.56E-01	mg/L	NA	NA	NA	NA	NA	7.8E-03	mg/kg-day	5.0E-04	mg/kg-day	16
			Exp. Route Total								NA					16
			Dermal	***VOCs***												
				1,2-Dichloroethane	7.30E-04	mg/L	NA	NA	NA	NA	NA	1.6E-06	mg/kg-day	6.0E-03	mg/kg-day	0.0003
				Chloroform	2.00E-03	mg/L	NA	NA	NA	NA	NA	8.0E-06	mg/kg-day	1.0E-02	mg/kg-day	0.0008
				cis-1,2-Dichloroethene	1.10E-02	mg/L	NA	NA	NA	NA	NA	6.1E-05	mg/kg-day	2.0E-03	mg/kg-day	0.03
				Trichloroethene	1.56E-01	mg/L	NA	NA	NA	NA	NA	1.1E-03	mg/kg-day	5.0E-04	mg/kg-day	2
			Exp. Route Total								NA					2
		Exposure Point Total									NA					18
	Exposure Medium Total										NA					18
Groundwater Total											NA					18
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater				NA	Total of Receptor Hazards Across Bedrock GW				18

NA - Not Applicable.

Table I.5-5
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Adult (Bedrock Groundwater — Boazman Well)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer: Intake/Exposure Concentration Value	Cancer: Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer: Intake/Exposure Concentration Value	Noncancer: Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock — Boazman Well)	Ingestion	***VOCs***												
				Trichloroethene	1.50E-03	mg/L	(1)	(1)	(1)	(1)	1E-06	4.5E-05	mg/kg-day	5.0E-04	mg/kg-day	0.09
			Exp. Route Total								1E-06					0.09
			Dermal	***VOCs***												
				Trichloroethene	1.50E-03	mg/L	(1)	(1)	(1)	(1)	2E-07	7.5E-06	mg/kg-day	5.0E-04	mg/kg-day	0.02
			Exp. Route Total								2E-07					0.02
		Exposure Point Total									2E-06					0.1
	Exposure Medium Total										2E-06					0.1
	Vapors from Groundwater	Water Vapors at Showerhead (2)	Inhalation	***VOCs***												
				Trichloroethene	7.50E-01	ug/m3	(1)	(1)	(1)	(1)	4E-08	2.1E-02	ug/m3	2.0E+00	ug/m3	0.01
			Exp. Route Total								4E-08					0.01
		Exposure Point Total									4E-08					0.01
	Exposure Medium Total										4E-08					0.01
Groundwater Total											2E-06					0.1
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater (Boazman Well)				2E-06	Total of Receptor Hazards Across Bedrock GW (Boazman Well)				0.1

(1) Refer to Appendix I.4 Tables for the risk estimates for Trichloroethene.
(2) Only Groundwater COPCs considered volatile are evaluated for inhalation while showering.

Table I.5-6
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Child (Bedrock Groundwater — Boazman Well)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock — Boazman Well)	Ingestion	***VOCs***												
				Trichloroethene	1.50E-03	mg/L	NA	NA	NA	NA	NA	7.5E-05	mg/kg-day	5.0E-04	mg/kg-day	0.1
			Exp. Route Total								NA					0.1
			Dermal	***VOCs***												
				Trichloroethene	1.50E-03	mg/L	NA	NA	NA	NA	NA	1.1E-05	mg/kg-day	5.0E-04	mg/kg-day	0.02
			Exp. Route Total								NA					0.02
		Exposure Point Total									NA					0.2
	Exposure Medium Total										NA					0.2
Groundwater Total											NA					0.2
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater (Boazman Well)				NA	Total of Receptor Hazards Across Bedrock GW (Boazman Well)				0.2

NA - Not Applicable.

Table I.5-7
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Adult (Bedrock Groundwater — PW-2)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock — PW-2)	Ingestion	***VOCs***												
				Trichloroethene	3.83E-02	mg/L	(1)	(1)	(1)	(1)	3E-05	1.1E-03	mg/kg-day	5.0E-04	mg/kg-day	2
			Exp. Route Total								3E-05					2
			Dermal	***VOCs***												
				Trichloroethene	3.83E-02	mg/L	(1)	(1)	(1)	(1)	5E-06	1.9E-04	mg/kg-day	5.0E-04	mg/kg-day	0.4
			Exp. Route Total								5E-06					0.4
		Exposure Point Total									4E-05					3
	Exposure Medium Total										4E-05					3
	Vapors from Groundwater	Water Vapors at Showerhead (2)	Inhalation	***VOCs***												
				Trichloroethene	1.92E+01	ug/m3	(1)	(1)	(1)	(1)	9E-07	5.4E-01	ug/m3	2.0E+00	ug/m3	0.3
			Exp. Route Total								9E-07					0.3
		Exposure Point Total									9E-07					0.3
	Exposure Medium Total										9E-07					0.3
Groundwater Total											4E-05					3
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater (PW-2)				4E-05	Total of Receptor Hazards Across Bedrock GW (PW-2)				3

(1) Refer to Appendix I.4 Tables for the risk estimates for Trichloroethene.
(2) Only Groundwater COPCs considered volatile are evaluated for inhalation while showering.
NA - Not Applicable.

Table I.5-8
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Child (Bedrock Groundwater — PW-2)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock — PW2)	Ingestion	***VOCs***												
				Trichloroethene	3.83E-02	mg/L	NA	NA	NA	NA	NA	1.9E-03	mg/kg-day	5.0E-04	mg/kg-day	4
			Exp. Route Total								NA					4
			Dermal	***VOCs***												
				Trichloroethene	3.83E-02	mg/L	NA	NA	NA	NA	NA	2.8E-04	mg/kg-day	5.0E-04	mg/kg-day	0.6
			Exp. Route Total								NA					0.6
		Exposure Point Total									NA					4
	Exposure Medium Total										NA					4
Groundwater Total											NA					4
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater (PW-2)				NA	Total of Receptor Hazards Across Bedrock GW (PW-2)				4

NA - Not Applicable.

Table I.5-9
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Adult (Bedrock Groundwater — PW-4)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer: Intake/Exposure Concentration Value	Cancer: Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer: Intake/Exposure Concentration Value	Noncancer: Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock — PW-4)	Ingestion	***VOCs***												
				Trichloroethene	9.00E-04	mg/L	(1)	(1)	(1)	(1)	8E-07	2.7E-05	mg/kg-day	5.0E-04	mg/kg-day	0.05
			Exp. Route Total								8E-07					0.05
			Dermal	***VOCs***												
				Trichloroethene	9.00E-04	mg/L	(1)	(1)	(1)	(1)	1E-07	4.5E-06	mg/kg-day	5.0E-04	mg/kg-day	0.009
			Exp. Route Total								1E-07					0.009
		Exposure Point Total									9E-07					0.06
	Exposure Medium Total										9E-07					0.06
	Vapors from Groundwater	Water Vapors at Showerhead (2)	Inhalation	***VOCs***												
				Trichloroethene	4.50E-01	ug/m3	(1)	(1)	(1)	(1)	2E-08	1.3E-02	ug/m3	2.0E+00	ug/m3	0.006
			Exp. Route Total								2E-08					0.006
		Exposure Point Total									2E-08					0.006
	Exposure Medium Total										2E-08					0.006
Groundwater Total											9E-07					0.07
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater (PW-4)				9E-07	Total of Receptor Hazards Across Bedrock GW (PW-4)				0.07

(1) Refer to Appendix I.4 Tables for the risk estimates for Trichloroethene.
(2) Only Groundwater COPCs considered volatile are evaluated for inhalation while showering.

Table I.5-10
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Child (Bedrock Groundwater — PW-4)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock — PW-4)	Ingestion	***VOCs***												
				Trichloroethene	9.00E-04	mg/L	NA	NA	NA	NA	NA	4.5E-05	mg/kg-day	5.0E-04	mg/kg-day	0.09
			Exp. Route Total								NA					0.09
			Dermal	***VOCs***												
				Trichloroethene	9.00E-04	mg/L	NA	NA	NA	NA	NA	6.6E-06	mg/kg-day	5.0E-04	mg/kg-day	0.01
			Exp. Route Total								NA					0.01
		Exposure Point Total									NA					0.1
	Exposure Medium Total										NA					0.1
Groundwater Total											NA					0.1
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater (PW-4)				NA	Total of Receptor Hazards Across Bedrock GW (PW-4)				0.1

NA - Not Applicable.

Table I.5-11
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Adult (Bedrock Groundwater — PW-5)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock — PW-5)	Ingestion	***VOCs***												
				Trichloroethene	1.50E-02	mg/L	(1)	(1)	(1)	(1)	1E-05	4.5E-04	mg/kg-day	5.0E-04	mg/kg-day	0.9
			Exp. Route Total								1E-05					0.9
			Dermal	***VOCs***												
				Trichloroethene	1.50E-02	mg/L	(1)	(1)	(1)	(1)	2E-06	7.5E-05	mg/kg-day	5.0E-04	mg/kg-day	0.2
			Exp. Route Total								2E-06					0.2
		Exposure Point Total									2E-05					1
	Exposure Medium Total										2E-05					1
	Vapors from Groundwater	Water Vapors at Showerhead (2)	Inhalation	***VOCs***												
				Trichloroethene	7.50E+00	ug/m3	(1)	(1)	(1)	(1)	4E-07	2.1E-01	ug/m3	2.0E+00	ug/m3	0.1
			Exp. Route Total								4E-07					0.1
		Exposure Point Total									4E-07					0.1
	Exposure Medium Total										4E-07					0.1
Groundwater Total											2E-05					1
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater (PW-5)				2E-05	Total of Receptor Hazards Across Bedrock GW (PW-5)				1

(1) Refer to Appendix I.4 Tables for the risk estimates for Trichloroethene.
(2) Only Groundwater COPCs considered volatile are evaluated for inhalation while showering.
NA - Not Applicable.

Table I.5-12
Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Child (Bedrock Groundwater — PW-5)
Shakespeare Composite Structures Site
Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock — PW-5)	Ingestion	***VOCs***												
				Trichloroethene	1.50E-02	mg/L	NA	NA	NA	NA	NA	7.5E-04	mg/kg-day	5.0E-04	mg/kg-day	1
			Exp. Route Total								NA					1
			Dermal	***VOCs***												
				Trichloroethene	1.50E-02	mg/L	NA	NA	NA	NA	NA	1.1E-04	mg/kg-day	5.0E-04	mg/kg-day	0.2
			Exp. Route Total								NA					0.2
		Exposure Point Total									NA					2
	Exposure Medium Total										NA					2
Groundwater Total											NA					2
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater (PW-5)				NA	Total of Receptor Hazards Across Bedrock GW (PW-5)				2

NA - Not Applicable.

Table I.5-13

Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Adult (Bedrock Groundwater — PW-8)

Shakespeare Composite Structures Site

Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer: Intake/Exposure Concentration Value	Cancer: Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer: Intake/Exposure Concentration Value	Noncancer: Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock — PW-8)	Ingestion	***VOCs***												
				Trichloroethene	5.00E-02	mg/L	(1)	(1)	(1)	(1)	4E-05	1.5E-03	mg/kg-day	5.0E-04	mg/kg-day	3
			Exp. Route Total								4E-05					3
			Dermal	***VOCs***												
				Trichloroethene	5.00E-02	mg/L	(1)	(1)	(1)	(1)	7E-06	2.5E-04	mg/kg-day	5.0E-04	mg/kg-day	0.5
			Exp. Route Total								7E-06					0.5
		Exposure Point Total									5E-05					3
	Exposure Medium Total										5E-05					3
	Vapors from Groundwater	Water Vapors at Showerhead (2)	Inhalation	***VOCs***												
				Trichloroethene	2.50E+01	ug/m3	(1)	(1)	(1)	(1)	1E-06	7.1E-01	ug/m3	2.0E+00	ug/m3	0.4
			Exp. Route Total								1E-06					0.4
		Exposure Point Total									1E-06					0.4
	Exposure Medium Total										1E-06					0.4
Groundwater Total											5E-05					4
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater (PW-8)				5E-05	Total of Receptor Hazards Across Bedrock GW (PW-8)				4

(1) Refer to Appendix I.4 Tables for the risk estimates for Trichloroethene.

(2) Only Groundwater COPCs considered volatile are evaluated for inhalation while showering.

Table I.5-14

Calculation Of Chemical Cancer Risks And Non-Cancer Hazards - Future Resident Child (Bedrock Groundwater — PW-8)

Shakespeare Composite Structures Site

Newberry, South Carolina

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

Medium	Exposure Medium	Exposure Point	Exposure Route	Chemical of Potential Concern	EPC Value	EPC Units	Cancer Risk Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	CSF/Unit Risk Value	CSF/Unit Risk Units	Cancer Risk	Noncancer Hazard Calculations: Intake/Exposure Concentration Value	Intake/Exposure Concentration Units	RfD/RfC Value	RfD/RfC Units	Hazard Quotient
Groundwater	Groundwater	Groundwater (Bedrock — PW-8)	Ingestion	***VOCs***												
				Trichloroethene	5.00E-02	mg/L	NA	NA	NA	NA	NA	2.5E-03	mg/kg-day	5.0E-04	mg/kg-day	5
			Exp. Route Total								NA					5
			Dermal	***VOCs***												
				Trichloroethene	5.00E-02	mg/L	NA	NA	NA	NA	NA	3.7E-04	mg/kg-day	5.0E-04	mg/kg-day	0.7
			Exp. Route Total								NA					0.7
		Exposure Point Total									NA					6
	Exposure Medium Total										NA					6
Groundwater Total											NA					6
Total Receptor Risk							Total of Receptor Risks Across Bedrock Groundwater (PW-8)				NA	Total of Receptor Hazards Across Bedrock GW (PW-8)				6

NA - Not Applicable.

Table I.5-15
Summary of Receptor Risks and Hazards for COPCs - Future Resident Adult (Shallow/Intermediate Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Groundwater	***VOCs***									
		(Shallow/Intermediate)	1,2-Dichloroethane	6E-07	--	3E-08	7E-07	Kidney	0.003	--	0.0001	0.003
			Benzene	5E-07	--	7E-08	5E-07	Immune System	0.005	--	0.0008	0.006
			Chloroform	1E-06	--	1E-07	2E-06	Liver	0.01	--	0.001	0.01
			cis-1,2-Dichloroethene	--	--	--	--	Kidney	2	--	0.2	2
			Tetrachloroethene	1E-07	--	8E-08	2E-07	Nervous System, Eyes	0.02	--	0.01	0.04
			Trichloroethene	4E-04	--	6E-05	5E-04	Fetus, Thymus, Immune System	28	--	5	32
			Vinyl chloride	4E-04	--	3E-05	4E-04	Liver	0.08	--	0.006	0.09
			Metals									
			Iron	--	--	--	--	Gastrointestinal	0.4	--	0.002	0.4
			Manganese	--	--	--	--	Nervous System	0.2	--	0.03	0.3
			Chemical Total	8E-04	--	9E-05	9E-04		30	--	5	35
		Exposure Point Total					9E-04					35
	Exposure Medium Total						9E-04					35
	Vapors from Groundwater	Water Vapors at Showerhead	***VOCs***									
			1,2-Dichloroethane	--	7E-08	--	7E-08	Liver	--		--	
			Benzene	--	3E-08	--	3E-08	Immune System	--	0.0003	--	0.0003
			Chloroform	--	4E-07	--	4E-07	Liver	--	0.0005	--	0.0005
			cis-1,2-Dichloroethene	--	--	--	--	ND	--	--	--	--
			Tetrachloroethene	--	6E-09	--	6E-09	Nervous System, Eyes	--	0.002	--	0.002
			Trichloroethene	--	1E-05	--	1E-05	Fetus, Thymus	--	3	--	3
			Vinyl chloride	--	2E-05	--	2E-05	Liver	--	0.001	--	0.001
			Chemical Total	--	3E-05	--	3E-05		--	3	--	3
		Exposure Point Total					3E-05					3
		Indoor Air Via Vapor Intrusion	***VOCs***									
			Trichloroethene	--	4E-06	--	4E-06	Fetus, Thymus	--	0.9	--	0.9
			Chemical Total	--	4E-06	--	4E-06		--	0.9	--	0.9
		Exposure Point Total					4E-06					0.9
	Exposure Medium Total						3E-05					4
Groundwater Total							9E-04					39

Notes
"--" - Not Applicable
ND - No Data

Target Organ HI per Medium

Organ	**Groundwater**
Eyes	0.04
Fetus	36
Gastrointestinal	0.4
Immune System	32
Kidney	2
Liver	0.1
Nervous System	0.3
Thymus	36

Table I.5-16
Summary of Receptor Risks and Hazards for COPCs - Future Resident Child (Shallow/Intermediate Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Groundwater (Shallow/Intermediate)	***VOCs***									
			1,2-Dichloroethane	--	--	--	--	Kidney	0.004	--	0.0002	0.005
			Benzene	--	--	--	--	Immune System	0.008	--	0.001	0.009
			Chloroform	--	--	--	--	Liver	0.02	--	0.001	0.02
			cis-1,2-Dichloroethene	--	--	--	--	Kidney	3	--	0.3	3
			Tetrachloroethene	--	--	--	--	Nervous System, Eyes	0.04	--	0.02	0.06
			Trichloroethene	--	--	--	--	Fetus, Thymus, Immune System	46	--	7	53
			Vinyl chloride	--	--	--	--	Liver	0.1	--	0.009	0.1
			Metals									
			Iron	--	--	--	--	Gastrointestinal	0.7	--	0.003	0.7
			Manganese	--	--	--	--	Nervous System	0.4	--	0.05	0.5
			Chemical Total	--	--	--	--		50	--	7	57
		Exposure Point Total					--					57
	Exposure Medium Total						--					57
	Vapors from Groundwater	Indoor Air Via Vapor Intrusion	***VOCs***									
			Trichloroethene	--	--	--	--	Fetus, Thymus	--	0.9	--	0.9
			Chemical Total	--	--	--	--		--	0.9	--	0.9
		Exposure Point Total					--					0.9
	Exposure Medium Total						--					0.9
Groundwater Total							--					58

Notes
"--" - Not Applicable

Target Organ HI per Medium

Organ	Groundwater
Eyes	0.06
Fetus	54
Gastrointestinal	0.7
Immune System	53
Kidney	3
Liver	0.2
Nervous System	0.5
Thymus	54

Table I.5-17
Summary of Receptor Risks and Hazards for COPCs - Future Resident Adult (Bedrock Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Groundwater (Bedrock)	***VOCs***									
			1,2-Dichloroethane	9E-07	--	4E-08	9E-07	Kidney	0.004	--	0.0002	0.004
			Chloroform	8E-07	--	7E-08	9E-07	Liver	0.006	--	0.0005	0.007
			cis-1,2-Dichloroethene	--	--	--	--	Kidney	0.2	--	0.02	0.2
			Trichloroethene	1E-04	--	2E-05	2E-04	Fetus, Thymus, Immune System	9	--	2	11
			Chemical Total	1E-04	--	2E-05	2E-04		10	--	2	11
		Exposure Point Total					2E-04					11
	Exposure Medium Total						2E-04					11
	Vapors from Groundwater	Water Vapors at Showerhead	***VOCs***									
			1,2-Dichloroethane	--	1E-07	--	1E-07	Liver	--	0.0015	--	0.0015
			Chloroform	--	2E-07	--	2E-07	Liver	--	0.0003	--	0.0003
			cis-1,2-Dichloroethene	--	--	--	--	ND	--	--	--	--
			Trichloroethene	--	4E-06	--	4E-06	Fetus, Thymus	--	1	--	1
			Chemical Total	--	4E-06	--	4E-06		--	1	--	1
		Exposure Point Total					4E-06					1
	Exposure Medium Total						4E-06					1
Groundwater Total							2E-04					12

Notes
"--" - Not Applicable
ND - No Data

Target Organ HI per Medium

Organ	**Groundwater**
Eyes	0
Fetus	12
Gastrointestinal	0
Immune System	11
Kidney	0.2
Liver	0.008
Nervous System	0
Thymus	12

Table I.5-18
Summary of Receptor Risks and Hazards for COPCs - Future Resident Child (Bedrock Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Groundwater (Bedrock)	***VOCs***									
			1,2-Dichloroethane	--	--	--	--	Kidney	0.006	--	0.0003	0.006
			Chloroform	--	--	--	--	Liver	0.01	--	0.0008	0.01
			cis-1,2-Dichloroethene	--	--	--	--	Kidney	0.3	--	0.03	0.3
			Trichloroethene	--	--	--	--	Fetus, Thymus, Immune System	16	--	2	18
			Chemical Total	--	--	--	--		16	--	2	18
		Exposure Point Total					--					18
	Exposure Medium Total						--					18
Groundwater Total							--					18

Notes
"--" - Not Applicable

Target Organ HI per Medium

Organ	**Groundwater**
Eyes	0
Fetus	18
Gastrointestinal	0
Immune System	18
Kidney	0.3
Liver	0.01
Nervous System	0
Thymus	18

Table I.5-19
Risk Summary - Future Resident Adult (Shallow/Intermediate Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Groundwater (Shallow/Intermediate)	***VOCs***									
			Chloroform	1E-06	--	1E-07	2E-06	--	--	--	--	--
			cis-1,2-Dichloroethene	--	--	--	--	Kidney	2	--	0.2	2
			Trichloroethene	4E-04	--	6E-05	5E-04	Fetus, Thymus, Immune System	28	--	5	32
			Vinyl chloride	4E-04	--	3E-05	4E-04	--	--	--	--	--
			Chemical Total	8E-04	--	9E-05	9E-04		29	--	5	34
		Exposure Point Total					9E-04					34
	Exposure Medium Total						9E-04					34
	Vapors from Groundwater	Water Vapors at Showerhead	***VOCs***									
			Chloroform	--	4E-07	--	4E-07	--	--	--	--	--
			cis-1,2-Dichloroethene	--	--	--	--	ND	--	--	--	--
			Trichloroethene	--	1E-05	--	1E-05	Fetus, Thymus	--	3	--	3
			Vinyl chloride	--	2E-05	--	2E-05	--	--	--	--	--
			Chemical Total	--	3E-05	--	3E-05		--	3	--	3
		Exposure Point Total					3E-05					3
		Indoor Air Via Vapor Intrusion	***VOCs***									
			Trichloroethene	--	4E-06	--	4E-06	Fetus, Thymus	--	0.9	--	0.9
			Chemical Total	--	4E-06	--	4E-06		--	0.9	--	0.9
		Exposure Point Total					4E-06					0.9
	Exposure Medium Total						3E-05					4
Groundwater Total							9E-04					38

Notes
"--" - Not Applicable
ND - No Data

Target Organ HI per Medium

Organ	**Groundwater**
Fetus	36
Immune System	32
Kidney	2
Thymus	36

Table I.5-20
Risk Summary - Future Resident Child (Shallow/Intermediate Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Groundwater (Shallow/Intermediate)	***VOCs***									
			cis-1,2-Dichloroethene	--	--	--	--	Kidney	3	--	0.3	3
			Trichloroethene	--	--	--	--	Fetus, Thymus, Immune System	46	--	7	53
			Chemical Total	--	--	--	--		49	--	7	56
		Exposure Point Total					--					56
	Exposure Medium Total						--					56
	Vapors from Groundwater	Indoor Air Via Vapor Intrusion	***VOCs***									
			Trichloroethene	--	--	--	--	Fetus, Thymus	--	0.9	--	0.9
			Chemical Total	--	--	--	--		--	0.9	--	0.9
		Exposure Point Total					--					0.9
	Exposure Medium Total						--					0.9
Groundwater Total							--					57

Notes
"--" - Not Applicable

Target Organ HI per Medium

Organ	**Groundwater**
Fetus	54
Immune System	53
Kidney	3
Thymus	54

Table I.5-21
Risk Summary - Future Resident Adult (Bedrock Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Groundwater (Bedrock)	***VOCs***									
			1,2-Dichloroethane	9E-07	--	4E-08	9E-07	--	--	--	--	--
			Chloroform	8E-07	--	7E-08	9E-07	--	--	--	--	--
			Trichloroethene	1E-04	--	2E-05	2E-04	Fetus, Thymus, Immune System	9	--	1	11
			Chemical Total	1E-04	--	2E-05	2E-04		9	--	1	11
		Exposure Point Total					2E-04					11
	Exposure Medium Total						2E-04					11
	Vapors from Groundwater	Water Vapors at Showerhead	***VOCs***									
			1,2-Dichloroethane	--	1E-07	--	1E-07	--	--	--	--	--
			Chloroform	--	2E-07	--	2E-07	--	--	--	--	--
			Trichloroethene	--	4E-06	--	4E-06	Fetus, Thymus	--	1	--	1
			Chemical Total	--	4E-06	--	4E-06		--	1	--	1
		Exposure Point Total					4E-06					1
	Exposure Medium Total						4E-06					1
Groundwater Total							2E-04					12

Notes
"--" - Not Applicable

Target Organ HI per Medium

Organ	**Groundwater**
Fetus	12
Immune System	11
Thymus	12

Table I.5-22
Risk Summary - Future Resident Child (Bedrock Groundwater)
Shakespeare Composite Structures Site
Newberry, South Carolina

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	Exposure Routes Total	Primary Target Organ(s)	Ingestion	Inhalation	Dermal	Exposure Routes Total
Groundwater	Groundwater	Groundwater (Bedrock)	***VOCs***									
			Trichloroethene	--	--	--	--	Fetus, Thymus, Immune System	16	--	2	18
			Chemical Total	--	--	--	--		16	--	2	18
		Exposure Point Total					--					18
	Exposure Medium Total						--					18
Groundwater Total							--					18

Notes
"--" - Not Applicable
ND - No Data

Target Organ HI per Medium

Organ	**Groundwater**
Fetus	18
Immune System	18
Thymus	18