

*Prepared for:*

**The Advertiser Company**

# **REVIEW OF USGS AUGUST 2011 VAPOR INTRUSION ASSESSMENT**

**Capitol City Plume Site  
Montgomery, Alabama**

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## 1.0 INTRODUCTION

Geosyntec Consultants has been retained by The Advertiser Company to provide consulting support for the Capitol City Plume (CCP) Superfund Site (the Site) in Montgomery, Alabama. In August 2011, the U.S. Geological Survey (USGS) conducted an indoor air assessment and vapor intrusion assessment at two buildings located within the “Generalized Boundary” of the CCP site identified by USGS [Landmeyer et al., 2011]. This assessment was conducted following employee complaints of odors in the two buildings. Geosyntec has been requested to conduct a screening-level vapor intrusion assessment for the CCP site and review and comment on the USGS study.

The USGS vapor intrusion investigation [Gore, 2011b] consisted of sampling and analysis of indoor air, soil gas, and air in utility corridors (e.g., potential preferential pathways) at the Attorney General Office Building<sup>1</sup> (AG Building), located at 501 Washington Avenue, and the Montgomery County Annex III Building (Annex III), located at 200 Washington Avenue. USEPA reported that contaminants detected in indoor air in the buildings tested were at levels below the USEPA’s recommended remediation levels and pose no unacceptable risk to humans; however, USEPA also reported that samples of indoor air collected from Annex III indicate ongoing vapor intrusion [USEPA, 2011c].

This memo provides: (i) a screening-level evaluation of the potential for vapor intrusion at the CCP site due to volatile organic compounds (VOCs; specifically tetrachloroethene [PCE]<sup>2</sup>) detected in groundwater and (ii) a review of the August 2011 USGS vapor intrusion assessment including the investigation methods and results. This review was primarily based on information presented in the Gore® Surveys Final Report dated September 27, 2011, which was prepared by the analytical laboratory. No USGS documentation describing sampling protocols, building conditions, field notes, or data quality evaluation was available for this review. However, draft figures and sample location descriptions included in the preliminary data report for the August 2011 sampling event [USGS, 2012] were considered in this evaluation.

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<sup>1</sup> Referenced as Department of Public Safety Building in USGS vapor intrusion investigation report [Gore, 2011b].

<sup>2</sup> PCE was selected for the screening evaluation because it is the most prevalent constituent and had the highest concentrations in groundwater.

## 2.0 SUMMARY

The following conclusions were made based on this review:

- The groundwater screening evaluation, including EPA's generic screening evaluation methodology [USEPA, 2002] indicates that vapor intrusion from VOCs, including PCE, in groundwater is not a complete pathway at or within more than 1000 feet of the AG or Annex III buildings.
- The investigation conducted by the USGS did not follow typical approaches used to evaluate the vapor intrusion pathway [USEPA, 2002; ITRC, 2007]. Deficiencies in the investigation approach were identified that bring into question the quality of the data for the vapor intrusion evaluation for these buildings.
- Concentrations of detected compounds in soil gas are below risk-based screening levels calculated following USEPA guidance [USEPA, 2002, 2011a].
- Reported concentrations of detected compounds in indoor air are below risk-based concentrations and/or are indistinguishable from background concentrations.

Based on this review, we conclude that the data from samples collected in the vicinity and inside of the AG and Annex III buildings do not demonstrate that the vapor intrusion pathway is complete.

Changes to the investigation approach should be implemented if the USGS plans to collect additional data to further evaluate the alleged vapor intrusion pathway at these two buildings. These recommended changes would make the vapor intrusion investigation more consistent with USEPA guidance and data quality requirements. Future vapor intrusion investigation activities for the site should include:

- Preparation of a work plan to document the investigation methodology, analytical methods and rationale for data to be collected;
- Field documentation of sampling methods;
- Sample location rationale based on building factors such as a description of the building exteriors and interiors, chemical storage, presence of floor drains, conditions of the building foundations, and the heating, ventilation, and air condition (HVAC) units, including HVAC operational parameters, and locations of odor complaints;
- Preparation of a chemical inventory and field screening for background sources prior to collecting indoor air samples;
- Collection of outdoor air samples concurrent with indoor air sampling event; and
- Collection of split samples using traditional sampling and analysis methods to confirm concentrations reported from analysis of passive samplers.

### 3.0 GROUNDWATER VAPOR INTRUSION SCREENING EVALUATION

Geosyntec conducted a vapor intrusion screening evaluation based on PCE concentrations in groundwater that have been measured at the Site. The purpose of the screening evaluation is to identify areas of the Site where the vapor intrusion pathway is potentially complete. This groundwater screening evaluation does not address potential vapor intrusion impacts due to vadose-zone sources that have not impacted groundwater; however, as discussed below, no vadose-zone PCE impacts have been documented in the investigation area. The screening evaluation is consistent with approaches described in vapor intrusion pathway guidance documents [USEPA, 2002; ITRC, 2007].

The groundwater vapor intrusion screening consists of comparing measured groundwater concentrations from the first encountered groundwater (i.e., groundwater samples collected near the water table depth) to conservative screening levels. Screening levels were calculated in two ways: (i) preliminary screening levels using conservative default assumptions and (ii) site-specific screening levels using refined vapor intrusion modeling to provide results that are more representative of Site conditions. Locations exceeding groundwater screening levels do not necessarily indicate the property poses a human health hazard, but are an indication of areas where further investigation may be warranted.

Groundwater screening levels are calculated using the following equation:

$$RBSL_{GW} = \frac{RBSL_{air}}{H \times \alpha} \frac{1 L}{1000 m^3}$$

Where:

- RBSL<sub>GW</sub> = Groundwater risk-based screening level (µg/L);
- RBSL<sub>air</sub> = Air risk-based screening level (µg/m<sup>3</sup>);
- H = Henry's Law Coefficient (dimensionless); and
- α = Vapor intrusion attenuation factor (dimensionless).

The attenuation factor, α, is the ratio of the indoor air and soil gas concentration<sup>3</sup> due to vapor intrusion. Different values of α were used in the preliminary and site-specific evaluations.

- For the preliminary screening evaluation, the empirical α of 0.001 for a groundwater source is used [USEPA, 2002]. This value is based on a USEPA evaluation of vapor intrusion sites across the country [USEPA, 2008].

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<sup>3</sup> Soil gas concentration is equivalent to the product of the concentration in groundwater, dimensionless Henry's Law, and the conversion factor (1000 L/m<sup>3</sup>).

- For the Site-specific evaluation, the Johnson and Ettinger model [Johnson and Ettinger, 1991] was used to calculate  $\alpha$  based on site-specific vadose-zone soil characteristics and depth to groundwater measurements for different areas of the Site. Details of the Site-specific vapor intrusion modeling are provided in Appendix A. Site-specific values for  $\alpha$  ranged from 0.00014 to 0.000024.

For the groundwater vapor intrusion screening evaluation, the  $RBSL_{air}$  for PCE was calculated following methods presented in the USEPA Regional Screening Level Table [USEPA, 2011a] utilizing typical exposure factors for a commercial worker and current toxicity factors for PCE<sup>4</sup> [USEPA, 2012]. The Henry's Law Coefficient for PCE was taken from the USEPA Johnson and Ettinger Model spreadsheets. The table below summarizes the inputs and resulting groundwater screening level calculated for this evaluation.

#### **Screening Level Calculation Inputs and Results**

Parameter	Preliminary Screening	Site-Specific Screening
$RBSL_{air}$	$47 \mu\text{g}/\text{m}^3$	$47 \mu\text{g}/\text{m}^3$
H	0.58	0.58
$\alpha$	0.001	0.00014 to 0.000024
$RBSL_{GW}$	$81 \mu\text{g}/\text{L}$	580 - 3,300 $\mu\text{g}/\text{L}$

The lower site-specific screening level was calculated for areas with shallow groundwater and sandy soils. The higher site-specific screening level was calculated for areas where silts and clays are present.

PCE concentrations for groundwater samples collected from 1999 through 2010 were compared to the screening levels presented above. These results are shown in Figure 1. This figure presents the sample locations where PCE concentrations are: (i) either non-detect or below the preliminary screening level and (ii) above the preliminary screening level, but below the site-specific screening level based on the location of the groundwater sample. None of the concentrations in groundwater samples exceeded the site-specific screening level.

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<sup>4</sup> The USEPA posted the final health assessment for PCE to the Integrated Risk Information System on February 10, 2012.

Locations exceeding preliminary screening levels are limited to the northern portion of the “Generalized Boundary” of the CCP site, and these locations are more than 1000 feet from the AG building or Annex III. However groundwater concentrations in these locations do not exceed site-specific screening levels. PCE concentrations in groundwater samples collected south of Monroe Street and east of McDonough Street indicate that the vapor intrusion pathway is not complete for the AG building or Annex III.

Site-specific screening levels are exceeded near monitoring wells MW-04S and MW-12S and grab samples CH2-SB3, TW-09<sup>5</sup>, and TW-13. Supplemental data (e.g., soil or soil gas data) are not available in these areas to provide additional lines of evidence for the vapor intrusion pathway evaluation. Based on the groundwater screening evaluation results, additional data are warranted in these areas to evaluate the vapor intrusion pathway.

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<sup>5</sup> Note that PCE was not detected in TW-09; however, the groundwater sample from this location had an elevated detection limit. The screening evaluation was conducted using ½ the sample reporting limit.



#### 4.0 USGS VAPOR INTRUSION INVESTIGATION

The strategy and techniques utilized in the USGS investigation did not follow common methods recommended for vapor intrusion pathway assessments [USEPA, 2002; ITRC, 2007]. The investigation consisted of twenty indoor air samples (seven from the AG building and thirteen from Annex III), eleven soil gas samples collected proximal to the buildings (seven from the AG Building and four from Annex III), one sub-slab soil gas sample from Annex III, and two soil gas samples more than 300 feet east of the Annex III. Additionally, seven samples were collected from grates or drain pipes associated with subsurface utilities. Samples were collected using a passive sampling technique (Gore<sup>®</sup> Modules) over a one week period from August 16–23, 2011.

#### 4.1 Review of Investigation Methodology

Limitations to the USGS investigation include:

- Insufficient documentation of field activities/observations for the sampling event was available for review.
- Sample descriptions provided in the Gore report were inadequate to determine where samples were collected. It is not clear whether some of the samples labeled as “indoor air” were collected from areas that are not representative of occupied spaces (e.g., ceiling panel/light fixture). Data collected from unoccupied areas are not representative of potential exposures to building occupants and are not useful in evaluating potential health risks.
- The investigation did not include appropriate steps to evaluate the potential for background sources to contribute to indoor air quality even though consideration of background sources is a key component of a vapor intrusion investigation [USEPA, 2002]. The presence of target compounds in outdoor air, building materials (e.g., carpets, paints, or glues) or products used indoors can contribute to concentrations detected in indoor air that are not related to vapor intrusion (for example, sample ID 667995 was collected from a closet with cleaning supplies).
- Background outdoor air samples were not collected during this investigation. Typically, outdoor air samples are collected when indoor air sampling is conducted to assess the potential contribution of background sources on indoor air quality. The purpose of the outdoor air sampling is to evaluate the potential impacts that chemical use or storage in the area may have on the measured indoor air concentrations. Since PCE is commonly used in a variety of applications (e.g., dry cleaning), outdoor air samples are an important component of a vapor intrusion investigation for this site.
- Documentation that pre-sampling indoor surveys were conducted as part of this investigation was not available. Pre-sampling indoor surveys are conducted to identify chemical storage and use in the building that may result in detection of

compounds in indoor air that are unrelated to vapor intrusion. Indoor sources of PCE are common (e.g., PCE is found in dry cleaned clothes, adhesives, and glues), making the pre-sampling survey an important step in the investigation. A pre-sampling survey of the sampling area should have been conducted to identify potential indoor sources that may bias the analytical results.

- The number of sub-slab soil gas samples collected in this investigation was inadequate to evaluate potential VOC migration from a subsurface source to indoor air. Additionally, no information regarding the construction of the sub-slab sample location was available in the materials available for review.
- Gore<sup>®</sup> Modules are not commonly used in vapor intrusion assessments for sample collection and analysis and their use for quantitative data analysis is not well documented. Some of the limitations of the quantification of detected concentrations are noted in the Gore<sup>®</sup> Surveys final report.
  - Indoor air analysis. Documentation on the use of the Gore<sup>®</sup> Modules to quantitatively determine air concentrations is not available for a thorough review and the reliability of the uptake rates used in the Gore<sup>™</sup> screening survey has not been assessed. The description of the methodology to calculate concentrations provided in the Gore<sup>®</sup> Surveys final report is not specific (e.g., graphs showing adsorption curves and uptake rates do not have values on their axes) and it appears that much of the calibration range used in their evaluation (0.1 ppb to 100 ppm) is outside the range of measured concentrations. Consequently, there is uncertainty regarding the concentration results reported in the Gore<sup>®</sup> Surveys final report.
  - Soil gas analysis. Typically, active soil gas sampling methods are used for soil gas investigations and passive techniques such as the Gore<sup>®</sup> Modules are used to make qualitative assessments of the distribution of VOCs in soil gas (i.e., identify areas with elevated VOC concentrations). The use of passive sampling techniques for quantitative soil gas sampling and analysis is an area of current research and the applicability of the Gore<sup>®</sup> Modules for this purpose has not been demonstrated.
  - Water analysis. The Gore<sup>®</sup> Module was used to monitor the concentration from a water sample in a drain line in the AG building. The Gore<sup>®</sup> Modules are not constructed like standard passive groundwater sampling devices. Documentation on the reliability of their application to measure groundwater concentrations is not available. Note that the Gore<sup>®</sup> Surveys final report states that the groundwater concentrations are calculated assuming groundwater flow rate of 10 m/day. However, because this sample was collected from an abandoned drain line (and not groundwater); the basis for the assumed groundwater flow rate is not clear. Additionally, no documentation to support the adjustment factor used in the concentration calculations was provided.

In summary, the methods used by the USGS should be limited to a qualitative assessment of the potential distribution of VOCs in soil gas and indoor air. Without supplemental sampling (e.g., outdoor air samples or additional sub-slab samples) using traditional methods and a pre-sampling survey for background sources, it cannot be determined whether the VOCs detected in indoor air are due to vapor intrusion or background sources. As discussed below, the data collected do not indicate that the vapor intrusion pathway is complete in the investigation area.

#### 4.2 Soil Gas Results

During the August 2011 investigation, soil gas samples were collected from seven locations around the AG Building and four locations around Annex III. Additionally, a sub-slab soil gas sample was collected from Annex III and two soil gas samples distant from the two buildings. Reported analytical results for compounds detected during the USGS investigation are shown in Table 1. The table below summarizes the detection frequency, the range of soil gas concentrations, and corresponding risk-based screening levels. Conservative soil gas risk-based screening levels were calculated by dividing the ambient air RSL for commercial indoor workers by an attenuation factor of 0.1<sup>6</sup>.

#### Summary of Soil Gas Results

Compound	AG Building		Annex III		Distal		RBSL
	Det. Freq.	Range	Det. Freq.	Range	Det. Freq.	Range	
PCE	5/7	1.5 - 58	5/5	2.3-8.2	0/2	ND	470 <sup>†</sup>
TCE	1/7	ND – 1.5	1/5	ND - 2.3	1/2	ND – 11	30
1,4 DCB	0/7	ND	0/5	ND	0/2	ND	11
Benzene	1/7	ND – 3.1	2/5	0.97 – 1.04	0/2	ND	16
Toluene	5/7	0.63 - 18	3/5	1.0 – 19	0/2	ND	220,000
Ethylbenzene	0/7	ND	1/5	ND – 3.3	0/2	ND	49
Xylenes	1/7	ND – 0.44	1/5	ND – 11	0/2	ND	4400

Concentrations reported in  $\mu\text{g}/\text{m}^3$

Sub-slab soil gas and exterior soil gas results included in summary for Annex III

<sup>6</sup> USEPA suggests a preliminary screening attenuation factor of 0.1 for sub-slab soil gas and shallow soil gas [USEPA, 2002]. Note that site-specific sub-slab and shallow soil gas screening levels will be higher than values listed in this table.

† Screening level for PCE calculated using toxicity values published in USEPA IRIS database on February 10, 2012

Det. Freq. = Detection frequency: number of detects/number of samples

Range = Range of detected concentrations

RBSL = Conservative risk-based screening level calculated by dividing the RSL for commercial land use by an attenuation factor of 0.1

ND = Not detected above the laboratory reporting limit

Reported soil gas concentrations were below the conservative screening levels. Thus, the soil gas data do not indicate that there is a vadose-zone source near these buildings and do not indicate that the vapor intrusion pathway is potentially complete in the investigation area.

### 4.3 Utility/Preferential Pathway Assessment Results

Air samples were collected from a drain pipe located in Annex III and other preferential pathways (“grate” samples) from Annex III and near the corner of Dexter and Decatur. Reported analytical results for compounds detected during the USGS investigation are shown in Table 2 and summarized in the table below. PCE was detected in the drain pipe sample and both PCE and TCE were detected in one of the grate samples for Annex III; each of these detections are below their corresponding risk-based screening level for indoor air (RBSL<sub>air</sub>). These results do not indicate the utilities are providing a preferential pathway for vapor migration to indoor air and do not indicate that the vapor intrusion pathway is potentially complete in the investigation area.

#### Summary of Utility/Preferential Pathway Results

Compound	Annex III		AG	
	Det. Freq.	Range	Det. Freq.	Range
PCE	2/5	0.37 – 0.70	0/2	ND
TCE	1/5	ND – 0.99	0/2	ND
1,4 DCB	4/5	0.08 – 0.17	0/2	ND
Benzene	0/5	ND	0/2	ND
Toluene	4/5	0.11 – 0.32	1/2	ND – 0.11
Ethylbenzene	2/5	0.50 – 1.2	0/2	ND
Xylenes	4/5	0.15 – 4.4	2/2	0.16 – 0.48

Concentrations reported in  $\mu\text{g}/\text{m}^3$

Det. Freq. = Detection frequency: number of detects/number of samples

Range = Range of detected concentrations

ND = Not detected above the laboratory reporting limit

#### 4.4 Indoor Air Results

Reported analytical results for compounds detected in indoor air samples collected from the AG Building and Annex III during the USGS investigation are shown in Table 3. PCE was not detected in any of the seven samples collected from the AG Building, but was detected in all thirteen samples collected from Annex III. However, as discussed below, the PCE indoor air concentrations in Annex III are similar to background concentrations reported in the literature [USEPA, 2011b]. Benzene was not detected in any of the samples, but other petroleum hydrocarbons (e.g., toluene, ethylbenzene, xylenes, trimethylbenzene, naphthalene, and some alkanes) were detected in all indoor air samples, suggesting that the presence of these constituents are likely related to indoor sources. Additionally, 1,4-dichlorobenzene was frequently detected in indoor air even though this compound was not detected in soil gas.

The table below summarizes the detection frequency and range of indoor air concentrations for the two buildings sampled and provides a comparison to risk-based screening levels and typical background indoor air concentrations. Risk-based screening levels were taken from the USEPA Regional Screening Level table (USEPA, 2011a) and indoor air background concentrations were taken from published references (USEPA, 2011b and Hodgson and Levin, 2003). The measured indoor air concentrations are below risk-based screening levels for commercial exposures and indistinguishable from background concentrations.

#### Summary of Indoor Air Results

Compound	AG Building		Annex III		Comparison Values		
	Det. Freq.	Range	Det. Freq.	Range	RSL	Background	Odor
PCE	0/7	ND	13/13	0.36 – 1.91	47 <sup>†</sup>	2.2 – 7.0	7,000
TCE	0/7	ND	1/13	0.99	3.0	1.1 – 2.1	150,000
1,4 DCB	7/7	0.17 – 0.75	11/13	0.06 – 0.25	1.1	0.54 – 28	1,100
Benzene	0/7	ND	0/13	ND	1.6	4.7 - 15	5,000

Compound	AG Building		Annex III		Comparison Values		
	Det. Freq.	Range	Det. Freq.	Range	RSL	Background	Odor
Toluene	7/7	0.2 – 0.93	13/13	0.17 – 1.04	22000	24 - 77	11,000
Ethylbenzene	7/7	0.29 – 0.85	13/13	0.5 – 1.72	4.9	3.7 - 13	10,000
Xylenes	7/7	0.95 – 3.81	13/13	1.94 – 6.39	440	18 - 72	5,000

Concentrations reported in  $\mu\text{g}/\text{m}^3$

† Screening level for PCE calculated using toxicity values published in USEPA IRIS database on February 10, 2012

Det. Freq. = Detection frequency: number of detects/number of samples

Range = Range of detected concentrations

RSL = Ambient Air Regional Screening Level for commercial land use (USEPA, 2011a)

Background = Median and 90%ile background concentrations from USEPA, 2011b. Background concentrations for 1,4 DCB are taken from Hodgson and Levin, 2003.

Odor thresholds taken from U.S. EPA Technology Transfer Network Air Toxics Web Site (<http://www.epa.gov/ttn/atw/index.html>)

ND = Not detected above laboratory reporting limit

This table also compares the measured concentrations to odor thresholds. The detected concentrations are much lower than odor thresholds for the compounds analyzed. The data do not indicate the constituents detected in indoor air are the source of odors noted by building occupants.

#### **4.5 Correlation Between Soil Gas and Indoor Air Results**

The data were reviewed to evaluate whether there is a correlation between the soil gas and indoor air results that may indicate the vapor intrusion pathway is potentially complete. Based on the data reviewed, there is no correlation between the soil gas and indoor air results. For example:

- The maximum concentration of PCE in soil gas was detected adjacent to the AG building. However, PCE was not detected in the indoor air samples collected from this building. The detection of PCE in soil gas alone does indicate that the vapor intrusion pathway is complete, especially when compared to applicable screening levels.
- Several petroleum hydrocarbons were detected in all indoor air samples collected. However, these constituents were detected infrequently in soil gas samples. Thus, detections of these compounds in indoor air are likely due to background sources and not a subsurface source.

Evaluation of the correlation between soil gas and indoor air results does not suggest that constituents measured in indoor air are a result of vapor intrusion. This finding is consistent with the groundwater vapor intrusion screening-level evaluation presented in Section 3 that concluded that PCE in groundwater will not result in a complete vapor intrusion pathway for locations south of Monroe Street.

## 5.0 REFERENCES

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# TABLES

Table 1  
Soil Vapor Results  
Gore Survey Final Report  
Capital City Plume Site, Montgomery, Alabama

Sample ID	Location	Area	Media	Units	PCE	TCE	1,4-Dichlorobenzene	Chloroform	TPH	Benzene	Toluene	Ethylbenzene	m,p-Xylene	o-Xylene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene
667996	Inside Annex III - in floor of Room 109	Annex III	SubSlab	µg/m <sup>3</sup>	8.2	2.35	bdl	nd	320.15	0.97	19.28	3.34	8.8	2.3	4.92	2.51
670800	Outside Annex III - Flower bed on Lawrence St.	Annex III	SV	µg/m <sup>3</sup>	2.92	bdl	nd	2.28	4.75	1.04	nd	nd	nd	nd	0.6	nd
670801	Outside Annex III - Flower bed by Lawrence St. Door	Annex III	SV	µg/m <sup>3</sup>	2.3	nd	nd	3.28	30.46	nd	1.02	nd	nd	nd	0.48	bdl
670803	Outside Annex III - (Washington Avenue flower bed nearest Lawrence St.)	Annex III	SV	µg/m <sup>3</sup>	4.6	nd	nd	2.45	998.77	nd	nd	nd	nd	nd	nd	nd
670804	Outside Annex III - (by Washington Ave. Elevator)	Annex III	SV	µg/m <sup>3</sup>	6.78	nd	nd	nd	76.63	nd	2.58	nd	nd	nd	nd	nd
670807	Under Magnolia tree in front of AG building	AG Building	SV	µg/m <sup>3</sup>	2.11	nd	nd	nd	973.2	bdl	14.45	nd	nd	nd	nd	nd
670808	Lawn sample front of AG building	AG Building	SV	µg/m <sup>3</sup>	bdl	nd	nd	nd	30.44	nd	0.63	nd	nd	nd	bdl	nd
670809	Lawn sample front of AG building	AG Building	SV	µg/m <sup>3</sup>	1.84	nd	nd	4.89	133.2	3.1	17.68	bdl	bdl	0.44	bdl	bdl
670810	Lawn sample front of AG building	AG Building	SV	µg/m <sup>3</sup>	20.3	bdl	nd	19.68	37.6	nd	3.22	nd	nd	nd	nd	nd
670811	Lawn sample by entrance steps in front of AG building	AG Building	SV	µg/m <sup>3</sup>	57.78	nd	nd	nd	247.34	nd	nd	nd	nd	nd	nd	nd
670814	In grass at corner of Dexter and Decatur	AG Building	SV	µg/m <sup>3</sup>	nd	1.53	nd	6.58	48.04	nd	2.92	nd	bdl	nd	nd	nd
670816	In grass at corner of Dexter and Decatur	AG Building	SV	µg/m <sup>3</sup>	1.51	nd	nd	nd	49.3	nd	nd	nd	bdl	nd	bdl	bdl
670805	Outside Annex III - Washington Avenue/McDonough Street by parking lot; west sample	Distal	SV	µg/m <sup>3</sup>	nd	nd	nd	nd	573.58	nd	nd	nd	nd	nd	nd	nd
670806	Outside Annex III - Washington Avenue/McDonough Street by parking lot; east sample	Distal	SV	µg/m <sup>3</sup>	nd	11.09	nd	nd	216.45	nd	nd	nd	nd	nd	nd	bdl

# detects AG Building	5	1	0	3	7	1	5	0	0	1	0	0	1	0	0
Min AG Bldg	1.51	1.53	0	4.89	30.44	3.1	0.63	0	0	0.44	0	0	0	0	
Max AG Bldg	57.78	1.53	0	19.68	973.2	3.1	17.68	0	0	0.44	0	0	0	0	
# detects Annex III	5	1	0	3	5	2	3	1	1	1	3	1			
Min Annex III	2.3	2.35	0	2.28	4.75	0.97	1.02	3.34	8.8	2.3	0.48	2.51			
Max Annex III	8.2	2.35	0	3.28	998.77	1.04	19.28	3.34	8.8	2.3	4.92	2.51			
# detects distal	0	1	0	0	2	0	0	0	0	0	0	0			
Min distal	0	11.09	0	0	216.45	0	0	0	0	0	0	0			
Max distal	0	11.09	0	0	573.58	0	0	0	0	0	0	0			
Commercial Soil Gas Risk-Based Screening Level (ug/m3)	470	30	11	5.3	NA	16	220000	49	4400	4400	310	NA			

Table 1  
Soil Vapor Results  
Gore Survey Final Report  
Capital City Plume Site, Montgomery, Alabama

Sample ID	Location	Area	Media	Units	Naphthalene	2-Methylnaphthalene	Octane	Undecane	Tridecane	Pentadecane
667996	Inside Annex III - in floor of Room 109	Annex III	SubSlab	µg/m <sup>3</sup>	1.5	2.41	1.7	2.37	3.6	4.23
670800	Outside Annex III - Flower bed on Lawrence St.	Annex III	SV	µg/m <sup>3</sup>	nd	bdl	nd	nd	bdl	bdl
670801	Outside Annex III - Flower bed by Lawrence St. Door	Annex III	SV	µg/m <sup>3</sup>	nd	bdl	nd	nd	bdl	nd
670803	Outside Annex III - (Washington Avenue flower bed nearest Lawrence St.)	Annex III	SV	µg/m <sup>3</sup>	nd	bdl	nd	bdl	0.73	nd
670804	Outside Annex III - (by Washington Ave. Elevator)	Annex III	SV	µg/m <sup>3</sup>	nd	nd	nd	nd	bdl	bdl
670807	Under Magnolia tree in front of AG building	AG Building	SV	µg/m <sup>3</sup>	nd	bdl	nd	nd	nd	nd
670808	Lawn sample front of AG building	AG Building	SV	µg/m <sup>3</sup>	nd	nd	nd	bdl	bdl	0.42
670809	Lawn sample front of AG building	AG Building	SV	µg/m <sup>3</sup>	0.42	bdl	bdl	bdl	bdl	nd
670810	Lawn sample front of AG building	AG Building	SV	µg/m <sup>3</sup>	0.54	0.46	nd	bdl	bdl	nd
670811	Lawn sample by entrance steps in front of AG building	AG Building	SV	µg/m <sup>3</sup>	nd	bdl	bdl	bdl	0.5	nd
670814	In grass at corner of Dexter and Decatur	AG Building	SV	µg/m <sup>3</sup>	nd	bdl	bdl	bdl	bdl	nd
670816	In grass at corner of Dexter and Decatur	AG Building	SV	µg/m <sup>3</sup>	nd	nd	nd	0.63	bdl	0.84
670805	Outside Annex III - Washington Avenue/McDonough Street by parking lot; west sample	Distal	SV	µg/m <sup>3</sup>	nd	bdl	nd	0.62	bdl	nd
670806	Outside Annex III - Washington Avenue/McDonough Street by parking lot; east sample	Distal	SV	µg/m <sup>3</sup>	nd	bdl	nd	bdl	bdl	nd

# detects AG Building	2	1	0	1	1	2
Min AG Bldg	0.42	0.46	0	0.63	0.5	0.42
Max AG Bldg	0.54	0.46	0	0.63	0.5	0.84
# detects Annex III	1	1	1	1	2	1
Min Annex III	1.5	2.41	1.7	2.37	0.73	4.23
Max Annex III	1.5	2.41	1.7	2.37	3.6	4.23
# detects distal	0	0	0	1	0	0
Min distal	0	0	0	0.62	0	0
Max distal	0	0	0	0.62	0	0
Commercial Soil Gas Risk-Based Screening Level (ug/m3)	3.6	NA	NA	NA	NA	NA

Table 2  
 Utility / Preferential Pathway Assessment Results  
 Gore Survey Final Report  
 Capital City Plume Site, Montgomery, Alabama

Sample ID	Location	Area	Media	Units	PCE	TCE	1,4-Dichlorobenzene	Chloroform	TPH	Benzene	Toluene	Ethylbenzene	m,p-Xylene	o-Xylene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene
667990	Inside Annex III - Room 109 Drain Pipe	Annex III	Drain Pipe	µg/m <sup>3</sup>	0.37	nd	0.09	nd	105.49	nd	0.17	0.5	1.46	0.48	3.2	1.71
667991	Inside Annex III - Air handler main office, sump grate	Annex III	Grate	µg/m <sup>3</sup>	0.7	0.99	0.17	nd	>194.05	bdl	0.32	1.16	3.42	1.03	3.51	2.56
668005	Outside Annex III (Grate N. corner of Lawrence/Washington)	Annex III	Grate	µg/m <sup>3</sup>	bdl	bdl	0.17	nd	30.39	bdl	0.28	bdl	bdl	bdl	0.32	0.37
670798	Outside Annex III - Grate in brick patio Lawrence/Washington corner	Annex III	Grate	µg/m <sup>3</sup>	bdl	nd	bdl	nd	9.23	bdl	bdl	bdl	0.15	bdl	0.26	0.75
670799	Outside Annex III - grate in Street by Wells at Lawrence (S. corner)	Annex III	Grate	µg/m <sup>3</sup>	bdl	bdl	0.08	nd	12.58	bdl	0.11	bdl	0.16	0.09	0.19	bdl
670813	Street Grate at Dexter and Decatur	AG Building	Grate	µg/m <sup>3</sup>	nd	nd	bdl	nd	11.3	bdl	0.11	bdl	0.16	bdl	0.25	nd
670815	Grate in grass at corner of Dexter and Decatur	AG Building	Grate	µg/m <sup>3</sup>	nd	nd	bdl	nd	12.29	bdl	bdl	bdl	0.31	0.17	0.28	nd

# detects Annex III	2	1	4	0	4	0	4	2	4	3	5	4
Min Annex III	0.37	0.99	0.08	0	9.23	0	0.11	0.5	0.15	0.09	0.19	0.37
Max Annex III	0.7	0.99	0.17	0	105.49	0	0.32	1.16	3.42	1.03	3.51	2.56
# detects AG Building	0	0	0	0	2	0	1	0	2	1	2	0
Min AG Building	0	0	0	0	11.3	0	0.11	0	0.16	0.17	0.25	0
Max AG Building	0	0	0	0	12.29	0	0.11	0	0.31	0.17	0.28	0

Table 2  
Utility / Preferential Pathway Assessment Results  
Gore Survey Final Report  
Capital City Plume Site, Montgomery, Alabama

Sample ID	Location	Area	Media	Units	Naphthalene	2-Methylnaphthalene	Octane	Undecane	Tridecane	Pentadecane
667990	Inside Annex III - Room 109 Drain Pipe	Annex III	Drain Pipe	µg/m <sup>3</sup>	0.75	0.24	nd	2.79	3.07	3.72
667991	Inside Annex III - Air handler main office, sump grate	Annex III	Grate	µg/m <sup>3</sup>	1.47	0.55	nd	4.03	6.22	8.76
668005	Outside Annex III (Grate N. corner of Lawrence/Washington)	Annex III	Grate	µg/m <sup>3</sup>	0.26	0.08	bdl	0.26	bdl	0.1
670798	Outside Annex III - Grate in brick patio Lawrence/Washington corner	Annex III	Grate	µg/m <sup>3</sup>	0.24	0.08	bdl	0.28	0.08	0.1
670799	Outside Annex III - grate in Street by Wells at Lawrence (S. corner)	Annex III	Grate	µg/m <sup>3</sup>	0.12	bdl	bdl	0.07	bdl	nd
670813	Street Grate at Dexter and Decatur	AG Building	Grate	µg/m <sup>3</sup>	0.24	0.13	bdl	0.27	0.2	0.12
670815	Grate in grass at corner of Dexter and Decatur	AG Building	Grate	µg/m <sup>3</sup>	0.34	0.85	bdl	0.46	bdl	0.08

# detects Annex III	5	4	0	5	3	4
Min Annex III	0.12	0.08	0	0.07	0.08	0.1
Max Annex III	1.47	0.55	0	4.03	6.22	8.76
# detects AG Building	2	2	0	2	1	2
Min AG Building	0.24	0.13	0	0.27	0.2	0.08
Max AG Building	0.34	0.85	0	0.46	0.2	0.12

Table 3  
Indoor Air Results  
Gore Survey Final Report  
Capital City Plume Site, Montgomery, Alabama

Sample ID	Location	Area	Media	Units	PCE	TCE	1,4-Dichlorobenzene	Chloroform	TPH	Benzene	Toluene	Ethylbenzene	m,p-Xylene	o-Xylene	1,2,4-Trimethylbenzene	1,3,5-Trimethylbenzene	
667984	Inside Annex III - behind white panel	Annex III	IA	µg/m <sup>3</sup>	0.41	nd	bdl	nd	88.81	nd	0.29	0.81	2.31	0.66	0.81	1.12	
667985	Inside Annex III - ceiling panel in mezzanine (Pat's office)	Annex III	IA	µg/m <sup>3</sup>	0.40	nd	0.07	nd	>129.07	bdl	0.28	0.76	2.25	0.68	1.12	1.77	
667986	Inside Annex III - light fixture mezzanine (room behind Pat's office)	Annex III	IA	µg/m <sup>3</sup>	0.40	nd	0.07	nd	>125.72	bdl	0.28	0.78	2.3	0.68	1.11	1.66	
667987	Inside Annex III - Mezzanine cubicle office (left cubicle)	Annex III	IA	µg/m <sup>3</sup>	0.37	nd	0.06	nd	>109.66	bdl	0.26	0.71	2.07	0.61	0.98	1.65	
667988	Inside Annex III - Mezzanine cubicle office (right cubicle)	Annex III	IA	µg/m <sup>3</sup>	0.36	nd	bdl	nd	106.66	bdl	0.25	0.64	1.89	0.56	0.9	1.56	
667989	Inside Annex III - short door storage w/ Santa Claus	Annex III	IA	µg/m <sup>3</sup>	1.74	nd	0.09	nd	>115.54	nd	0.22	1.24	3.29	0.86	1.55	1.47	
667990	Inside Annex III - Room 109 Drain Pipe	Annex III	IA	µg/m <sup>3</sup>	0.37	nd	0.09	nd	105.49	nd	0.17	0.5	1.46	0.48	3.2	1.71	
667991	Inside Annex III - Air handler main office, sump grate	Annex III	IA	µg/m <sup>3</sup>	0.70	0.99	0.17	nd	>194.05	bdl	0.32	1.16	3.42	1.03	3.51	2.56	
667992	Inside Annex III - Archives Room 121	Annex III	IA	µg/m <sup>3</sup>	0.52	nd	0.12	nd	>161.26	nd	0.38	0.99	3.01	1.04	2.18	1.93	
667993	Inside Annex III - Book Room	Annex III	IA	µg/m <sup>3</sup>	1.60	nd	0.16	nd	>154.33	bdl	0.32	1.64	4.56	1.16	2.86	2.22	
667994	Inside Annex III HVAC control room	Annex III	IA	µg/m <sup>3</sup>	1.42	nd	0.25	nd	>160.83	nd	0.29	1.34	3.68	1.03	4.46	2.72	
667995	Inside Annex III - in Grate Room 126 (closet w/ cleaning supplies)	Annex III	IA	µg/m <sup>3</sup>	1.23	nd	0.12	nd	>201.68	bdl	0.27	1.72	5.02	1.37	2.24	0.97	
670802	Inside Annex III - 2nd floor Tag Office Plant	Annex III	IA	µg/m <sup>3</sup>	1.91	nd	0.1	nd	106.53	bdl	1.04	0.91	2.58	1.18	0.88	1.59	
667998	Old ALDOT lab ceiling beam	AG Building	IA	µg/m <sup>3</sup>	bdl	nd	0.17	nd	78.83	nd	0.2	0.29	0.68	0.27	0.83	0.26	
667999	Patty's office in Victim services support area in AG building	AG Building	IA	µg/m <sup>3</sup>	nd	nd	0.25	nd	>227.99	nd	0.39	0.82	2.86	0.73	0.62	0.86	
668000	Doris Hancock office - victim services support area in AG building	AG Building	IA	µg/m <sup>3</sup>	nd	nd	0.27	nd	>217.67	bdl	0.4	0.81	2.84	0.73	0.59	0.94	
668001	Ashley's office victim services support area	AG Building	IA	µg/m <sup>3</sup>	nd	nd	0.27	nd	>216.49	nd	0.43	0.82	2.86	0.72	0.63	0.96	
668002	cubicle in Room SB15 (victim services support area)	AG Building	IA	µg/m <sup>3</sup>	nd	nd	0.43	nd	>234.75	nd	0.4	0.85	3.03	0.78	0.74	1.02	
668003	Basement HVAC room inside supply room in AG building	AG Building	IA	µg/m <sup>3</sup>	nd	nd	0.28	nd	>236.26	bdl	0.93	0.36	1.18	0.41	1.07	1.27	
668004	Dirt room in sub-basement of AG building	AG Building	Sub-Basement	µg/m <sup>3</sup>	nd	nd	0.75	nd	>179.83	nd	0.55	0.65	2.15	0.61	1.17	2.01	
# detects Annex III					13	1	11	0		0	13	13	13	13	13	13	
Min Annex III					0.36	0.99	0.06	0		0	0.17	0.5	1.46	0.48	0.81	0.97	
Max Annex III					1.91	0.99	0.25	0		0	1.04	1.72	5.02	1.37	4.46	2.72	
# detects AG Building					0	0	7	0		0	7	7	7	7	7	7	
Min AG Bldg					0	0	0.17	0		0	0.2	0.29	0.68	0.27	0.59	0.26	
Max AG Bldg					0	0	0.75	0		0	0.93	0.85	3.03	0.78	1.17	2.01	
Commercial Ambient Air RSL (ug/m3)					47	3.0	1.1	0.53	NA		1.6	22000	4.9	440	440	31	NA

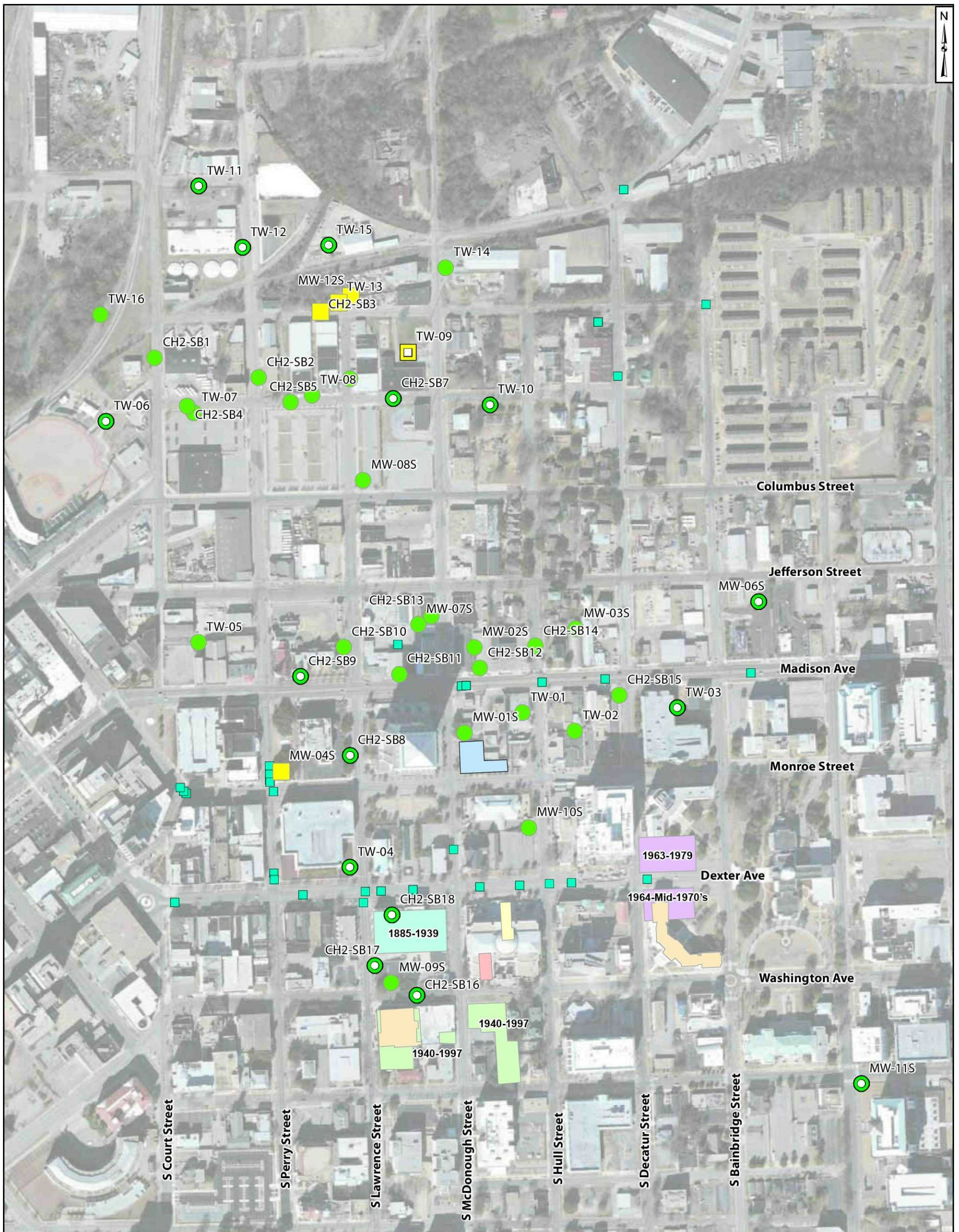
Table 3  
Indoor Air Results  
Gore Survey Final Report  
Capital City Plume Site, Montgomery, Alabama

Sample ID	Location	Area	Media	Units	Naphthalene	2-Methylnaphthalene	Octane	Undecane	Tridecane	Pentadecane
667984	Inside Annex III - behind white panel	Annex III	IA	µg/m <sup>3</sup>	0.44	0.12	nd	2.32	1.03	2.27
667985	Inside Annex III - ceiling panel in mezzanine (Pat's office)	Annex III	IA	µg/m <sup>3</sup>	0.74	0.22	0.59	2.99	1.9	3.84
667986	Inside Annex III - light fixture mezzanine (room behind Pat's office)	Annex III	IA	µg/m <sup>3</sup>	0.71	0.2	nd	2.76	1.94	3.78
667987	Inside Annex III - Mezzanine cubicle office (left cubicle)	Annex III	IA	µg/m <sup>3</sup>	0.64	0.18	nd	2.51	1.48	3.1
667988	Inside Annex III - Mezzanine cubicle office (right cubicle)	Annex III	IA	µg/m <sup>3</sup>	0.57	0.17	nd	2.39	1.55	3.11
667989	Inside Annex III - short door storage w/ Santa Claus	Annex III	IA	µg/m <sup>3</sup>	0.85	0.23	nd	2.53	2.01	4.37
667990	Inside Annex III - Room 109 Drain Pipe	Annex III	IA	µg/m <sup>3</sup>	0.75	0.24	nd	2.79	3.07	3.72
667991	Inside Annex III - Air handler main office, sump grate	Annex III	IA	µg/m <sup>3</sup>	1.47	0.55	nd	4.03	6.22	8.76
667992	Inside Annex III - Archives Room 121	Annex III	IA	µg/m <sup>3</sup>	0.82	0.3	nd	3.54	3.61	6.15
667993	Inside Annex III - Book Room	Annex III	IA	µg/m <sup>3</sup>	0.91	0.32	nd	3.38	3.54	6.31
667994	Inside Annex III HVAC control room	Annex III	IA	µg/m <sup>3</sup>	1.11	0.36	nd	3.97	5.07	7.89
667995	Inside Annex III - in Grate Room 126 (closet w/ cleaning supplies)	Annex III	IA	µg/m <sup>3</sup>	0.75	0.26	bdl	2.98	3.8	8.42
670802	Inside Annex III - 2nd floor Tag Office Plant	Annex III	IA	µg/m <sup>3</sup>	0.52	0.15	0.72	3.15	0.65	3.03
667998	Old ALDOT lab ceiling beam	AG Building	IA	µg/m <sup>3</sup>	1.27	1.64	bdl	2.43	0.72	0.45
667999	Patty's office in Victim services support area in AG building	AG Building	IA	µg/m <sup>3</sup>	0.43	0.12	0.3	14.1	1.2	1.59
668000	Doris Hancock office - victim services support area in AG building	AG Building	IA	µg/m <sup>3</sup>	0.42	0.12	nd	14.4	1.18	1.61
668001	Ashley's office victim services support area	AG Building	IA	µg/m <sup>3</sup>	0.45	0.13	0.3	13.04	1.22	1.72
668002	cubicle in Room SB15 (victim services support area)	AG Building	IA	µg/m <sup>3</sup>	0.53	0.14	nd	13.76	1.72	2.37
668003	Basement HVAC room inside supply room in AG building	AG Building	IA	µg/m <sup>3</sup>	0.72	0.26	0.51	13.86	2.41	3.81
668004	Dirt room in sub-basement of AG building	AG Building	Sub-Basement	µg/m <sup>3</sup>	1.01	0.36	nd	6.15	5.52	5.24

# detects Annex III	13	13	2	13	13	13
Min Annex III	0.44	0.12	0.59	2.32	0.65	2.27
Max Annex III	1.47	0.55	0.72	4.03	6.22	8.76
# detects AG Building	7	7	3	7	7	7
Min AG Bldg	0.42	0.12	0.3	2.43	0.72	0.45
Max AG Bldg	1.27	1.64	0.51	14.4	5.52	5.24
Commercial Ambient Air RSL (ug/m3)	0.36	NA	NA	NA	NA	NA



# FIGURES



**PCE Groundwater Concentration**

- Non-Detect or <Preliminary Screening Level
- <Site-Specific Screening Level
- Potential Sources Identified by ADEM
- RSA Chiller Plant
- August 2011 VI Investigation Property
- Montgomery Advertiser Property
- State of Alabama Property
- Davis Printing Company Property
- Walker Printing Company Property
- Other Historical Printing Operation

Note: Results from shallow groundwater samples collected after 2000 considered in evaluation. Open symbol indicates analytical result was non-detect. Screening evaluation based on 1/2 reporting limit.



**Vapor Intrusion Screening Evaluation for Tetrachloroethene (PCE) In Groundwater**  
 Capitol City Plume Superfund Site



Kennesaw, GA

15-Feb-2012

Figure  
**1**

Path: N:\Capitol City\GIS\mxd\Map\mxd\Analysis\_Figure.mxd\Contents

# APPENDIX A

## Figures and Sample Location Descriptions from USGS Preliminary Indoor Air and Soil-Gas Sampling Event Report

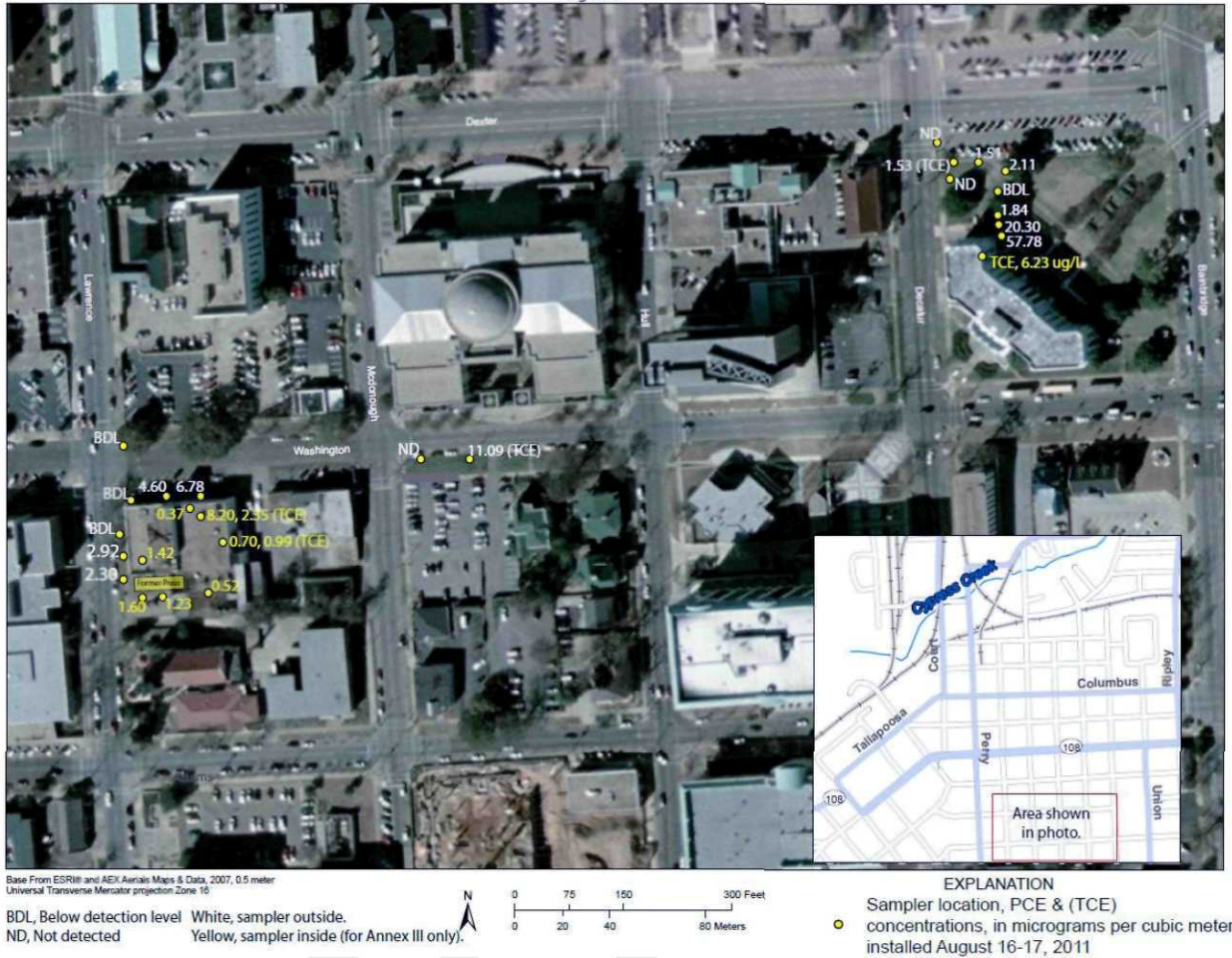
**Preliminary data<sup>1</sup>**  
**for**  
**Indoor Air and Soil-Gas Sampling Event,**  
**Selected Sites, Montgomery, AL**  
**August 16-17, 2011**

Prepared by the U.S. Geological Survey for the U.S. Environmental Protection Agency,  
Superfund Branch, Section C

<sup>1</sup>All results are provisional and subject to revision—not for quote or release.

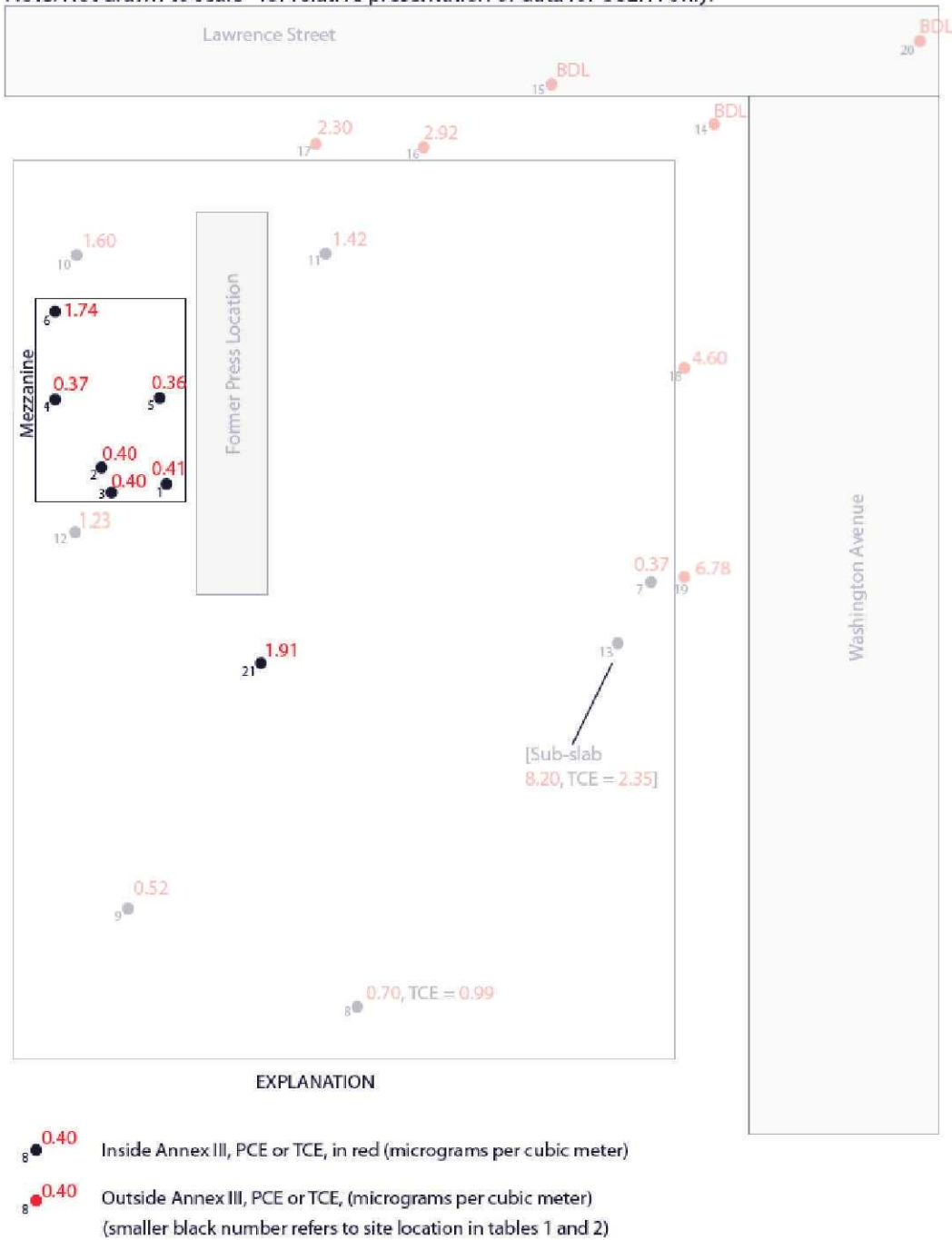
September 26, 2011

Figure 1



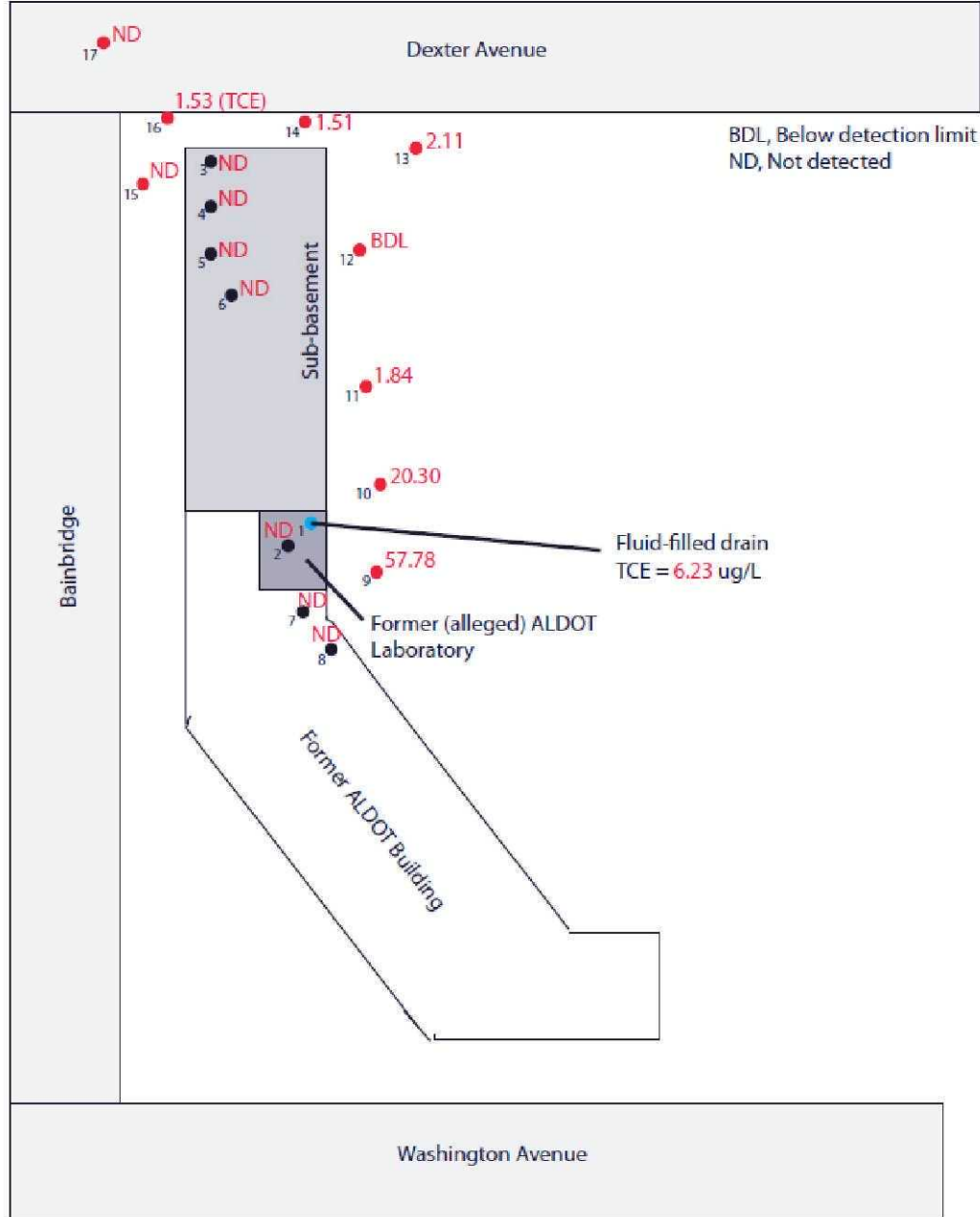
**Figure 1.** Selected results of perchloroethylene (PCE) and trichloroethylene (TCE, shown in parentheses) detection, in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ), for indoor air samples (yellow numbers) and soil-gas samples (white numbers), Annex III (left) and Department of Public Safety (former Alabama Department of Transportation[ALDOT]) building (right) and adjacent areas, installed August 16-17, 2011. The indoor air results for the Annex III Mezzanine are shown in **Figure 2**. The indoor sample shown for the Department of Public Safety (former ALDOT) building is a water sample and the result for TCE is shown in micrograms per liter ( $\mu\text{g}/\text{L}$ ). BDL, below detection level; ND, not detected.

Note: Not drawn to scale - for relative presentation of data for USEPA only.



**Figure 2.** Selected results of perchloroethylene (PCE) and trichloroethylene (TCE) detection, in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ), for indoor air samples (black circles) and soil-gas samples (red circles), Annex III and Mezzanine, August 16-17, 2011. The small black number refers to the sample collection location shown on tables 1 and 2. Sample 21 is located in room 430. BDL, below detection level.

Note: Not drawn to scale - for relative presentation of data for USEPA only.



- 20.30 PCE or TCE detection, inside Department of Public Safety building and sub-basement (micrograms per cubic meter)
- 20.30 PCE or TCE detection, outside former Alabama Department of Transportation building Laboratory and sub-basement (micrograms per cubic meter)

**Figure 3.** Selected results of perchloroethylene (PCE) and trichloroethylene (TCE) detection, in micrograms per cubic meter ( $\mu\text{g}/\text{m}^3$ ), for indoor air samples (black circles) and soil-gas samples (red circles), Department of Public Safety (former ALDOT) building, installed August 16-17, 2011. The small black number refers to the sample collection location shown on tables 3 and 4. BDL, below detection level; ND, not detected.

**Table 1.** Locations of samplers and concentration of volatile organic compounds, **inside** the Montgomery County Commission Annex III Building, Montgomery, Alabama, August 2011.

[ID, identification; MDL, method detection limit; ug/m<sup>3</sup>; micrograms per cubic meter of airspace; nd, not detected; bdl, below detection level; >, greater than]

<u>Sampler ID</u>	<u>ID on Figure</u>	<u>Sampler Location (Inside Annex III Building)</u>	<u>Installed Date</u>	<u>Installed Time</u>
667984	1	Behind white panel, under stairs	8/16/2011	10:43
667985	2	Ceiling panel in Pat's office, mezzanine	8/16/2011	10:40
667986	3	Hanging from light fixture mezzanine, behind Pat's office	8/16/2011	10:46
667987	4	Mezzanine cubicle office (left)	8/16/2011	10:48
667988	5	Mezzanine cubicle office (right)	8/16/2011	10:52
667989	6	Mezzanine storage closet low ceiling and HVAC	8/16/2011	10:55
667990	7	Main electrical room 109 in old drain pipe vent	8/16/2011	11:26
667991	8	Air handler main office, sump grate	8/16/2011	11:30
667992	9	Archives Room 121	8/16/2011	11:53
667993	10	Archives Room 129 (book storage)	8/16/2011	12:52
667994	11	HVAC Control room	8/16/2011	13:10
667995	12	In closet room 126, sump grate	8/16/2011	13:17
667996	13	Installed beneath 6-inch thick floor slab, room 109	8/16/2011	14:01
670802	21	2nd Floor Tag Office room 430	8/17/2011	13:00



**Table 2.** Locations of samplers and concentration of volatile organic compounds, **outside** the Montgomery County Commission Annex III Building, Montgomery, Alabama, August 2011.

[ID, identification; MDL, method detection limit; ug/m<sup>3</sup>; micrograms per cubic meter of soil airspace; nd, not detected; bdl, below detection level; soil porosity of 0.399 used to calculate soil-gas concentration from mass adsorbed; Different MDLs reflect samplers placed below ground in air (drains, etc) or soil.]

<u>Sampler ID</u>	<u>ID on Figure 2</u>	<u>Sampler Location (Outside Annex III Building)</u>
670798	14	Square drain entrance
670799	15	Drain, side of Lawrence, flowing, with sewer odor
668005	20	Drain, middle of Lawrence Street, water flowing
670800	16	Landscaped area near Annex III, Lawrence Street side
670801	17	Landscaped area old main entrance, Annex III, Lawrence Street side
670803	18	Landscaped area, in front of Annex III, Washington Avenue side
670804	19	Landscaped area, in front of Annex III, Washington Avenue side

**Table 3.** Locations of samplers and concentrations of volatile organic compounds, **inside** the Department Of Public Safety (Former ALDOT) Building, Montgomery, Alabama, August 2011.

[ID, identification; MDL, method detection limit; ug/m<sup>3</sup>; micrograms per cubic meter of airspace; nd, not detected; bdl, below detection level; >, greater than]

<u>Sampler ID</u>	<u>ID on Figure 3</u>	<u>Sampler Location (Inside Building)</u>
667998	2	Old ALDOT basement test lab, air
667999	3	Patty's office air, sub-basement
668000	4	Doris' office air, sub-basement
668001	5	Ashley's office air, sub-basement
668002	6	Support area air, sub-basement
668003	7	Mechanical room B15, HVAC
668004	8	Mechanical room SB06, air above exposed earth
667997	1	Old ALDOT basement (alleged) test lab, in drain standing fluid

**Table 4.** Locations of samplers and mass of volatile organic compounds, **outside** the Department of Public Safety (Former ALDOT) Building, Montgomery, Alabama, August 2011.

[ID, identification; MDL, method detection limit; ug, micrograms; nd, not detected; bdl, below detection level]

<u>Sampler ID</u>	<u>ID on Figure 3</u>	<u>Sampler Location (Outside Building)</u>
670811	9	Lawn, near former sump discharge pipe outfall
670810	10	Lawn, downgradient from former sump discharge pipe outfall
670809	11	Lawn, downgradient from former sump discharge pipe outfall
670808	12	Lawn, downgradient from former sump discharge pipe outfall
670807	13	Sidewalk, downgradient from former sump discharge pipe outfall
670816	14	Near Dexter Avenue sidewalk
670815	15	Hung in drain, Bainbridge
670814	16	Corner of Dexter and Bainbridge
670813	17	Old drain grate, Dexter

# APPENDIX B

## Site-Specific Screening Level Calculations

Appendix B, Table 1  
 Johnson and Ettinger Vapor Intrusion Model Input Parameters  
 Capitol City Plume Site  
 Montgomery, Alabama

Model Input Parameter	Value Used	Rationale
<b>Industrial/Commercial Building Parameters</b>		
Enclosed space floor thickness ( $L_{crack}$ ), cm	10	Default assumption
Enclosed space floor length ( $L_B$ ), cm	1000	Default assumption (10 meters)
Enclosed space floor width ( $W_B$ ), cm	1000	Default assumption (10 meters)
Enclosed space height ( $H_B$ ), cm	244	Assumed 1-floor ceiling height (8 feet)
Floor-wall seam crack width ( $w$ ), cm	0.1	Default assumption
Indoor air exchange rate (ER), hour <sup>-1</sup>	1	Default commercial building assumption
Average vapor flow rate into building ( $Q_{soil}$ ), L/m	5	Based on 5 L/min per 100 m <sup>2</sup> of building floor space
<b>Soil Properties</b>		
Average Soil Temperature ( $T_s$ ), °C	20	Typical value
Depth below grade to bottom of enclosed space floor ( $L_F$ ), cm	15	Slab construction
Depth to Groundwater, cm	762 - 3200	Range for Site Evaluated - See Table 2
Thickness of soil stratum A (Sand), cm	Ls,A	Thickness of Sand layer
Thickness of soil stratum B (Sand Loam), cm	Ls,B	Thickness of Sandy Loam Layer (clayey or silty sand, sand with clay interbeds)
Thickness of soil stratum C (Clay Loam), cm	Ls,C	Thickness of Clay Loam Layer (clay, silt, and sandy clay)
Soil stratum A SCS soil type	Sand	Default
Soil dry bulk density - Stratum A, gm/cm <sup>3</sup>	1.66	Default assumption, or Site-specific data if available
Soil total porosity - Stratum A, unitless	0.375	Default assumption, or Site-specific data if available
Soil water-filled porosity - Stratum A, cm <sup>3</sup> /cm <sup>3</sup>	0.054	Default assumption, or Site-specific data if available

Appendix B, Table 2  
 Johnson and Ettinger Vapor Intrusion Model Scenarios and Results  
 Capitol City Plume Site  
 Montgomery, Alabama

Scenario	25 ft Vadose Zone	30 ft Vadose Zone	MW-03S Lithology	MW-08S Lithology	MW-11S Lithology
<i>Input Values</i>					
Depth to Groundwater, cm	762.5	915	1738.5	1006.5	3202
Thickness of soil stratum A (Sand), cm	762.5	915	457.5	671	2409.5
Thickness of soil stratum B (Sand Loam), cm	0	0	1006.5	335.5	793
Thickness of soil stratum C (Clay Loam), cm	0	0	274.5	0	0
Soil Stratum Directly Above Water Table	A	A	B	A	A
<i>Calculated Values</i>					
Attenuation Factor (from J&E Spreadsheet)	1.39E-04	1.25E-04	2.44E-05	1.04E-04	3.46E-05
Henry's Law Coefficient (from J&E Spreadsheet)	0.581	0.581	0.581	0.581	0.581
RBSL <sub>air</sub> (µg/m <sup>3</sup> ) (Calculated following USEPA RSL Methodology)	47	47	47	47	47
RBSL <sub>GW</sub> (µg/L) (calculated using equation below)	581	649	3320	774	2340

$$RBSL_{GW} = \frac{RBSL_{air}}{H \times \alpha} \frac{1 L}{1000 m^3}$$

DATA ENTRY SHEET

Vapor Intrusion Modeling  
25 ft Sand Vadose Zone  
Commercial Worker Exposure Scenario  
Capitol City Plume Site  
Montgomery, Alabama

GW-ADV  
Version 3.1; 02/04

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

YES

OR

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

YES

Reset to Defaults

<b>ENTER</b> Chemical CAS No. (numbers only, no dashes)		<b>ENTER</b> Initial groundwater conc., $C_w$ ( $\mu\text{g/L}$ )		<b>Chemical</b>																			
127184		5.81E+02		Tetrachloroethylene																			
<b>ENTER</b> Average soil/groundwater temperature, $T_s$ ( $^{\circ}\text{C}$ )		<b>ENTER</b> Depth below grade to bottom of enclosed space floor, $L_f$ (cm)		<b>ENTER</b> Depth below grade to water table, $L_{WT}$ (cm)		<b>ENTER</b> Thickness of soil stratum A, $h_A$ (cm)		<b>ENTER</b> Thickness of soil stratum B, $h_B$ (cm)		<b>ENTER</b> Thickness of soil stratum C, $h_C$ (cm)		<b>ENTER</b> Soil stratum directly above water table, (Enter A, B, or C)		<b>ENTER</b> SCS soil type directly above water table		<b>ENTER</b> Soil stratum A SCS soil type (used to estimate soil vapor permeability)		<b>ENTER</b> User-defined stratum A soil vapor permeability, $k_v$ ( $\text{cm}^2$ )					
20		15		762.5 25.0 ft		762.5 25.0 ft		0 0.0 ft		0 0.0 ft		A		S		S		S		1.00E-08 Error			
<b>ENTER</b> Stratum A SCS soil type		<b>ENTER</b> Stratum A soil dry bulk density, $\rho_b^A$ ( $\text{g/cm}^3$ )		<b>ENTER</b> Stratum A soil total porosity, $n^A$ (unitless)		<b>ENTER</b> Stratum A soil water-filled porosity, $\theta_w^A$ ( $\text{cm}^3/\text{cm}^3$ )		<b>ENTER</b> Stratum B SCS soil type		<b>ENTER</b> Stratum B soil dry bulk density, $\rho_b^B$ ( $\text{g/cm}^3$ )		<b>ENTER</b> Stratum B soil total porosity, $n^B$ (unitless)		<b>ENTER</b> Stratum B soil water-filled porosity, $\theta_w^B$ ( $\text{cm}^3/\text{cm}^3$ )		<b>ENTER</b> Stratum C SCS soil type		<b>ENTER</b> Stratum C soil dry bulk density, $\rho_b^C$ ( $\text{g/cm}^3$ )		<b>ENTER</b> Stratum C soil total porosity, $n^C$ (unitless)		<b>ENTER</b> Stratum C soil water-filled porosity, $\theta_w^C$ ( $\text{cm}^3/\text{cm}^3$ )	
S		1.66		0.375		0.054		SL		1.62		0.387		0.103		CL		1.48		0.442		0.168	
<b>ENTER</b> Enclosed space floor thickness, $L_{crack}$ (cm)		<b>ENTER</b> Soil-bldg. pressure differential, $\Delta P$ ( $\text{g/cm-s}^2$ )		<b>ENTER</b> Enclosed space floor length, $L_B$ (cm)		<b>ENTER</b> Enclosed space floor width, $W_B$ (cm)		<b>ENTER</b> Enclosed space height, $H_B$ (cm)		<b>ENTER</b> Floor-wall seam crack width, $w$ (cm)		<b>ENTER</b> Indoor air exchange rate, ER (1/h)		<b>ENTER</b> Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m)									
10		40		1000		1000		244 8.0 ft		0.1		1		5									
<b>ENTER</b> Averaging time for carcinogens, $AT_C$ (yrs)		<b>ENTER</b> Averaging time for noncarcinogens, $AT_{NC}$ (yrs)		<b>ENTER</b> Exposure duration, ED (yrs)		<b>ENTER</b> Exposure frequency, EF (days/yr)		<b>ENTER</b> Target risk for carcinogens, TR (unitless)		<b>ENTER</b> Target hazard quotient for noncarcinogens, THQ (unitless)													
70		25		25		250		1.0E-06		1													
<b>END</b>																							

CHEMICAL PROPERTIES SHEET

25 ft Sand Vadose Zone  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

Diffusivity in air, $D_a$ ( $\text{cm}^2/\text{s}$ )	Diffusivity in water, $D_w$ ( $\text{cm}^2/\text{s}$ )	Henry's law constant at reference temperature, H ( $\text{atm}\cdot\text{m}^3/\text{mol}$ )	Henry's law constant reference temperature, $T_R$ ( $^\circ\text{C}$ )	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ ( $\text{cal}/\text{mol}$ )	Normal boiling point, $T_B$ ( $^\circ\text{K}$ )	Critical temperature, $T_C$ ( $^\circ\text{K}$ )	Organic carbon partition coefficient, $K_{oc}$ ( $\text{cm}^3/\text{g}$ )	Pure component water solubility, S ( $\text{mg}/\text{L}$ )	Unit risk factor, URF ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference conc., RfC ( $\text{mg}/\text{m}^3$ )	Chemical
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.9E-06	3.5E-02	Tetrachloroethylene

END



INTERMEDIATE CALCULATIONS SHEET

25 ft Sand Vadose Zone  
Commercial Worker Exposure Scenario  
Capitol City Plume Site  
Montgomery, Alabama

Exposure duration, $\tau$ (sec)	Source-building separation, $L_T$ (cm)	Stratum A soil air-filled porosity, $\theta_a^A$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum B soil air-filled porosity, $\theta_a^B$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum C soil air-filled porosity, $\theta_a^C$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum A effective total fluid saturation, $S_{ie}$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum A soil intrinsic permeability, $k_i$ ( $\text{cm}^2$ )	Stratum A soil relative air permeability, $k_{ra}$ ( $\text{cm}^2$ )	Stratum A soil effective vapor permeability, $k_v$ ( $\text{cm}^2$ )	Thickness of capillary zone, $L_{cz}$ (cm)	Total porosity in capillary zone, $n_{cz}$ ( $\text{cm}^3/\text{cm}^3$ )	Air-filled porosity in capillary zone, $\theta_{a,cz}$ ( $\text{cm}^3/\text{cm}^3$ )	Water-filled porosity in capillary zone, $\theta_{w,cz}$ ( $\text{cm}^3/\text{cm}^3$ )	Floor-wall seam perimeter, $X_{crack}$ (cm)
---------------------------------	--	--	--	--	--	--	--	--	--	--	--	--	---

7.88E+08	747.5	0.321	0.284	0.274	0.003	1.01E-07	0.998	ERROR	17.05	0.375	0.122	0.253	4,000
----------	-------	-------	-------	-------	-------	----------	-------	-------	-------	-------	-------	-------	-------

Bldg. ventilation rate, $Q_{building}$ ( $\text{cm}^3/\text{s}$ )	Area of enclosed space below grade, $A_B$ ( $\text{cm}^2$ )	Crack-to-total area ratio, $\eta$ (unitless)	Crack depth below grade, $Z_{crack}$ (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, $H_{TS}$ ( $\text{atm}\cdot\text{m}^3/\text{mol}$ )	Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless)	Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s)	Stratum A effective diffusion coefficient, $D^{eff}_A$ ( $\text{cm}^2/\text{s}$ )	Stratum B effective diffusion coefficient, $D^{eff}_B$ ( $\text{cm}^2/\text{s}$ )	Stratum C effective diffusion coefficient, $D^{eff}_C$ ( $\text{cm}^2/\text{s}$ )	Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ ( $\text{cm}^2/\text{s}$ )	Total overall effective diffusion coefficient, $D^{eff}_T$ ( $\text{cm}^2/\text{s}$ )	Diffusion path length, $L_d$ (cm)
---	---	--	---	---	---	--	---	---	---	---	---	---	-----------------------------------

6.78E+04	1.06E+06	3.77E-04	15	9,451	1.40E-02	5.81E-01	1.78E-04	1.16E-02	0.00E+00	0.00E+00	4.62E-04	7.50E-03	747.5
----------	----------	----------	----	-------	----------	----------	----------	----------	----------	----------	----------	----------	-------

Convection path length, $L_p$ (cm)	Source vapor conc., $C_{source}$ ( $\mu\text{g}/\text{m}^3$ )	Crack radius, $r_{crack}$ (cm)	Average vapor flow rate into bldg., $Q_{soil}$ ( $\text{cm}^3/\text{s}$ )	Crack effective diffusion coefficient, $D^{crack}$ ( $\text{cm}^2/\text{s}$ )	Area of crack, $A_{crack}$ ( $\text{cm}^2$ )	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, $\alpha$ (unitless)	Infinite source bldg. conc., $C_{building}$ ( $\mu\text{g}/\text{m}^3$ )	Unit risk factor, URF ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference conc., RfC ( $\text{mg}/\text{m}^3$ )	Chemical
------------------------------------	---	--------------------------------	---	---	--	--	---	--	--	---	----------

15	3.38E+05	0.10	8.33E+01	1.16E-02	4.00E+02	5.42E+77	1.39E-04	4.70E+01	5.9E-06	3.5E-02	Tetrachloroethylene
----	----------	------	----------	----------	----------	----------	----------	----------	---------	---------	---------------------

END

DATA ENTRY SHEET

Vapor Intrusion Modeling  
30 ft Sand Vadose Zone  
Commercial Worker Exposure Scenario  
Capitol City Plume Site  
Montgomery, Alabama

GW-ADV  
Version 3.1; 02/04

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

YES

OR

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

YES

Reset to Defaults

<b>ENTER</b> Chemical CAS No. (numbers only, no dashes)		<b>ENTER</b> Initial groundwater conc., $C_w$ ( $\mu\text{g/L}$ )		<b>Chemical</b>																			
127184		6.49E+02		Tetrachloroethylene																			
<b>ENTER</b> Average soil/groundwater temperature, $T_s$ ( $^{\circ}\text{C}$ )		<b>ENTER</b> Depth below grade to bottom of enclosed space floor, $L_f$ (cm)		<b>ENTER</b> Depth below grade to water table, $L_{WT}$ (cm)		<b>ENTER</b> Thickness of soil stratum A, $h_A$ (cm)		<b>ENTER</b> Thickness of soil stratum B, $h_B$ (cm)		<b>ENTER</b> Thickness of soil stratum C, $h_C$ (cm)		<b>ENTER</b> Soil stratum directly above water table, (Enter A, B, or C)		<b>ENTER</b> SCS soil type directly above water table		<b>ENTER</b> Soil stratum A SCS soil type (used to estimate soil vapor permeability)		<b>ENTER</b> User-defined stratum A soil vapor permeability, $k_v$ ( $\text{cm}^2$ )					
20		15		915		915		0		0		A		S		S		S		1.00E-08			
				30.0 ft		30.0 ft		0.0 ft		0.0 ft										Error			
<b>ENTER</b> Stratum A SCS soil type		<b>ENTER</b> Stratum A soil dry bulk density, $\rho_b^A$ ( $\text{g/cm}^3$ )		<b>ENTER</b> Stratum A soil total porosity, $n^A$ (unitless)		<b>ENTER</b> Stratum A soil water-filled porosity, $\theta_w^A$ ( $\text{cm}^3/\text{cm}^3$ )		<b>ENTER</b> Stratum B SCS soil type		<b>ENTER</b> Stratum B soil dry bulk density, $\rho_b^B$ ( $\text{g/cm}^3$ )		<b>ENTER</b> Stratum B soil total porosity, $n^B$ (unitless)		<b>ENTER</b> Stratum B soil water-filled porosity, $\theta_w^B$ ( $\text{cm}^3/\text{cm}^3$ )		<b>ENTER</b> Stratum C SCS soil type		<b>ENTER</b> Stratum C soil dry bulk density, $\rho_b^C$ ( $\text{g/cm}^3$ )		<b>ENTER</b> Stratum C soil total porosity, $n^C$ (unitless)		<b>ENTER</b> Stratum C soil water-filled porosity, $\theta_w^C$ ( $\text{cm}^3/\text{cm}^3$ )	
S		1.66		0.375		0.054		SL		1.62		0.387		0.103		CL		1.48		0.442		0.168	
<b>ENTER</b> Enclosed space floor thickness, $L_{crack}$ (cm)		<b>ENTER</b> Soil-bldg. pressure differential, $\Delta P$ ( $\text{g/cm-s}^2$ )		<b>ENTER</b> Enclosed space floor length, $L_B$ (cm)		<b>ENTER</b> Enclosed space floor width, $W_B$ (cm)		<b>ENTER</b> Enclosed space height, $H_B$ (cm)		<b>ENTER</b> Floor-wall seam crack width, $w$ (cm)		<b>ENTER</b> Indoor air exchange rate, ER (1/h)		<b>ENTER</b> Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m)									
10		40		1000		1000		244		0.1		1		5									
<b>ENTER</b> Averaging time for carcinogens, $AT_C$ (yrs)		<b>ENTER</b> Averaging time for noncarcinogens, $AT_{NC}$ (yrs)		<b>ENTER</b> Exposure duration, ED (yrs)		<b>ENTER</b> Exposure frequency, EF (days/yr)		<b>ENTER</b> Target risk for carcinogens, TR (unitless)		<b>ENTER</b> Target hazard quotient for noncarcinogens, THQ (unitless)													
70		25		25		250		1.0E-06		1													
<b>END</b>																						Used to calculate risk-based groundwater concentration.	

CHEMICAL PROPERTIES SHEET

Vapor Intrusion Modeling  
 30 ft Sand Vadose Zone  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

Diffusivity in air, $D_a$ ( $\text{cm}^2/\text{s}$ )	Diffusivity in water, $D_w$ ( $\text{cm}^2/\text{s}$ )	Henry's law constant at reference temperature, H ( $\text{atm}\cdot\text{m}^3/\text{mol}$ )	Henry's law constant reference temperature, $T_R$ ( $^\circ\text{C}$ )	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ ( $\text{cal}/\text{mol}$ )	Normal boiling point, $T_B$ ( $^\circ\text{K}$ )	Critical temperature, $T_C$ ( $^\circ\text{K}$ )	Organic carbon partition coefficient, $K_{oc}$ ( $\text{cm}^3/\text{g}$ )	Pure component water solubility, S ( $\text{mg}/\text{L}$ )	Unit risk factor, URF ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference conc., RfC ( $\text{mg}/\text{m}^3$ )	Chemical
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.9E-06	3.5E-02	Tetrachloroethylene

END

INTERMEDIATE CALCULATIONS SHEET

Vapor Intrusion Modeling  
30 ft Sand Vadose Zone  
Commercial Worker Exposure Scenario  
Capitol City Plume Site  
Montgomery, Alabama

Exposure duration, $\tau$ (sec)	Source-building separation, $L_T$ (cm)	Stratum A soil air-filled porosity, $\theta_a^A$ (cm <sup>3</sup> /cm <sup>3</sup> )	Stratum B soil air-filled porosity, $\theta_a^B$ (cm <sup>3</sup> /cm <sup>3</sup> )	Stratum C soil air-filled porosity, $\theta_a^C$ (cm <sup>3</sup> /cm <sup>3</sup> )	Stratum A effective total fluid saturation, $S_{fe}$ (cm <sup>3</sup> /cm <sup>3</sup> )	Stratum A soil intrinsic permeability, $k_i$ (cm <sup>2</sup> )	Stratum A soil relative air permeability, $k_{ra}$ (cm <sup>2</sup> )	Stratum A soil effective vapor permeability, $k_v$ (cm <sup>2</sup> )	Thickness of capillary zone, $L_{cz}$ (cm)	Total porosity in capillary zone, $n_{cz}$ (cm <sup>3</sup> /cm <sup>3</sup> )	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm <sup>3</sup> /cm <sup>3</sup> )	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm <sup>3</sup> /cm <sup>3</sup> )	Floor-wall seam perimeter, $X_{crack}$ (cm)
7.88E+08	900	0.321	0.284	0.274	0.003	1.01E-07	0.998	ERROR	17.05	0.375	0.122	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ (cm <sup>3</sup> /s)	Area of enclosed space below grade, $A_B$ (cm <sup>2</sup> )	Crack-to-total area ratio, $\eta$ (unitless)	Crack depth below grade, $Z_{crack}$ (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-m <sup>3</sup> /mol)	Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless)	Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s)	Stratum A effective diffusion coefficient, $D^{eff}_A$ (cm <sup>2</sup> /s)	Stratum B effective diffusion coefficient, $D^{eff}_B$ (cm <sup>2</sup> /s)	Stratum C effective diffusion coefficient, $D^{eff}_C$ (cm <sup>2</sup> /s)	Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ (cm <sup>2</sup> /s)	Total overall effective diffusion coefficient, $D^{eff}_T$ (cm <sup>2</sup> /s)	Diffusion path length, $L_d$ (cm)
6.78E+04	1.06E+06	3.77E-04	15	9,451	1.40E-02	5.81E-01	1.78E-04	1.16E-02	0.00E+00	0.00E+00	4.62E-04	7.98E-03	900

Convection path length, $L_p$ (cm)	Source vapor conc., $C_{source}$ (µg/m <sup>3</sup> )	Crack radius, $r_{crack}$ (cm)	Average vapor flow rate into bldg., $Q_{soil}$ (cm <sup>3</sup> /s)	Crack effective diffusion coefficient, $D^{crack}$ (cm <sup>2</sup> /s)	Area of crack, $A_{crack}$ (cm <sup>2</sup> )	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, $\alpha$ (unitless)	Infinite source bldg. conc., $C_{building}$ (µg/m <sup>3</sup> )	Unit risk factor, URF (µg/m <sup>3</sup> ) <sup>-1</sup>	Reference conc., RfC (mg/m <sup>3</sup> )	Chemical
15	3.77E+05	0.10	8.33E+01	1.16E-02	4.00E+02	5.42E+77	1.25E-04	4.70E+01	5.9E-06	3.5E-02	Tetrachloroethylene

END

DATA ENTRY SHEET

Vapor Intrusion Modeling  
 MW-03S Boring Log  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

GW-ADV  
 Version 3.1; 02/04

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

YES

OR

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

YES

Reset to Defaults

<b>ENTER</b> Chemical CAS No. (numbers only, no dashes)		<b>ENTER</b> Initial groundwater conc., $C_w$ ( $\mu\text{g/L}$ )		<b>Chemical</b>								
127184		3.32E+03		Tetrachloroethylene								
<b>ENTER</b> Average soil/groundwater temperature, $T_s$ ( $^{\circ}\text{C}$ )	<b>ENTER</b> Depth below grade to bottom of enclosed space floor, $L_f$ (cm)	<b>ENTER</b> Depth below grade to water table, $L_{WT}$ (cm)	<b>ENTER</b> Totals must add up to value of $L_{WT}$ (cell G28)			<b>ENTER</b> Soil stratum directly above water table, (Enter A, B, or C)	<b>ENTER</b> SCS soil type directly above water table	<b>ENTER</b> Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	<b>ENTER</b> User-defined stratum A soil vapor permeability, $k_v$ ( $\text{cm}^2$ )	Error	Error
			<b>ENTER</b> Thickness of soil stratum A, $h_A$ (cm)	<b>ENTER</b> Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm)	<b>ENTER</b> Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm)							
20	15	1738.5	457.5	1006.5	274.5	B	SL	S				
		57.0 ft	15.0 ft	33.0 ft	9.0 ft							
<b>ENTER</b> Stratum A SCS soil type	<b>ENTER</b> Stratum A soil dry bulk density, $\rho_b^A$ ( $\text{g/cm}^3$ )	<b>ENTER</b> Stratum A soil total porosity, $n^A$ (unitless)	<b>ENTER</b> Stratum A soil water-filled porosity, $\theta_w^A$ ( $\text{cm}^3/\text{cm}^3$ )	<b>ENTER</b> Stratum B SCS soil type	<b>ENTER</b> Stratum B soil dry bulk density, $\rho_b^B$ ( $\text{g/cm}^3$ )	<b>ENTER</b> Stratum B soil total porosity, $n^B$ (unitless)	<b>ENTER</b> Stratum B soil water-filled porosity, $\theta_w^B$ ( $\text{cm}^3/\text{cm}^3$ )	<b>ENTER</b> Stratum C SCS soil type	<b>ENTER</b> Stratum C soil dry bulk density, $\rho_b^C$ ( $\text{g/cm}^3$ )	<b>ENTER</b> Stratum C soil total porosity, $n^C$ (unitless)	<b>ENTER</b> Stratum C soil water-filled porosity, $\theta_w^C$ ( $\text{cm}^3/\text{cm}^3$ )	
												Lookup Soil Parameters
S	1.66	0.375	0.054	SL	1.62	0.387	0.103	CL	1.48	0.442	0.168	
<b>ENTER</b> Enclosed space floor thickness, $L_{crack}$ (cm)	<b>ENTER</b> Soil-bldg. pressure differential, $\Delta P$ ( $\text{g/cm-s}^2$ )	<b>ENTER</b> Enclosed space floor length, $L_B$ (cm)	<b>ENTER</b> Enclosed space floor width, $W_B$ (cm)	<b>ENTER</b> Enclosed space height, $H_B$ (cm)	<b>ENTER</b> Floor-wall seam crack width, $w$ (cm)	<b>ENTER</b> Indoor air exchange rate, ER (1/h)	<b>ENTER</b> Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m)					
							10	40	1000	1000	244	0.1
				8.0 ft								
<b>ENTER</b> Averaging time for carcinogens, $AT_C$ (yrs)	<b>ENTER</b> Averaging time for noncarcinogens, $AT_{NC}$ (yrs)	<b>ENTER</b> Exposure duration, ED (yrs)	<b>ENTER</b> Exposure frequency, EF (days/yr)	<b>ENTER</b> Target risk for carcinogens, TR (unitless)	<b>ENTER</b> Target hazard quotient for noncarcinogens, THQ (unitless)	<b>Used to calculate risk-based groundwater concentration.</b>						
						70	25	25	250	1.0E-06	1	

END

CHEMICAL PROPERTIES SHEET

Vapor Intrusion Modeling  
 MW-03S Boring Log  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

Diffusivity in air, $D_a$ ( $\text{cm}^2/\text{s}$ )	Diffusivity in water, $D_w$ ( $\text{cm}^2/\text{s}$ )	Henry's law constant at reference temperature, H ( $\text{atm}\cdot\text{m}^3/\text{mol}$ )	Henry's law constant reference temperature, $T_R$ ( $^\circ\text{C}$ )	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ ( $\text{cal}/\text{mol}$ )	Normal boiling point, $T_B$ ( $^\circ\text{K}$ )	Critical temperature, $T_C$ ( $^\circ\text{K}$ )	Organic carbon partition coefficient, $K_{oc}$ ( $\text{cm}^3/\text{g}$ )	Pure component water solubility, S ( $\text{mg}/\text{L}$ )	Unit risk factor, URF ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference conc., RfC ( $\text{mg}/\text{m}^3$ )	Chemical
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.9E-06	3.5E-02	Tetrachloroethylene

END

INTERMEDIATE CALCULATIONS SHEET

Vapor Intrusion Modeling  
 MW-03S Boring Log  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

Exposure duration, $\tau$ (sec)	Source-building separation, $L_T$ (cm)	Stratum A soil air-filled porosity, $\theta_a^A$ (cm <sup>3</sup> /cm <sup>3</sup> )	Stratum B soil air-filled porosity, $\theta_a^B$ (cm <sup>3</sup> /cm <sup>3</sup> )	Stratum C soil air-filled porosity, $\theta_a^C$ (cm <sup>3</sup> /cm <sup>3</sup> )	Stratum A effective total fluid saturation, $S_{le}$ (cm <sup>3</sup> /cm <sup>3</sup> )	Stratum A soil intrinsic permeability, $k_i$ (cm <sup>2</sup> )	Stratum A soil relative air permeability, $k_{rg}$ (cm <sup>2</sup> )	Stratum A soil effective vapor permeability, $k_v$ (cm <sup>2</sup> )	Thickness of capillary zone, $L_{cz}$ (cm)	Total porosity in capillary zone, $n_{cz}$ (cm <sup>3</sup> /cm <sup>3</sup> )	Air-filled porosity in capillary zone, $\theta_{a,cz}$ (cm <sup>3</sup> /cm <sup>3</sup> )	Water-filled porosity in capillary zone, $\theta_{w,cz}$ (cm <sup>3</sup> /cm <sup>3</sup> )	Floor-wall seam perimeter, $X_{crack}$ (cm)
7.88E+08	1723.5	0.321	0.284	0.274	0.003	1.01E-07	0.998	ERROR	25.00	0.387	0.067	0.320	4,000

Bldg. ventilation rate, $Q_{building}$ (cm <sup>3</sup> /s)	Area of enclosed space below grade, $A_B$ (cm <sup>2</sup> )	Crack-to-total area ratio, $\eta$ (unitless)	Crack depth below grade, $Z_{crack}$ (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, $H_{TS}$ (atm-m <sup>3</sup> /mol)	Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless)	Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s)	Stratum A effective diffusion coefficient, $D^{eff}_A$ (cm <sup>2</sup> /s)	Stratum B effective diffusion coefficient, $D^{eff}_B$ (cm <sup>2</sup> /s)	Stratum C effective diffusion coefficient, $D^{eff}_C$ (cm <sup>2</sup> /s)	Capillary zone effective diffusion coefficient, $D^{eff}_{cz}$ (cm <sup>2</sup> /s)	Total overall effective diffusion coefficient, $D^{eff}_T$ (cm <sup>2</sup> /s)	Diffusion path length, $L_d$ (cm)
6.78E+04	1.06E+06	3.77E-04	15	9,451	1.40E-02	5.81E-01	1.78E-04	1.16E-02	7.27E-03	4.95E-03	6.22E-05	2.74E-03	1723.5

Convection path length, $L_p$ (cm)	Source vapor conc., $C_{source}$ (ug/m <sup>3</sup> )	Crack radius, $r_{crack}$ (cm)	Average vapor flow rate into bldg., $Q_{soil}$ (cm <sup>3</sup> /s)	Crack effective diffusion coefficient, $D^{crack}$ (cm <sup>2</sup> /s)	Area of crack, $A_{crack}$ (cm <sup>2</sup> )	Exponent of equivalent foundation Peclet number, $\exp(Pe^f)$ (unitless)	Infinite source indoor attenuation coefficient, $\alpha$ (unitless)	Infinite source bldg. conc., $C_{building}$ (ug/m <sup>3</sup> )	Unit risk factor, URF (ug/m <sup>3</sup> ) <sup>-1</sup>	Reference conc., RfC (mg/m <sup>3</sup> )	Chemical
15	1.93E+06	0.10	8.33E+01	1.16E-02	4.00E+02	5.42E+77	2.44E-05	4.70E+01	5.9E-06	3.5E-02	Tetrachloroethylene

END

DATA ENTRY SHEET

Vapor Intrusion Modeling  
 MW-08S Boring Log  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

GW-ADV  
 Version 3.1; 02/04

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

YES

OR

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

YES

Reset to Defaults

<b>ENTER</b> Chemical CAS No. (numbers only, no dashes)		<b>ENTER</b> Initial groundwater conc., $C_w$ ( $\mu\text{g/L}$ )		<b>Chemical</b>							
127184		7.74E+02		Tetrachloroethylene							
<b>ENTER</b> Average soil/groundwater temperature, $T_s$ ( $^{\circ}\text{C}$ )	<b>ENTER</b> Depth below grade to bottom of enclosed space floor, $L_f$ (cm)	<b>ENTER</b> Depth below grade to water table, $L_{WT}$ (cm)	<b>ENTER</b> Totals must add up to value of $L_{WT}$ (cell G28)			<b>ENTER</b> Soil stratum directly above water table, (Enter A, B, or C)	<b>ENTER</b> SCS soil type directly above water table	<b>ENTER</b> Soil stratum A SCS soil type (used to estimate soil vapor permeability)	OR	<b>ENTER</b> User-defined stratum A soil vapor permeability, $k_v$ ( $\text{cm}^2$ )	
			<b>ENTER</b> Thickness of soil stratum A, $h_A$ (cm)	<b>ENTER</b> Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm)	<b>ENTER</b> Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm)						
20	15	1006.5	671	335.5	0	A	S	S	S	1.00E-08	Error
		33.0 ft	22.0 ft	11.0 ft	0.0 ft						
<b>ENTER</b> Stratum A SCS soil type (Lookup Soil Parameters)	<b>ENTER</b> Stratum A soil dry bulk density, $\rho_b^A$ ( $\text{g/cm}^3$ )	<b>ENTER</b> Stratum A soil total porosity, $n^A$ (unitless)	<b>ENTER</b> Stratum A soil water-filled porosity, $\theta_w^A$ ( $\text{cm}^3/\text{cm}^3$ )	<b>ENTER</b> Stratum B SCS soil type (Lookup Soil Parameters)	<b>ENTER</b> Stratum B soil dry bulk density, $\rho_b^B$ ( $\text{g/cm}^3$ )	<b>ENTER</b> Stratum B soil total porosity, $n^B$ (unitless)	<b>ENTER</b> Stratum B soil water-filled porosity, $\theta_w^B$ ( $\text{cm}^3/\text{cm}^3$ )	<b>ENTER</b> Stratum C SCS soil type (Lookup Soil Parameters)	<b>ENTER</b> Stratum C soil dry bulk density, $\rho_b^C$ ( $\text{g/cm}^3$ )	<b>ENTER</b> Stratum C soil total porosity, $n^C$ (unitless)	<b>ENTER</b> Stratum C soil water-filled porosity, $\theta_w^C$ ( $\text{cm}^3/\text{cm}^3$ )
<b>ENTER</b> Enclosed space floor thickness, $L_{crack}$ (cm)	<b>ENTER</b> Soil-bldg. pressure differential, $\Delta P$ ( $\text{g/cm-s}^2$ )	<b>ENTER</b> Enclosed space floor length, $L_B$ (cm)	<b>ENTER</b> Enclosed space floor width, $W_B$ (cm)	<b>ENTER</b> Enclosed space height, $H_B$ (cm)	<b>ENTER</b> Floor-wall seam crack width, $w$ (cm)	<b>ENTER</b> Indoor air exchange rate, ER (1/h)	<b>ENTER</b> Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m)				
							10	40	1000	1000	244
<b>ENTER</b> Averaging time for carcinogens, $AT_C$ (yrs)	<b>ENTER</b> Averaging time for noncarcinogens, $AT_{NC}$ (yrs)	<b>ENTER</b> Exposure duration, ED (yrs)	<b>ENTER</b> Exposure frequency, EF (days/yr)	<b>ENTER</b> Target risk for carcinogens, TR (unitless)	<b>ENTER</b> Target hazard quotient for noncarcinogens, THQ (unitless)	<b>ENTER</b> Used to calculate risk-based groundwater concentration.					
						70	25	25	250	1.0E-06	1

END



CHEMICAL PROPERTIES SHEET

Vapor Intrusion Modeling  
 MW-08S Boring Log  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

Diffusivity in air, $D_a$ ( $\text{cm}^2/\text{s}$ )	Diffusivity in water, $D_w$ ( $\text{cm}^2/\text{s}$ )	Henry's law constant at reference temperature, H ( $\text{atm}\cdot\text{m}^3/\text{mol}$ )	Henry's law constant reference temperature, $T_R$ ( $^{\circ}\text{C}$ )	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ ( $\text{cal}/\text{mol}$ )	Normal boiling point, $T_B$ ( $^{\circ}\text{K}$ )	Critical temperature, $T_C$ ( $^{\circ}\text{K}$ )	Organic carbon partition coefficient, $K_{oc}$ ( $\text{cm}^3/\text{g}$ )	Pure component water solubility, S ( $\text{mg}/\text{L}$ )	Unit risk factor, URF ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference conc., RfC ( $\text{mg}/\text{m}^3$ )	Chemical
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.9E-06	3.5E-02	Tetrachloroethylene

END

INTERMEDIATE CALCULATIONS SHEET

Vapor Intrusion Modeling  
 MW-08S Boring Log  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

Exposure duration, $\tau$ (sec)	Source-building separation, $L_T$ (cm)	Stratum A soil air-filled porosity, $\theta_a^A$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum B soil air-filled porosity, $\theta_a^B$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum C soil air-filled porosity, $\theta_a^C$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum A effective total fluid saturation, $S_{fe}$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum A soil intrinsic permeability, $k_i$ ( $\text{cm}^2$ )	Stratum A soil relative air permeability, $k_{ra}$ ( $\text{cm}^2$ )	Stratum A soil effective vapor permeability, $k_v$ ( $\text{cm}^2$ )	Thickness of capillary zone, $L_{cz}$ (cm)	Total porosity in capillary zone, $n_{cz}$ ( $\text{cm}^3/\text{cm}^3$ )	Air-filled porosity in capillary zone, $\theta_{a,cz}$ ( $\text{cm}^3/\text{cm}^3$ )	Water-filled porosity in capillary zone, $\theta_{w,cz}$ ( $\text{cm}^3/\text{cm}^3$ )	Floor-wall seam perimeter, $X_{crack}$ (cm)
7.88E+08	991.5	0.321	0.284	0.274	0.003	1.01E-07	0.998	ERROR	17.05	0.375	0.122	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ ( $\text{cm}^3/\text{s}$ )	Area of enclosed space below grade, $A_B$ ( $\text{cm}^2$ )	Crack-to-total area ratio, $\eta$ (unitless)	Crack depth below grade, $Z_{crack}$ (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, $H_{TS}$ ( $\text{atm}\cdot\text{m}^3/\text{mol}$ )	Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless)	Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s)	Stratum A effective diffusion coefficient, $D^{\text{eff}}_A$ ( $\text{cm}^2/\text{s}$ )	Stratum B effective diffusion coefficient, $D^{\text{eff}}_B$ ( $\text{cm}^2/\text{s}$ )	Stratum C effective diffusion coefficient, $D^{\text{eff}}_C$ ( $\text{cm}^2/\text{s}$ )	Capillary zone effective diffusion coefficient, $D^{\text{eff}}_{cz}$ ( $\text{cm}^2/\text{s}$ )	Total overall effective diffusion coefficient, $D^{\text{eff}}_T$ ( $\text{cm}^2/\text{s}$ )	Diffusion path length, $L_d$ (cm)
6.78E+04	1.06E+06	3.77E-04	15	9,451	1.40E-02	5.81E-01	1.78E-04	1.16E-02	7.27E-03	0.00E+00	4.62E-04	7.23E-03	991.5

Convection path length, $L_p$ (cm)	Source vapor conc., $C_{source}$ ( $\mu\text{g}/\text{m}^3$ )	Crack radius, $r_{crack}$ (cm)	Average vapor flow rate into bldg., $Q_{soil}$ ( $\text{cm}^3/\text{s}$ )	Crack effective diffusion coefficient, $D^{crack}$ ( $\text{cm}^2/\text{s}$ )	Area of crack, $A_{crack}$ ( $\text{cm}^2$ )	Exponent of equivalent foundation Peclet number, $\exp(\text{Pe}^f)$ (unitless)	Infinite source indoor attenuation coefficient, $\alpha$ (unitless)	Infinite source bldg. conc., $C_{building}$ ( $\mu\text{g}/\text{m}^3$ )	Unit risk factor, URF ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference conc., RfC ( $\text{mg}/\text{m}^3$ )	Chemical
15	4.50E+05	0.10	8.33E+01	1.16E-02	4.00E+02	5.42E+77	1.04E-04	4.70E+01	5.9E-06	3.5E-02	Tetrachloroethylene

END

DATA ENTRY SHEET

Vapor Intrusion Modeling  
 MW-11S Boring Log  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

GW-ADV  
 Version 3.1; 02/04

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

YES

OR

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

YES

Reset to Defaults

<b>ENTER</b> Chemical CAS No. (numbers only, no dashes)		<b>ENTER</b> Initial groundwater conc., $C_w$ ( $\mu\text{g/L}$ )		<b>Chemical</b>							
127184		2.34E+03		Tetrachloroethylene							
<b>ENTER</b> Average soil/groundwater temperature, $T_s$ ( $^{\circ}\text{C}$ )	<b>ENTER</b> Depth below grade to bottom of enclosed space floor, $L_f$ (cm)	<b>ENTER</b> Depth below grade to water table, $L_{WT}$ (cm)	<b>ENTER</b> Totals must add up to value of $L_{WT}$ (cell G28)			<b>ENTER</b> Soil stratum directly above water table, (Enter A, B, or C)	<b>ENTER</b> SCS soil type directly above water table	<b>ENTER</b> Soil stratum A SCS soil type (used to estimate soil vapor permeability)	<b>OR</b>	<b>ENTER</b> User-defined stratum A soil vapor permeability, $k_v$ ( $\text{cm}^2$ )	
			<b>ENTER</b> Thickness of soil stratum A, $h_A$ (cm)	<b>ENTER</b> Thickness of soil stratum B, (Enter value or 0) $h_B$ (cm)	<b>ENTER</b> Thickness of soil stratum C, (Enter value or 0) $h_C$ (cm)						
20	15	3202.5	2409.5	793	0	A	S	S	S	1.00E-08	
		105.0 ft	79.0 ft	26.0 ft	0.0 ft					Error	
<b>ENTER</b> Stratum A SCS soil type	<b>ENTER</b> Stratum A soil dry bulk density, $\rho_b^A$ ( $\text{g/cm}^3$ )	<b>ENTER</b> Stratum A soil total porosity, $n^A$ (unitless)	<b>ENTER</b> Stratum A soil water-filled porosity, $\theta_w^A$ ( $\text{cm}^3/\text{cm}^3$ )	<b>ENTER</b> Stratum B SCS soil type	<b>ENTER</b> Stratum B soil dry bulk density, $\rho_b^B$ ( $\text{g/cm}^3$ )	<b>ENTER</b> Stratum B soil total porosity, $n^B$ (unitless)	<b>ENTER</b> Stratum B soil water-filled porosity, $\theta_w^B$ ( $\text{cm}^3/\text{cm}^3$ )	<b>ENTER</b> Stratum C SCS soil type	<b>ENTER</b> Stratum C soil dry bulk density, $\rho_b^C$ ( $\text{g/cm}^3$ )	<b>ENTER</b> Stratum C soil total porosity, $n^C$ (unitless)	<b>ENTER</b> Stratum C soil water-filled porosity, $\theta_w^C$ ( $\text{cm}^3/\text{cm}^3$ )
S	1.66	0.375	0.054	SL	1.62	0.387	0.103	CL	1.48	0.442	0.168
<b>ENTER</b> Enclosed space floor thickness, $L_{crack}$ (cm)	<b>ENTER</b> Soil-bldg. pressure differential, $\Delta P$ ( $\text{g/cm-s}^2$ )	<b>ENTER</b> Enclosed space floor length, $L_B$ (cm)	<b>ENTER</b> Enclosed space floor width, $W_B$ (cm)	<b>ENTER</b> Enclosed space height, $H_B$ (cm)	<b>ENTER</b> Floor-wall seam crack width, $w$ (cm)	<b>ENTER</b> Indoor air exchange rate, ER (1/h)	<b>ENTER</b> Average vapor flow rate into bldg. OR Leave blank to calculate $Q_{soil}$ (L/m)				
							10	40	1000	1000	305
<b>ENTER</b> Averaging time for carcinogens, $AT_C$ (yrs)	<b>ENTER</b> Averaging time for noncarcinogens, $AT_{NC}$ (yrs)	<b>ENTER</b> Exposure duration, ED (yrs)	<b>ENTER</b> Exposure frequency, EF (days/yr)	<b>ENTER</b> Target risk for carcinogens, TR (unitless)	<b>ENTER</b> Target hazard quotient for noncarcinogens, THQ (unitless)	<b>Used to calculate risk-based groundwater concentration.</b>					
						70	25	25	250	1.0E-06	1

END

CHEMICAL PROPERTIES SHEET

Vapor Intrusion Modeling  
 MW-11S Boring Log  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

Diffusivity in air, $D_a$ ( $\text{cm}^2/\text{s}$ )	Diffusivity in water, $D_w$ ( $\text{cm}^2/\text{s}$ )	Henry's law constant at reference temperature, H ( $\text{atm}\cdot\text{m}^3/\text{mol}$ )	Henry's law constant reference temperature, $T_R$ ( $^\circ\text{C}$ )	Enthalpy of vaporization at the normal boiling point, $\Delta H_{v,b}$ ( $\text{cal}/\text{mol}$ )	Normal boiling point, $T_B$ ( $^\circ\text{K}$ )	Critical temperature, $T_C$ ( $^\circ\text{K}$ )	Organic carbon partition coefficient, $K_{oc}$ ( $\text{cm}^3/\text{g}$ )	Pure component water solubility, S ( $\text{mg}/\text{L}$ )	Unit risk factor, URF ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference conc., RfC ( $\text{mg}/\text{m}^3$ )	Chemical
7.20E-02	8.20E-06	1.84E-02	25	8,288	394.40	620.20	1.55E+02	2.00E+02	5.9E-06	3.5E-02	Tetrachloroethylene

END

INTERMEDIATE CALCULATIONS SHEET

Vapor Intrusion Modeling  
 MW-11S Boring Log  
 Commercial Worker Exposure Scenario  
 Capitol City Plume Site  
 Montgomery, Alabama

Exposure duration, $\tau$ (sec)	Source-building separation, $L_T$ (cm)	Stratum A soil air-filled porosity, $\theta_a^A$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum B soil air-filled porosity, $\theta_a^B$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum C soil air-filled porosity, $\theta_a^C$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum A effective total fluid saturation, $S_{fe}$ ( $\text{cm}^3/\text{cm}^3$ )	Stratum A soil intrinsic permeability, $k_i$ ( $\text{cm}^2$ )	Stratum A soil relative air permeability, $k_{ra}$ ( $\text{cm}^2$ )	Stratum A soil effective vapor permeability, $k_v$ ( $\text{cm}^2$ )	Thickness of capillary zone, $L_{cz}$ (cm)	Total porosity in capillary zone, $n_{cz}$ ( $\text{cm}^3/\text{cm}^3$ )	Air-filled porosity in capillary zone, $\theta_{a,cz}$ ( $\text{cm}^3/\text{cm}^3$ )	Water-filled porosity in capillary zone, $\theta_{w,cz}$ ( $\text{cm}^3/\text{cm}^3$ )	Floor-wall seam perimeter, $X_{crack}$ (cm)
7.88E+08	3187.5	0.321	0.284	0.274	0.003	1.01E-07	0.998	ERROR	17.05	0.375	0.122	0.253	4,000

Bldg. ventilation rate, $Q_{building}$ ( $\text{cm}^3/\text{s}$ )	Area of enclosed space below grade, $A_B$ ( $\text{cm}^2$ )	Crack-to-total area ratio, $\eta$ (unitless)	Crack depth below grade, $Z_{crack}$ (cm)	Enthalpy of vaporization at ave. groundwater temperature, $\Delta H_{v,TS}$ (cal/mol)	Henry's law constant at ave. groundwater temperature, $H_{TS}$ ( $\text{atm}\cdot\text{m}^3/\text{mol}$ )	Henry's law constant at ave. groundwater temperature, $H'_{TS}$ (unitless)	Vapor viscosity at ave. soil temperature, $\mu_{TS}$ (g/cm-s)	Stratum A effective diffusion coefficient, $D^{\text{eff}}_A$ ( $\text{cm}^2/\text{s}$ )	Stratum B effective diffusion coefficient, $D^{\text{eff}}_B$ ( $\text{cm}^2/\text{s}$ )	Stratum C effective diffusion coefficient, $D^{\text{eff}}_C$ ( $\text{cm}^2/\text{s}$ )	Capillary zone effective diffusion coefficient, $D^{\text{eff}}_{cz}$ ( $\text{cm}^2/\text{s}$ )	Total overall effective diffusion coefficient, $D^{\text{eff}}_T$ ( $\text{cm}^2/\text{s}$ )	Diffusion path length, $L_d$ (cm)
8.47E+04	1.06E+06	3.77E-04	15	9,451	1.40E-02	5.81E-01	1.78E-04	1.16E-02	7.27E-03	0.00E+00	4.62E-04	9.12E-03	3187.5

Convection path length, $L_p$ (cm)	Source vapor conc., $C_{source}$ ( $\mu\text{g}/\text{m}^3$ )	Crack radius, $r_{crack}$ (cm)	Average vapor flow rate into bldg., $Q_{soil}$ ( $\text{cm}^3/\text{s}$ )	Crack effective diffusion coefficient, $D^{crack}$ ( $\text{cm}^2/\text{s}$ )	Area of crack, $A_{crack}$ ( $\text{cm}^2$ )	Exponent of equivalent foundation Peclet number, $\exp(\text{Pe}^f)$ (unitless)	Infinite source indoor attenuation coefficient, $\alpha$ (unitless)	Infinite source bldg. conc., $C_{building}$ ( $\mu\text{g}/\text{m}^3$ )	Unit risk factor, URF ( $\mu\text{g}/\text{m}^3$ ) <sup>-1</sup>	Reference conc., RfC ( $\text{mg}/\text{m}^3$ )	Chemical
15	1.36E+06	0.10	8.33E+01	1.16E-02	4.00E+02	5.42E+77	3.46E-05	4.70E+01	5.9E-06	3.5E-02	Tetrachloroethylene

END