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EPA WORK ASSIGNMENT NUMBER: 037-2PY4

EPA CONTRACT NUMBER: 68-W8-0124

ICF TECHNOLOGY INCORPORATED

REPORT OF OFF-SITE SOIL GAS MODELING FOR THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY OVERSIGHT AT THE ROSEN BROTHERS SCRAP YARD SITE CORTLAND, CORTLAND COUNTY, NEW YORK

AUGUST 1995

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18 August 1995

Mr. Mark Granger
Work Assignment Manager
U.S. Environmental Protection Agency
290 Broadway, 20th Floor
New York, New York 10007-1866

SUBJECT: ROSEN BROTHERS SCRAP YARD SITE RI/FS OVERSIGHT
OFF-SITE SOIL GAS MODELING
USEPA WORK ASSIGNMENT NUMBER: 037-2PY4
USEPA CONTRACT NUMBER: 68-W8-0124

Dear Mr. Granger:

At your direction, ICF Technology, Incorporated (ICF) has conducted a screening-level analysis, using a worst-case scenario, to assess whether VOCs from groundwater could affect indoor air quality in nearby buildings. This letter report presents a summary of our work and findings.

Introduction

Volatile organic compounds (VOCs) detected in groundwater at the Rosen Brothers Scrap Yard Site could potentially be transported through the unsaturated zone and through soils into nearby buildings in sufficient concentrations to affect indoor air quality. In light of this potential health concern, air modeling was conducted to determine if concentrations of VOCs detected in on-site groundwater in the upper outwash aquifer are at levels high enough to negatively affect indoor air quality in a hypothetical building located at the site.

The analysis presented here follows USEPA's *Assessing Potential Indoor Air Impacts for Superfund Sites* (USEPA 1992). The guidance outlines a four step graduated approach to assessing the extent and magnitude of volatilization of VOCs from groundwater into indoor air. The first step is a screening-level analysis, in which conservative assumptions are used to develop a worst-case type of scenario. Screening-level modeling generally results in an over-estimation of results and is intended to provide "order of magnitude" estimates. If the results of a screening-level analysis indicate that levels are acceptable (i.e., that adverse health effects associated with a particular chemical concentration would not occur), then no additional modeling is required. If a screening-level analysis (Step 1) indicates that levels are unacceptable (i.e., adverse effects could potentially occur), USEPA (1992) recommends that a more refined analysis be conducted (Step 2). Step 2 incorporates more sophisticated modeling and the use of more site-specific parameters. If the results from Step 2 refined modeling indicate that adverse effects could occur (based on modeling indoor air concentrations at the Rosen Brothers Scrap Yard Site, for example), USEPA (1992) recommends that Step 3 be carried out, in which exterior monitoring in the immediate vicinity of the potentially affected building be conducted. Step 3, which could consist of soil gas monitoring, for example, may be used to confirm the refined model predictions and make better estimates of indoor exposures. When the results of Step 3 are considered to be unacceptably high, indoor air monitoring at the building site may be conducted. USEPA (1992) identifies this as the fourth and final step to estimating potential effects associated with indoor air concentrations as a result of Superfund site-related exposure.

The following report describes the screening-level air modeling that was conducted to predict indoor air concentrations in a hypothetical building at the Rosen Brothers Scrap Yard Site, as a result of volatilization of VOCs from groundwater. The analysis derived vapor phase VOC concentrations at the groundwater/soil interface from the groundwater concentrations detected at the Rosen Brothers Scrap Yard Site. Next, the extent of VOC movement up through the soil to the hypothetical building was determined. Finally, the infiltration of the VOCs into the building was calculated, and the air concentrations within the building were determined. The modeling results and the assumptions and parameters used in the modeling calculations are described below in more detail.

Screening-Level Air Modeling Analysis

The first step in this analysis involved the calculation of soil gas concentrations from the measured concentrations of chemicals in groundwater. USEPA (1992) recommends the Farmer model, which is a simple soil gas emissions model for calculating air emissions of chemicals dissolved in groundwater or contaminated soils. The methodology of the Farmer model as presented in Appendix A of USEPA (1992) was followed to predict the soil gas concentrations and emissions from groundwater at the Rosen Brothers Scrap Yard Site. A key assumption of this model is that the source pollutant concentration (i.e., chemical concentrations in groundwater) is not decreased by transport of the chemical to the surface and that the depth from the surface to the top of the pollutant source remains constant. The single maximum detected groundwater concentration for each chemical from the on-site groundwater wells screened in the upper outwash at the Rosen Brothers Scrap Yard Site (as listed in the Baseline Risk Assessment prepared by Blasland, Bouck and Lee, Inc. [1994]) was conservatively used for this screening analysis. Groundwater concentrations used in this analysis are presented in the second column of Table 1.

Soil gas concentrations at the pollutant source (i.e., the water table surface) were calculated using the following equation:

$$C_g = \frac{C_l * H}{R * T}$$

HENRYS LAW: $P_A = C_{AL} H_A(T)$; $P_A = \left(\frac{P_A}{MW_A}\right) RT = C_{Aq} RT$

$C_{Aq} = \frac{C_{AL} H_A(T)}{RT}$ @ LIQUID TEMP. OF VAPOR

(THIS IS THE EQUILIBRIUM CONDITION - NO TYPE OF FLUX HERE)

where:

C_g = chemical concentration in the vapor phase (g/cm^3),
C_l = liquid phase concentration of chemical (g/cm^3),
H = Henry's law constant (atm-m^3/mole),
R = universal gas constant (8.2x10^{-5} atm-m^3/mole-K), and
T = soil temperature (K).

The universal gas constant and chemical-specific Henry's law constants were obtained from the available literature, and the soil temperature of 40°F (277.4K) was based on professional experience and judgement. A higher soil temperature (50°F) was considered, however, a lower soil temperature has denser soil gas and correspondingly higher VOC concentrations in the soil gas. Therefore, the 40°F soil temperature adds to the conservatism of the screening-level air modeling.

(However H will be lower for lower TEMP. (UNLESS THEY USE 25°C VALUE.)

The next step of the Farmer model was to calculate the soil gas flux rates associated with the calculated soil gas concentrations. The flux rate calculated using the Farmer model assumes Fickian diffusion of vapor through the soil matrix (USEPA 1992). Chemicals in the soil gas (i.e., the vapor phase) diffuse through the soil at a rate dependent on the soil porosity, pore space geometry, each

chemical's air diffusion coefficient, and the concentration gradient between the pollutant source and the soil surface. The effective diffusion coefficient was calculated using the following equation:

$$D_s = \frac{D_A P_a^{10/3}}{P_T^2}$$

AN EQUATION FOR DIFFUSION COEFICIENT FOR A GAS THROUGH A POROUS MEDIUM. (INVERSE RESISTANCE)

where:

D_s = Diffusion coefficient (cm^2/sec),
D_A = chemical-specific vapor phase diffusion coefficient in air (cm^2/sec),
P_a = air-filled soil porosity (unitless), and
P_T = total soil porosity (unitless).

Chemical-specific diffusion coefficients in air (D_A) were obtained from literature sources including Lung (1968), Shen (1982) and Lyman et al. (1982). A total soil porosity equal to 43% and an air-filled porosity of 6% was assumed for the soils at the Rosen Brothers Scrap Yard Site area based on information presented in the risk assessment (Blasland, Bouck and Lee, Inc. 1994).

The calculated effective diffusion coefficients for each chemical were combined with the soil gas concentrations (C_g) calculated in the first step of the Farmer model to calculate a steady-state flux of chemical into air in units of g/m^2-sec, using the following equation:

$$J = \frac{D_s(C_g - C_o)}{L * X}$$

$$\text{FLUX} = \frac{D(\Delta \text{conc.})}{\Delta Z}$$

where:

J = chemical flux rate (g/m^2-sec),
D_s = effective diffusion coefficient (cm^2/sec),
C_g = calculated soil gas concentration at the water table surface (g/cm^3),
C_o = assumed soil gas concentration at the soil/building interface (g/cm^3),
L = vertical distance from the contaminant source to the soil/building interface (cm), and
X = conversion factor (1 m^2/10,000 cm^2).

FLUX/FLOW OF GAS THROUGH THE SOIL. DIFFUSION OF GAS FROM H_2O TO THE SOIL IS NOT CONSIDERED SINCE THE SOIL FLOW WILL BE THE LIMITING DIFFUSION.

The Rosen Brothers Scrap Yard Site risk assessment (Blasland, Bouck and Lee, Inc. 1994) stated the depth to groundwater on-site to be between 0.1 and 15 feet. For this evaluation, the vertical distance (L) from the water table to the soil/basement interface (see Figure 1) was assumed to be an average value of 228.6 cm (i.e., 7.5 feet). As recommended in USEPA (1992), the soil gas concentration at the soil/basement interface (C_o) was set to zero to maximize the chemical flux rate. Setting C_o to zero creates the largest concentration gradient between the water table and the soil/building interface which maximizes the movement of VOCs in the soil gas to the soil/building interface. Using these assumptions and the equation presented above, chemical flux rates were calculated. Chemical flux rates are presented in the fourth column of Table 1.

Estimates of indoor air concentrations were based on the methodology presented in Appendix A (Section 3.2) of USEPA (1992). The total chemical infiltration rate of each chemical from the soil into

IT ASSUMES THE VAPOR IS INSTANTANEOUSLY CARRIED AWAY AT SURFACE

the basement of the hypothetical building was calculated by combining the contaminant flux rate (calculated previously) with assumptions concerning the area of the building floor and the fraction of the floor through which soil gas enters, as follows:

$$C_{ind} = \frac{E}{Q} * X$$

where:

C_{ind} = indoor air concentration ($\mu g/m^3$),
E = chemical infiltration rate (g/sec),
Q = building ventilation rate (m^3/sec), and
X = conversion factor (10^6 $\mu g/g$).

The infiltration rate of the chemical into the building was calculated using the following equation:

$$E = J * A * F$$

where:

E = chemical infiltration rate (g/sec),
J = estimated soil gas flux rate (g/m^2-sec),
A = area of building floor (m^2), and
F = fraction of floor through which the soil gas enters (dimensionless).

The building ventilation rate was calculated using the following equation:

$$Q = \frac{ACH}{3600} * V$$

where:

Q = building ventilation rate (m^3/sec),
ACH = building air changes per hour (events/hour), and
V = volume of building (m^3).

A hypothetical 20m x 20m x 9.14m (approximately 2 level) building with a conservative air exchange rate of 0.5 exchanges per hour were assumed to estimate indoor air concentrations. In accordance with USEPA (1992) guidance, it was conservatively assumed that soil gas enters at *all* points, instead of only a portion, of the basement floor (i.e., F=1.0). In essence, this would be similar to the VOCs entering through a loosely packed dirt floor, without any type of concrete barrier that would prevent VOCs from infiltrating into the building. The estimated indoor air concentrations that were calculated using the equations presented above are presented in the fifth column of Table 1.

Risk Evaluation

The next step in the analysis was to conduct a risk evaluation, in which risks associated with inhalation of the modeled chemical air concentrations were estimated. To quantitatively evaluate risks associated with inhalation exposures, USEPA inhalation toxicity criteria (unit risks for carcinogenic chemicals and reference concentrations [RfCs] for noncarcinogenic chemicals) were combined with the modeled air concentrations. Risks, which were estimated assuming that either a worker could work in a building or that a resident could live in a house at the modeled location, are presented on Tables 2 and 3, respectively. As seen on Tables 2 and 3, the evaluated chemicals are separated into two groupings, depending on whether they exhibit carcinogenic or noncarcinogenic effects.

The second column on Tables 2 and 3 presents the modeled air concentrations that were developed on Table 1. The third column on Table 2 presents adjusted air concentrations, which reflect the exposures obtained by an industrial worker working in the hypothetical building. The adjustment to the air concentration is made because the inhalation toxicity criteria are developed based on continuous (i.e., 24 hours/day, 365 days/year, and 70 years) exposures, whereas it is assumed that the workers in the building are exposed to volatilizing chemicals for 8 hours/day, 250 days/year, for 25 years. These are default worker exposure parameters obtained from the *Risk Assessment Guidance for Superfund* [USEPA 1989] and from the *Standard Default Exposure Factors* [USEPA 1991] guidance. In similar manner, the third column on Table 3 presents the adjusted air concentrations reflective of exposures by a resident living in a house at the modeled location. The adjustment to the air concentration assumes residents are exposed to volatilizing chemicals for 24 hours/day, 350 days/year, for 30 years. These are default residential exposure parameters obtained from USEPA (1989 and 1991).

The fourth column on Tables 2 and 3 presents the USEPA inhalation toxicity criteria from either the first quarter 1995 Integrated Risk Information System (IRIS) or the 1994 Health Effects Assessment Summary Tables (HEAST). The final column on Tables 2 and 3 presents the risks for carcinogenic chemicals and the hazard indices for noncarcinogenic chemicals for each exposure scenario. Potential effects associated with inhalation exposures for carcinogenic chemicals were obtained by multiplying the air concentration by the unit risk, while potential effects associated with inhalation exposures for noncarcinogenic chemicals are obtained by dividing the air concentration by the RfC.

Upper-bound cancer risk estimates are typically compared to a USEPA risk range of 1×10^{-6} to 1×10^{-4} for health protectiveness at Superfund Sites. For the industrial worker, all the cancer risks, as well as the cumulative cancer risk were much lower than the risk range of 1×10^{-6} to 1×10^{-4} as shown on Table 2. Hazard indices for noncarcinogens are typically compared to a level of one, which is a threshold level below which adverse noncarcinogenic effects would not be expected to occur. As shown on Table 2, the hazard indices for all noncarcinogenic chemicals are below one for the industrial worker. For the residential scenario, a cancer risk of 3×10^{-6} was calculated, as shown on Table 3. This calculated risk is at the lower end of the USEPA risk range of 1×10^{-6} to 1×10^{-4} for health protectiveness at Superfund Sites. Table 3 also shows that the hazard indices for all noncarcinogenic chemicals were below one for the resident.

Risks associated with inhalation of acetone, 1,2-dichloroethene, and 1,1,1-trichloroethane are not presented in Tables 2 and 3 because they lack inhalation toxicity criteria. As an alternative, the modeled indoor air concentrations of these three parameters (presented in Table 1) were compared to conservatively-derived Risk Based Concentrations (RBCs) developed by USEPA Region III. RBCs are health-protective chemical concentrations that are back-calculated using USEPA approved toxicity

criteria, a $1x10^{-6}$ target risk level or 0.1 hazard index, and conservative residential exposure parameters. The ambient air RBCs for these three parameters are:

Parameter	Ambient Air RBC ($\mu g/m^3$)
acetone	$3.7x10^2$
1,2-dichloroethene	$3.3x10^1$
1,1,1-trichloroethane	$1.0x10^3$

"ACGS"

A comparison of the Table 1 indoor air concentrations to the RBCs presented above show that the modeled indoor air concentrations for these three parameters are three to seven orders of magnitude lower than the conservatively-derived RBCs, and are not likely to negatively affect receptors in a hypothetical on-site building.

Conclusions

It is important to note that numerous conservative assumptions used in the screening-level air modeling result in indoor air concentrations that are likely to be significantly overestimated. These assumptions for the Farmer model include:

- The Farmer model does not consider any depletion of the contaminant source over time.
- The model assumes that soil gas concentrations are zero at the soil/basement interface, in order to maximize the predicted soil gas flux rate.
- The maximum measured groundwater concentrations for each VOC in the upper outwash aquifer at the Rosen Brothers Scrap Yard Site were used in the calculations, even if the maximum concentrations were at different wells.
- Using on-site groundwater data as a basis for this analysis assumes a worst-case scenario of a building being located on-site.
- A conservative soil temperature of 40°F was used in the analysis.

Other conservative assumptions used to predict indoor air concentrations include:

- The indoor air concentrations are based on a low building air exchange rate of 0.5 exchanges per hour.
- The modeling approach is based on the assumption that soil gas enters through 100% of the area of the building basement floor (similar to volatilization through a loosely packed dirt floor.)

Despite the very conservative assumptions used to develop worst-case indoor air concentrations (as a result of volatilization of VOCs from groundwater) at the Rosen Brothers Scrap Yard Site, the results of this screening-level analysis indicate that levels are acceptable (i.e., that adverse health effects associated with modeled chemical concentrations would not occur). The risk assessment results indicated that upper-bound cancer risk estimates for the industrial worker scenario are much lower

than the risk range of 1×10^{-6} to 1×10^{-4} for health protectiveness at Superfund Sites, while hazard indices for noncarcinogens were below one, indicating that adverse noncarcinogenic effects would not be expected to occur. For the residential scenario, the 1×10^{-6} to 1×10^{-4} risk range for carcinogenic effects was slightly exceeded with a calculated risk of 3×10^{-6} for 1,1-dichloroethene. However, because of the conservatism inherent in the screening-level air modeling, it is likely that all calculated risks would actually be much lower, and that the actual residential risk for 1,1-dichloroethene would be lower than the 1×10^{-6} to 1×10^{-4} risk range. With the above in mind, and because the modeling effort indicates that the risk associated with this pathway to be negligible, it appears that Step 2 modeling for 1,1-dichloroethene is unnecessary.

Please call me at (203) 250-7066 if you have any questions regarding this letter report.

Sincerely,

ICF TECHNOLOGY, INC.

Curtis A. Kraemer

Curtis A. Kraemer
Site Manager

TABLE 1

CALCULATED INDOOR AIR CONCENTRATIONS
ROSEN BROTHERS SCRAP YARD SITE
CORTLAND, NEW YORK

Parameter	Maximum On-Site Groundwater Concentration (mg/L) (a)	Maximum Off-Site Groundwater Concentration (mg/L) (b)	Estimated Soil Gas Flux Rate (g/m^2-sec) (c)	Indoor Air Concentration ($\mu g/m^3$) (d)
Acetone	0.017		6.31×10^{-14}	4.97×10^{-5}
Bromoform	0.0002		7.78×10^{-15}	6.13×10^{-6}
Chloromethane	0.014		1.70×10^{-11}	1.34×10^{-2}
Chloroethane	0.023		4.64×10^{-12}	3.66×10^{-3}
Chloroform	0.0003		8.89×10^{-14}	7.00×10^{-5}
1,1-Dichloroethane	0.425	0.093	2.04×10^{-10}	1.61×10^{-1}
1,1-Dichloroethene	0.013	0.011	1.77×10^{-10}	1.40×10^{-1}
1,2-Dichloroethane	0.029	0.0008	2.65×10^{-12}	2.09×10^{-3}
1,2-Dichloroethene (total)	0.056	0.029	3.24×10^{-11}	2.56×10^{-2}
Ethylbenzene	0.071		3.51×10^{-11}	2.76×10^{-2}
Methylene Chloride	0.096		1.88×10^{-11}	1.48×10^{-2}
Tetrachloroethene	0.079	0.002	1.18×10^{-10}	9.32×10^{-2}
Toluene	1.5		6.82×10^{-10}	5.37×10^{-1}
1,1,1-Trichloroethane	3.1		6.08×10^{-09}	4.79×10^{0}
Trichloroethene	0.15	0.019	9.53×10^{-11}	7.51×10^{-2}
Xylenes	0.71		3.15×10^{-10}	2.48×10^{-1}

(a) The maximum detected parameter concentrations in the on-site upper outwash aquifer (Table 2-4 of the Baseline Risk Assessment, July 1994).

(b) The maximum detected parameter concentrations in the off-site upper outwash aquifer (Table 2-6 of the Baseline Risk Assessment, July 1994). **These values are for comparison only.**

(c) Calculated using the methodology of the Farmer Model as presented in USEPA's Guidance on Assessing Potential Indoor Air Impacts for Superfund Sites (USEPA 1992). Assumptions used in the Farmer Model include an air filled soil porosity of 0.06, a total soil porosity of 0.43, and an average depth to groundwater of 7.5 feet.

(d) Calculated using the methodology presented in Appendix A, Section 3.2 of USEPA (1992). The indoor air concentration was based on 0.5 air exchanges per hour of a 20m x 20m x 9.14m building. Based on recommendations from USEPA 1992, soil gas is assumed to enter all points of the basement area floor.

0.887 prb

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TABLE 2

RISKS ASSOCIATED WITH INHALATION OF MODELED INDOOR AIR CONCENTRATIONS ROSEN BROTHERS SCRAP YARD SITE, CORTLAND, NEW YORK

WORKER SCENARIO[a]

Carcinogenic Chemicals	Modeled Indoor Air Concentration ($\mu g/m^3$)	Inhalation Exposure Concentration for a Worker ($\mu g/m^3$) **(b)**	Inhalation Unit Risk ($\mu g/m^3$)	Weight-of-Evidence Classification **(c)**	Excess Upper-Bound Lifetime Cancer Risk
Bromoform	6.1×10^{-6}	5.0×10^{-7}	1.1×10^{-6}	B2	5.5×10^{-13}
Chloromethane	1.3×10^{-2}	1.1×10^{-3}	1.8×10^{-6}	C	2.0×10^{-9}
Chloroform	7.0×10^{-5}	5.7×10^{-6}	2.3×10^{-5}	B2	1.3×10^{-10}
1,1-Dichloroethene	1.4×10^{-1}	1.1×10^{-2}	5.0×10^{-5}	C	5.7×10^{-7}
1,2-Dichloroethane	2.1×10^{-3}	1.7×10^{-4}	2.6×10^{-5}	B2	4.4×10^{-9}
Methylene Chloride	1.5×10^{-2}	1.2×10^{-3}	4.7×10^{-7}	B2	5.7×10^{-10}
Tetrachloroethene	9.3×10^{-2}	7.6×10^{-3}	5.8×10^{-7}	B2/C	4.4×10^{-9}
Trichloroethene	7.5×10^{-2}	6.1×10^{-3}	1.7×10^{-6}	B2/C	1.0×10^{-8}
TOTAL					6.0×10^{-7}
Noncarcinogenic Chemicals	Modeled Indoor Air Concentration ($\mu g/m^3$)	Inhalation Exposure Concentration for a Worker (mg/m^3) **(b)**	Inhalation Reference Concentration (mg/m^3)	Target Organ/ Critical Effect **(d)**	Concentration: RfC Ratio
Chloroethane	3.7×10^{-3}	8.3×10^{-7}	$1.0 \times 10^{+1}$	Fetotoxicity	8.3×10^{-8}
1,1-Dichloroethane	1.6×10^{-1}	3.7×10^{-5}	5.0×10^{-1}	Kidney	7.3×10^{-5}
Ethylbenzene	2.8×10^{-2}	6.3×10^{-6}	1.0×10^{0}	Developmental	6.3×10^{-6}
Methylene Chloride	1.5×10^{-2}	3.4×10^{-6}	3.0×10^{0}	Liver	1.1×10^{-6}
Toluene	5.4×10^{-1}	1.2×10^{-4}	4.0×10^{-1}	CNS/Nasal	3.1×10^{-4}
TOTAL					4.0×10^{-4}

NOTES:

(a) Acetone, 1,2-Dichloroethene, and 1,1,1-Trichloroethane are not presented in the table because they lack inhalation toxicity criteria.

(b) Calculated by adjusting the modeled indoor air concentration with exposure parameters appropriate for a worker. This adjustment assumed a worker was indoors 8 hours/day, 250 days/year for 25 years.

(c) EPA Weight-of-Evidence Classification for Carcinogens:

- [B2] Probable human carcinogen based on inadequate or lack of evidence from human studies and sufficient evidence from animal studies.
- [C] Possible human carcinogen based on limited evidence from animal studies and inadequate or lack of human studies.

(d) A target organ or critical effect is the organ or endpoint most sensitive to a chemical's toxic effect. If an RfC is based on a study in which a target organ or critical effect was not identified, an organ's system known to be affected by the chemical is listed.

TABLE 3

RISKS ASSOCIATED WITH INHALATION OF MODELED INDOOR AIR CONCENTRATIONS ROSEN BROTHERS SCRAP YARD SITE, CORTLAND, NEW YORK

RESIDENTIAL SCENARIO[a]

Carcinogenic Chemicals	Modeled Indoor Air Concentration ($\mu g/m^3$)	Inhalation Exposure Concentration for a Resident ($\mu g/m^3$) **(b)**	Inhalation Unit Risk ($\mu g/m^3$)	Weight-of-Evidence Classification **(c)**	Excess Upper-Bound Lifetime Cancer Risk
Bromoform	6.1×10^{-6}	2.5×10^{-6}	1.1×10^{-6}	B2	2.8×10^{-12}
Chloromethane	1.3×10^{-2}	5.5×10^{-3}	1.8×10^{-6}	C	9.9×10^{-9}
Chloroform	7.0×10^{-5}	2.9×10^{-5}	2.3×10^{-5}	B2	6.6×10^{-10}
1,1-Dichloroethene	1.4×10^{-1}	5.7×10^{-2}	5.0×10^{-5}	C	2.9×10^{-6}
1,2-Dichloroethane	2.1×10^{-3}	8.6×10^{-4}	2.6×10^{-5}	B2	2.2×10^{-8}
Methylene Chloride	1.5×10^{-2}	6.1×10^{-3}	4.7×10^{-7}	B2	2.9×10^{-9}
Tetrachloroethene	9.3×10^{-2}	3.8×10^{-2}	5.8×10^{-7}	B2/C	2.2×10^{-8}
Trichloroethene	7.5×10^{-2}	3.1×10^{-2}	1.7×10^{-6}	B2/C	5.2×10^{-8}
TOTAL					3.0×10^{-6}
Noncarcinogenic Chemicals	Modeled Indoor Air Concentration ($\mu g/m^3$)	Inhalation Exposure Concentration for a Resident (mg/m^3) **(b)**	Inhalation Reference Concentration (mg/m^3)	Target Organ/ Critical Effect	Concentration: RfC Ratio
Chloroethane	3.7×10^{-3}	3.5×10^{-6}	$1.0 \times 10^{+1}$	Fetotoxicity	3.5×10^{-7}
1,1-Dichloroethane	1.6×10^{-1}	1.5×10^{-4}	5.0×10^{-1}	Kidney	3.1×10^{-4}
Ethylbenzene	2.8×10^{-2}	2.7×10^{-5}	1.0×10^{0}	Developmental	2.7×10^{-5}
Methylene Chloride	1.5×10^{-2}	1.4×10^{-5}	3.0×10^{0}	Liver	4.7×10^{-6}
Toluene	5.4×10^{-1}	5.1×10^{-4}	4.0×10^{-1}	CNS/Nasal	1.3×10^{-3}
TOTAL					2.0×10^{-3}

NOTES:

(a) Acetone, 1,2-Dichloroethene, and 1,1,1-Trichloroethane are not presented in the table because they lack inhalation toxicity criteria.

(b) Calculated by adjusting the modeled indoor air concentration with exposure parameters appropriate for a resident. This adjustment assumed a resident was indoors 24 hours/day, 350 days/year for 30 years.

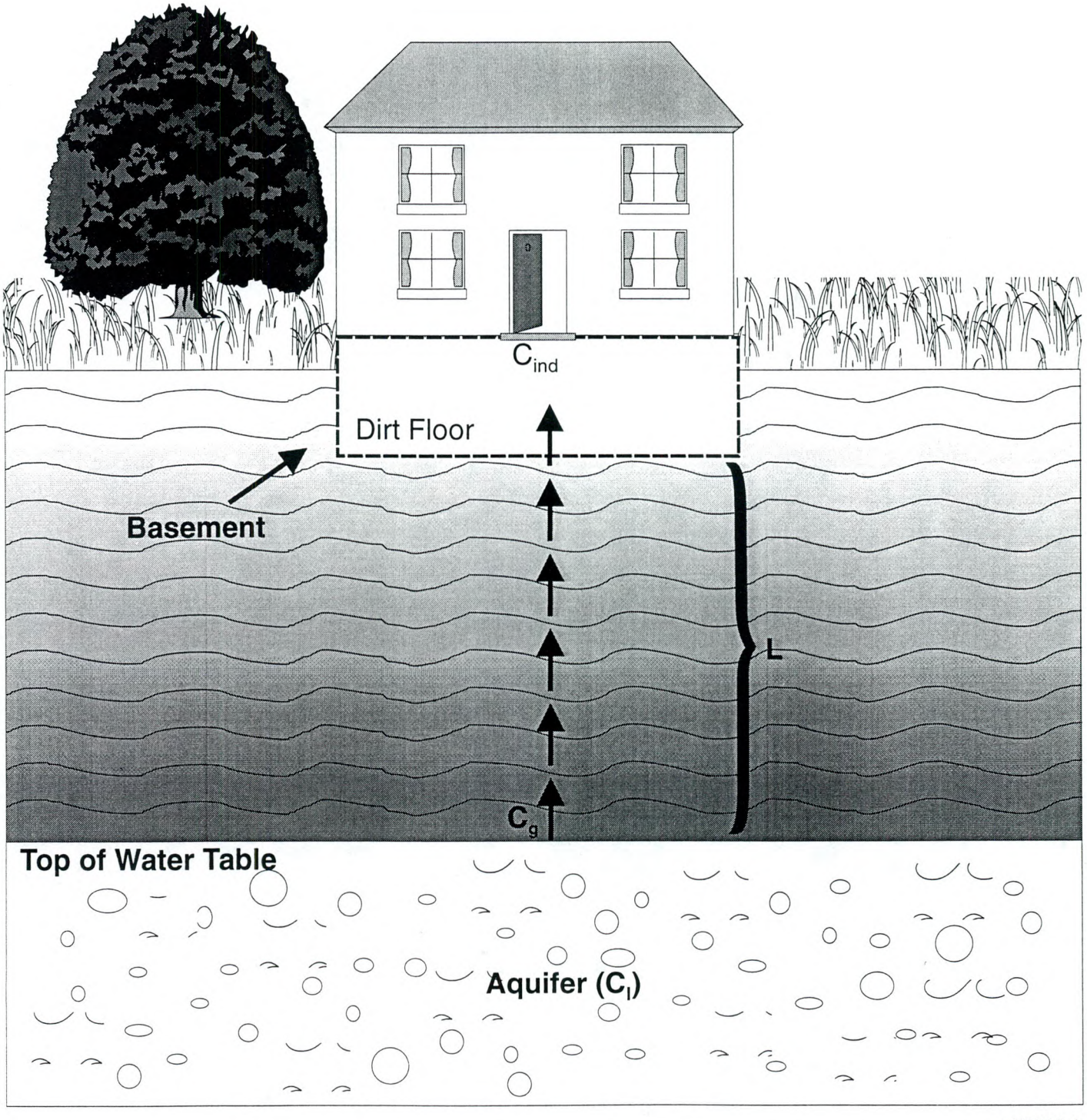
(c) EPA Weight-of-Evidence Classification for Carcinogens:

[B2] Probable human carcinogen based on inadequate or lack of evidence from human studies and sufficient evidence from animal studies.

[C] Possible human carcinogen based on limited evidence from animal studies and inadequate or lack of human studies.

(d) A target organ or critical effect is the organ or endpoint most sensitive to a chemical's toxic effect. If an RfC is based on a study in which a target organ or critical effect was not identified, an organ's system known to be affected by the chemical is listed.

Figure 1
Conceptual Diagram of Volatilization Modeling for the Rosen Site



c57016-1

THE H_2O & FILM DIFFUSION IS ASSUMED TO BE FAST (ie CONSTANT H_2O CONCENTRATION AND FILM ALWAYS IN EQUILIBRIUM BASED ON HENRY'S LAW). THUS THE LIMITING FLUX IS THE SOIL DIFFUSION. NOTE: ONCE THE FILM IS IN EQUILIBRIUM, TRANSFER FROM H_2O WILL CEASE.