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Risk Assessment Plan for Petroleum Underground Storage Tanks in Kentucky, Part II: Diesel, Heating Oil, Other Middle Distillates and Waste Oil

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Appendix I
Risk Assessment Procedures and Calculations
A.J. Grant^a, J.R. Shaw and W.J. Birge

Appendix II

Environmental Half-life and Ecological Effects of PAHs
D.P. Keogh, M.D. Kercher, and W.J. Birge

School of Biological Sciences and Graduate Center for Toxicology, in association with the Kentucky Water Resources Research Institute

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July, 1995 U.K

RISK ASSESSMENT PLAN FOR PETROLEUM UNDERGROUND STORAGE TANKS IN KENTUCKY PART II: DIESEL, HEATING OIL, OTHER MIDDLE DISTILLATES AND WASTE OIL

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Assumptions and Procedures

A series of investigations has focused on the transport, fate and risk assessment of petroleum products that enter the environment from underground storage tanks (USTs). Risk from outfalls of gasoline was based on benzene, toluene, ethylbenzene and xylene (BTEX) and has been reported separately (Birge et al., 1995). The present study concerns diesel oil, heating fuels, kerosene and waste oil. Risk was based primarily on a series of carcinogenic and non-carcinogenic polycyclic aromatic hydrocarbons (PAHs). The effect of lead also was addressed under separate cover (Birge et al., 1995).

Unless stated otherwise, loss of fuel from defective USTs was treated as a subsurface outfall. The non-carcinogenic PAHs considered in assessing effects on human health included acenaphthene, anthracene, fluoranthene, fluorene, naphthalene, and pyrene. Cancer risk was determined for the three carcinogenic PAHs most commonly detected in diesel and fuel oils and included benzo(a)pyrene, benzo(a)anthracene and chrysene. Physical and chemical characteristics of these compounds are given in Tables AI-1 and AI-2.

Formulae used in risk assessment calculations for defective USTs were based primarily on procedures recommended by the Risk Assessment Guidance for Superfund. Volume I. Human Health Evaluation Manual. Parts A and B. (U.S. EPA, 1989b; 1991a) and Exposure Factors Handbook (U.S. EPA, 1990); hereafter referred to as RAGS Part A and B, and EFH, respectively. Parameter values were obtained from the ATSDR, Agency for Toxic Substances and Disease Registry (1994a,b); RAGS Parts A and B; EFH; SEAM, the Superfund Exposure Assessment Manual (U.S. EPA, 1988); and the Dermal

Exposure Assessment: Principles and Applications, Interim Report (U.S. EPA, 1992). Development of the risk assessment strategy and supporting documentation are given separately (Birge et al., 1995). It should be reiterated that risk to residential households was based on distance from the UST (i.e. 0 to 100m, 100 to 300m, ≥300m).

Exposure Duration and Toxicity Values

In determining risk, an exposure duration of nine years was This included five child and four used (Birge et al., 1995). adolescent years. In addition, cancer risk also was calculated for a 30-year period of exposure (i.e. child 2-6 years, adolescent 7-18 years, adult 19-31 years). The values for the body weight of children ages 2-6 of 16 kg, ages 7-18 of 41 kg and adults of 70 kg The average life expectancy was 70 years, in were from EFH. agreement with RAGS Parts A and B (U.S. EPA, 1989b; 1991a) and Ohio Department of Commerce (1992). Toxicity values for PAHs are given in Tables AI-1 and AI-2. Oral and inhalation reference doses (Rfd) and slope factors were those from the U.S. EPA Risk-Based Concentration Table (1995) and were taken from IRIS and HEAST, except for naphthalene. The naphthalene value was taken from U.S. EPA Region III, after consultation with U.S. EPA personnel in Region IV.

Soil Ingestion and Dermal Exposure

Soil ingestion was based on soil consumption rates of 200 mg/day for children ages 2-6, 100 mg/day for ages 7-18, and 100 mg/day for adults, listed in EFH and RAGS Part B. An oral absorption of 100 percent was selected for the calculations.

The values for dermal exposure to soil were taken from EFH and surface areas were 3910 cm² for children (50th percentile value for exposure to arms, hands and legs) and 3120 cm² for adults (50th percentile value for exposure to arms and hands). The soil to skin adherence factor of 1.0 mg/cm² was taken from U.S. EPA (1992) and the dermal absorption coefficient for PAHs of 10% was derived from the ATSDR profiles (1994a,b).

Inhalation of Soil Vapor

The inhalation rate was 20 m³/day for all ages as observed by the Commonwealth of Kentucky (NREPC, 1995; U.S. EPA, 1991b). Inhalation exposure was based on the formula given in RAGS, Part B, with incorporation of the chemical-specific volatilization factors The calculations of calculated in Section 3.3.1, equation 8. volatilization factors for non-carcinogenic PAHs are given in Table Modifications proposed in December, 1994 (U.S. EPA, 1994) for the determination of volatilization factors postdated the risk assessment calculations reported below and had not received final confirmation upon completion of this study. Two of the noncarcinogens (i.e. fluoranthene, pyrene) and three carcinogenic PAHs did not fit the quideline for volatility (molecular wt. <200 g/mol, Henry's Law constant >1 x 10⁻⁵; U.S. EPA, 1991a). Accordingly, volatilization factors were not calculated, and soil vapor inhalation and shower inhalation were excluded from the risk calculations for these compounds.

Dimensions of the air box were 45 meters \times 45 meters and represented the U.S. EPA default values (1991a). This provided a good fit to the exposure scenarios used, particularly in

determining the frequency at which residential receptors located at 100 to 300 meters and ≥300 meters visited the UST site. The use of a smaller box (i.e. 20 m x 20 m) also was considered. However, the volatilization factors were somewhat larger and inhalation exposure within the box was slightly reduced. Of greater importance, the smaller box would have reduced frequency and/or duration of exposure. Exposure frequencies for inhalation are discussed below (i.e. Exposure Scenarios for Soil). Absorption of PAH's from inhalation was set at 50% (ATSDR, 1994a,b). Exposure via vapor inhalation was based on steady state volatilization of the compounds and did not take into account wind dilution or decreases in soil concentration with time due to dispersion or biodegradation.

Exposure Scenarios for Soil

and soil exposures were based on proximity of the residence to the UST site. The three receptor zones selected included 0 to 100 meters (i.e. on-site, calculated at 0 m), 100 to 300 meters (calculated at 100 m) and 300 to 1000 meters (calculated at 300 m) from the UST site . All calculations for total exposure to contaminated soil (except where noted) included soil ingestion, soil dermal exposure, and vapor inhalation. The inhalation of particulates was excluded. For an on-site residence, it was assumed that the receptor visited the site and received soil exposure for 180 days of the year (Westerman, 1993). This also corresponded to the "best guess" exposure frequency in Section 6.6.2 of RAGS Part A (~143 days/year). Days were discounted for indoor time, inclement weather and time away. It was assumed that days in the area of contamination would decrease to 90 and 45 when

the residence was located at 100 to 300 meters and at or beyond 300 meters, respectively. While visiting the site, it also was assumed that one-half of the soil ingested was contaminated based on the area of a UST site compared with residential lot size and total play area for children (Sendlein, 1994). CERCLA sources (U.S. EPA, 1990; 1991a) recommend that all soil should be considered as contaminated, assuming that residential soil contamination generally is not accurately localized. However, with respect to UST's, except for special circumstances that may require sitespecific investigations, the area of contamination can circumscribed with relative accuracy. Upon review of conditions and best professional judgement, it was concluded that the maximum amount of a receptor's time in the contaminated area would be fifty percent.

Vapor inhalation was assumed to occur 350 days per year for a residence within 100 meters of a UST (U.S. EPA, 1990; 1991a), but the frequency was decreased to 250 and 150 days when dwellings (i.e. homes) were situated 100 to 300 meters and at or beyond 300 meters from the UST site, respectively. One-half of the air was assumed to be contaminated, based on the rationale stated above. Inhalation exposure included no contaminant dilution due to wind mixing, and PAH half-life in air was not considered.

Groundwater Consumption

Residential groundwater (GW) ingestion (e.g. well water) was assumed to occur 350 days per year. The value chosen for water consumption rate was 1.4 L/day. This was the average adult value given in EFH and is close to the upper-bound value for the five child years used with BTEX and the five child plus four adolescent

years (i.e. 9 y duration of exposure) used with PAHs. The dietary fraction of 0.75 also was taken from EFH. The K_d value for transfer from soil pore water to GW was based on the K_∞ for each PAH (Table AI-1; ATSDR, 1994a,b), multiplied by a soil organic carbon fraction of 0.005 (U.S. EPA, 1989a).

Shower Dermal and Inhalation Exposure

Dermal exposure from showering was based on the same values for dermal absorption and K_d as given above (Tables AI-1 and AI-2). Total skin surface area was 7200 cm² for children 2-6 years old, 13175 cm² for children 7-18 years old, and 18150 cm² for adults (U.S. EPA, 1990). Dermal permeability (Kp) values were those calculated by the U.S. EPA (1992) and included 0.36, fluoranthene; 0.069, naphthalene; 0.81, benzo(a)anthracene; 1.2 benzo(a)pyrene; and 0.81, chrysene. Using the formula of Potts and Guy (1992) as recommended by the U.S. EPA, values were calculated of 0.146, 0.225, 0.171 and 0.324 for acenaphthene, anthracene, fluorene and pyrene, respectively. Considering the large molecular weights and the highly skewed Kows of the carcinogenic PAHs, this formula may overestimate dermal permeability. Shower time was 12 minutes/day or 0.2 hour as given in EFH. Exposure frequency was 350 days/year. Shower inhalation exposure was based on shower time, exposure frequency and K_d. The inhalation rate of 0.6 m³/hour was from EFH and the volatilization factor (K) was taken from RAGS Part B.

Soil Transport and Groundwater Attenuation

Standard risk assessment procedures do not allow for reductions in PAH concentrations that occur with migration through soil or during GW transport. Taking into account that the initial

contaminated area at a given UST site is underground (i.e. subsurface), SESOIL was used to model changes in PAH soil concentrations resulting from vertical migration upward to the soil surface and downward to the saturated zone. For soil contamination only, SESOIL soil multipliers (McGinley, 1994a,b) were used to model the upward migration of PAH compounds to the surface. These multipliers were incorporated as transport factors (TR) into soil ingestion, soil dermal and vapor inhalation exposures. In modeling PAH transport, it was assumed that the contaminated zone was initially covered with 1.5 meters of clean soil and 2% soil organic carbon was used in risk calculations.

For soil and GW contamination, SESOIL soil multipliers and GW multipliers (McGinley, 1994a,b) were used in modeling transport from the UST to the receptor. The soil multipliers were used as described above. In addition, GW multipliers were entered into calculations of exposure due to GW consumption, shower inhalation and shower dermal contact. The GW multipliers represent 1) changes in PAH concentration that occur with downward movement through soil from the UST to the saturated zone (i.e. SESOIL) and 2) attenuation that results in GW, as determined with a simplified GW transport Soil organic carbon of 0.1% and local climatic conditions were used in the SESOIL model. In the GW pathway, biodegradation was based on 100-day or 700-day half-lives to correlate with different geologic conditions. Velocity was set at 0.1 meter/day and mixing in the GW was complete to a depth of 0.5 meter at the UST site. Attenuation was two dimensional from the UST to receptors at 100 meters and 300 meters, with only modest dilution in the transverse axis (McGinley, 1994a,b). In modeling the GW

pathway in the karst system, half-life was set at 15-days, velocity was 10 meters/day and there was complete mixing in the vertical axis to a depth of 1 meter in the GW. Attenuation from the UST to the receptor was unidimensional.

The cleanup levels determined with the risk assessment strategy used were considered to be adequately conservative estimates of exposure. No decrease in the level of initial soil contamination was assumed to occur over the duration of exposure. However, it would be expected that a remediated UST site would have only a finite amount of contaminant remaining and that the concentration would decrease progressively due to volatilization, biodegradation or other processes. In addition, the GW transport model tended to minimize attenuation.

Description of Risk Data Sheets

As noted above, exposure calculations were based on U.S. EPA guidance (1989a,b; 1990; 1991a) for determining exposure at hazardous waste sites. The equations were formulated to isolate the concentration term from the other parameters so that the soil concentration could be back-calculated for a given level of risk. The risk calculations were obtained using a spreadsheet program created for Lotus 123° software. The spreadsheet consists of a title at the top which denotes the specific scenario. The left column shows calculations for seven types of exposure. The formula for each exposure calculation is given to the right of each dose/exposure line, and the abbreviations used are listed after the

individual parameters. The soil contaminant concentration which results in the hazard index is shown individually for each dose and the combined result appears in the soil concentration box to the upper right. The upper right of the spreadsheet (i.e. on/off EXPOSURE) also shows those exposures that are on or off in the calculations. This binary system denotes those that are used to derive the total exposure and total risk for each scenario. Therefore, even though all exposures are listed in this section (i.e. upper right), only those preceded by a "1" are "on" and summed in the calculations of risk.

The decision box for transport (i.e. on/off TRANSPORT) also is at the top right of the spreadsheet. Of the three choices the first is for SESOIL TRs (i.e. Transport), the second is for coefficients (Kd) that represent partitioning between soil and pore water with or without attenuation, and the third is for other possible treatments of attenuation not used in these calculations. Options that are used in a given calculation are preceded by a "1", whereas "0" indicates "off".

Within the seven categories of exposure given in the left column there are factors which allow for the inclusion of transport multipliers (TR). The transport multipliers are listed above each dose exposure line and have a quantity of "1" if not used in the calculation (i.e. no attenuation). Actual transport multipliers used in determining dose are mostly decimal fractions less than "1". As noted above, there are two types, one for upward migration of compounds to the soil surface (SESOIL soil multiplier), and one for downward movement to the saturated zone, plus GW transport (SESOIL GW multiplier). Soil TRs are incorporated into

calculations of soil ingestion, soil dermal exposure, and inhalation of vapors; whereas GW TRs are entered in those exposure categories associated with water use. A macro command series was constructed to expedite calculations that employed sets of transport multipliers with different soil types, soil depths and distances to receptors.

The inhalation of particulates was not considered to be a significant route of exposure, and therefore was not used. Formulae for the other six exposure categories are given below, wherein the "Transport" choice is represented by the abbreviation "TT" and the "Kd/Attenuation Factor" choice by "KT". In determining the risk associated with these exposures, the result was divided by a reference dose for non-carcinogens and multiplied by a slope factor for carcinogenic effects.

Soil Ingestion

Exposure =
$$\frac{C \times ((TT \times TR) + KT) \times CR \times EF \times ED \times AF \times CF \times 1E-6}{BW \times L \times 365}$$

Soil Dermal Exposure

32772

Exposure =
$$\frac{C \times ((TT \times TR) + KT) \times SA \times AD \times ED \times EF \times AF \times CF}{BW \times L \times 365}$$

Groundwater Consumption

$$Exposure = \frac{C \times ((TT \times TR) + (KT \times 1/Kd \times AT)) \times CR \times EF \times ED \times DF}{BW \times L \times 365}$$

Inhalation of Vapors

$$Exposure = \frac{C \times ((TT \times TR) + KT) \times IR \times 1/VF \times EF \times ED \times AF \times CF}{BW \times L \times 365}$$

Dermal Exposure to Groundwater

$$Exposure = \frac{C \times ((TT \times TR) + (KT \times 1/Kd \times AT)) \times SA \times EF \times ED \times Kp \times SL \times AF \times 0.001}{BW \times L \times 365}$$

Inhalation of Vapors in the Shower

$$Exposure = \frac{C \times ((TT \times TR) + (KT \times 1/Kd \times AT)) \times IR \times SL \times EF \times ED \times K \times AF}{BW \times L \times 365}$$

Calculation of Risk and Hazard

Risk = Exposure × Slope Factor

$$Hazard Quotient = \frac{Exposure}{Reference Dose}$$

Abbreviations:

Transport

- TT Modeled Transport (i.e. SESOIL) (0 or 1)
- KT Kd and attenuation factors for transport (0 or 1)

Soil Ingestion

- C Soil concentration (mg/kg)
- CR Soil consumption rate (mg/day)
- EF Exposure frequency (days/year)
- ED Exposure duration (years)
- BW Average body weight (kg)
- L Average life expectancy (years)
- AF Absorption fraction (0-1)
- CF Contaminated fraction (0-1)
- TR Transport multiplier (soil)

Soil Dermal

- SA Surface area exposed (cm²)
- AD Soil adherence factor (mg/cm²)

Groundwater Consumption

- CR GW consumption rate (L/day)
- Kd Soil-water partitioning coefficient (L/kg)
- DF Diet fraction (0-1)
- AT Attenuation factor (0-1)
- TR Transport multiplier (GW)

Inhalation of Vapors

- IR Inhalation rate (m³/day)
- VF Volatilization factor (m³/kg)

Dermal Contact in Shower

SA Surface area exposed (cm²)

Kp Dermal permeability constant (cm/hour)

Inhalation in Shower

IR Hourly inhalation rate (m³/hour)

SL Daily shower length (hours)

K Volatilization factor constant (0.5 L/m³)

Reference doses and slope factors were collectively referred to as toxicity values. When toxicity values were missing for a specific route of exposure, available values were substituted (e.g. using an oral reference dose for dermal exposure). Oral toxicity values were used for the following routes of exposure: soil ingestion, dermal exposure to soil, GW consumption, and dermal exposure to GW. Inhalation toxicity values were used in calculating the risk associated with inhalation of vapors, and vapor inhalation while showering. The sum of the risks from the individual routes of exposure was considered the total risk.

Results of Risk Calculations

#11V20

Initially, risk was calculated for each of the six non-carcinogenic PAHs for a hazard index (HI) of 1.0 and of 0.165. Summing the latter values gives a total HI=1, allowing for additive effects. These results are presented in Table AI-4, and the spreadsheets are on pages AI-31 to AI-102. Soil transport and GW attenuation were not incorporated into these calculations and only on-site conditions were considered. Soil exposure was based on surface contamination, whereas for soil and GW exposure contamination

was considered to be uniform from the soil surface to the saturated zone. These results were intended to represent worst case exposure conditions and to provide baseline information for final selection of compounds and assessment scenarios to be used in developing recommendations on UST remediations. This information also may be directly applicable 1) to major site-specific remediations where large petroleum outfalls have contaminated surface and subsurface soils and 2) to establish guidelines for disposal of remediated soils.

Acenaphthene and naphthalene were the non-carcinogenic compounds selected for establishing UST cleanup guidelines. The first set of performed involved subsurface soil (i.e. calculations sand) contamination and employed the use of SESOIL soil multipliers. was assumed that 1.5 meters of clean soil overlaid the contaminated The hazard index was set at 0.5 per compound to give a total area. The results are given in Table AI-5, and the spreadsheets are HI=1.on pages AI-103 to AI-120. Though considered to be the most mobile of the six non-carcinogenic PAHs, the soil values obtained with sand indicate little movement to the soil surface and essentially no exposure via soil ingestion, dermal uptake or vapor inhalation. In determining the final soil values to be used in cleanup guidelines with acenaphthene and naphthalene, calculations were performed in which SESOIL soil transport and GW attenuation were included for sand, silt and clay and receptor zones of 0 to 100 meters, 100 to 300 meters and ≥300 meters. Allowances also were made for varying depths from the UST contamination source to the saturated zone. Depths from 0 up to 9 meters to GW were included where mobility in soil warranted. These results are given in Tables AI-6 through AI-11 and were obtained using the macro command program with Lotus 123° software as described above. Sample spreadsheets are given on pages AI-121 to AI-138.

The results obtained with the carcinogenic PAHs, including benzo(a)pyrene, benzo(a)anthracene and chrysene were based on an exposure duration of 9 years. Calculations also were performed for an exposure duration of 30 years as a basis of comparison. high K values and other characteristics (Table AI-2), these PAHs exhibited little or no mobility in sand or other soils when transport was modeled with the SESOIL program. Therefore, risk from subsurface contamination was based on the GW pathway only. Contamination was assumed to occur at the saturated zone, allowing direct transfer of these compounds from soil pore water to GW. Even with this modification GW transport was highly restrictive, presumably due to extremely low water solubility, high adsorptive capacity and other characteristics. These results were considered highly conservative for typical site conditions at most UST installations (Table AI-12). Spreadsheets for benzo(a)pyrene, benzo(a)anthracene and chrysene for the GW pathway only are given on pages AI-139 to AI-192.

The last assessment attempted included a simulation of the GW pathway as given above, plus contamination at the soil surface (no soil transport). These results are presented in Table AI-13 and may be applicable to worst case, site-specific conditions involving high levels of contamination that include surface soils. Sample spreadsheets for benzo(a)pyrene for surface soil and GW contamination are given on pages AI-193 to AI-210.

Table AI-1. Characteristics of Noncarcinogenic Polycyclic Aromatic Hydrocarbons

.

Parameter	Acenaphthene	Anthracene	Fluoranthene	Fluorene	Naphthalene	Pyrene
	0.06805	0.06183	0.05700	0.06472	0.07265	0.05953
	4600	14000	38000	7300	930	38000
^b Henry's Law Constant (atm-m³/mol)	°2.6 x 10 ⁻³	8.6 x 10 ⁻⁵	6.5 x 10 ⁻⁶	6.4 x 10 ⁻⁵	4.6 x 10 ⁴	°1.2 x 10-5
	0.146	0.225	0.36	0.171	0.069	0.324
	0.06	0.3	0.04	0.04	0.04	0.03
	0.06	0.3	0.04	0.04	0.04	0.03
	4.47 x 10 ⁻³	7.5 x 10 ⁻⁶	5.0 x 10 ⁻⁶	6 x 10 ⁴	8.7 x 10 ⁻²	2.5 x 10 ⁻⁶
	3.8	0.07	0.26	1.68 - 1.98	32	0.129 - 0.165
	1.225	1.25	1.252	1.203	1.145	1.271

^a Evaluated using information from U.S. EPA SEAM (1988) ^b ATSDR (1994a,b) ^c U.S. EPA Risk Based Concentration Table (1995)

^d Lide (1991) ^e Fendinger and Glotfelty (1989) ^f U.S. EPA (1992)

^g Mackay et al. (1992)

Table AI-2. Characteristics of Carcinogenic Polycyclic Aromatic Hydrocarbons

Parameter	Benzo(a)pyrene	Benzo(a)anthracene	Chrysene
⁴ D _i (cm ² /s)	0.05314	0.05473	0.05473
bK _{oc} (cm³/g)	5,500,000	200,000	200,000
^b Henry's Law Constant (atm-m³/mol)	4.9 x 10 ⁻⁷	1 x 10 ⁻⁶	1.05 x 10 ⁻⁶
°K _P (cm/hr)	1.2	0.81	0.81
°CPS (oral) (risk per mg/kg/day)	7.3	0.73	0.0073
°CPS (inhalation) (risk per mg/kg/day)	6.1	0.61	0.0061
^b Vapor Pressure (mm Hg)	5.6 x 10 ^{.9}	2.2 x 10 ⁻⁸	6.3 x 10 ⁻⁹
^b Water Solubility (mg/L)	3.8×10^{-3}	9 - 14 x 10 ⁻³	1.5 - 2.2 x 10 ⁻³
Density (gm/cm³ at 4°C)	^b 1.35	^b 1.27	^d 1.252

Calculated using information from U.S. EPA SEAM (1988)
 ATSDR (1994b)
 U.S. EPA Risk Based Concentration Table (1995)
 Lide (1991)
 U.S. EPA (1992)

Table AI-3.

Volatilization Factor Calculation	for	Noncarcinogenic Polycyclic	Aromatic	Hydrocarbons
	Acenaphthene	Anthracene	Fluoranthene	Naphthalene
INPUT VALUES				
side length (m)	45	45	45	45
wind speed (m/s)	2.25	2.25	2.25	2.25
diffusion height (m)	2	2	8	2
area of contamination (cm^2)	20250000	20250000	20250000	20250000
D, diffusivity coeff. (cm^2/s)	0.06805	0.06183	0.06472	0.07265
soil porosity	0.35	0.35	0.35	0.35
cu. root of soil porosity	0.704	0.704	0.704	0.704
K_{∞} (cm ³ /q)	4600	14000	7300	930
oc fraction	0.02	0.02	0.02	0.02
H Henry's Law const. (atm-m3/mol)	2.60×10^{-3}	8.60x10 ⁻⁵	$6.40 \text{x} 10^{-5}$	4.60x10 ⁴
soil/part. density (g/cm³)	2.65	2.65	2.65	2.65
exposure interval (y)	6	თ	6	6
CALCULATED VALUES				
D _{ei} (cm ² /s) effect. diffusivity	0.04790962	0.04352537	0.04556288	0.0511437837
K_d (cm ³ /q)	92	280	146	18.6
K, (g soil/cm ³ air)	0.0011587	1.259x10 ⁻⁵	1.797x10 ⁻⁵	0.0010139785
alpha (cm^2/s)	1.128×10^{-5}	1.114×10^{-7}	$1.664 \text{x} 10^{-7}$	1.05352x10 ⁻⁵
exposure interval (s)	284018400	284018400	284018400	284018400
VF	25807.58	259752.96	212511.56	26701.70
Miles of the Control				

Table AI-4.

Soil Values (mg/kg) for Noncarcinogenic Polycyclic Aromatic Hydrocarbons, 0-100 m from the Site^a

	Soil E	xposure	Soil and G	W Exposure
	HI= 1	HI= 0.165	HI= 1	HI= 0.165
Acenaphthene	4043.9779	677.2564	23.4318	3.8662
Anthracene	41589.7449	6862.3079	327.7520	54.0791
Fluoranthene	6277.1417	1035.7284	102.4179	16.8990
Fluorene	5405.2089	891.8595	23.9497	3.9517
Naphthalene	2748.4917	453.5011	3.5462	0.5851
Pyrene	4573.5704	754.6391	79.7273	13.1550

^{*}No soil transport (i.e. SESOIL) or GW attenuation.

Table AI-5. Soil Values (mg/kg) for Acenaphthene and Naphthalene Determined with SESOIL, Soil Multipliers for Sand*

	0 - 100	Distance from Site 100 - 300	≥300
Acenaphthene ^b	51845.871	83319.786	147341.168
Naphthalene°	149374.551	240748.397	426318.353

^{*} The HI equals 0.5 for each compound, assuming additivity.

b The soil multiplier was 0.039.

[°] The soil multiplier was 0.0092.

Table AI-6. ACENAPHTHENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION*. HI=0.5, SAND.

SOIL TYPE:	HALF LIFE	DIST FROM	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
SAND	700	0-100	0 1 3	0.141 0.0641 0.042	3.6565 8.0425 12.2734
	100	0-100	0 1 3	0.147 0.0534 0.0287	3.5073 9.6537 17.9591
	15	0-100	0 1 3	0.00218 0.000953 0.000625	235.4422 535.4465 812.0476
	700	100-300	0 1 3	0.00392 0.00171 0.00112	131.3247 300.4365 457.8324
	100	100-300	0 1 3	0.0000296 0.0000108 5.780E-06	14407.1088 30350.6750 43081.0326
	15	100-300	0 1 3	0.000114 0.0000763 0.00005	4289.9821 6250.6526 9176.7859
	700	≥300	0 1 3	0.0000148 6.440E-06 4.230E-06	28176.0912 51874.9207 66707.0668
	100	≥300	0 1 3	6.350E-12 2.310E-12 1.240E-12	147340.9003 147341.0704 147341.1154
	15	≥300	0 1 3	1.370E-06 4.870E-07 3.190E-07	105886.8938 129341.1760 135031.8641

 $^{^{2}}$ 5 child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-121 to A-129.

Table AI-7. ACENAPHTHENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION*. HI=0.5, SILT.

SOIL TYPE:	HALF LIFE	DIST FROM SITE	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
SILT	700	0-100	0 1 3	0.14 0.0901 0.0467	3.6826 5.7220 11.0385
	100	0-100	0 1	0.14 0.017	3.6826 30.3120
	15	0-100	0 1 3	0.00208 0.00134 0.000695	246.7077 381.9456 731.4125
	700	100-300	0 1 3	0.00374 0.0024 0.00125	137.6347 214.2831 410.4524
	100	100-300	0 1	0.0000285 3.43000E-06	14863.9727 53606.8757
_	15	100-300	0 1 3	0.000166 0.000107 0.0000503	2994.4289 4555.2912 9127.6563
	700	≥300	0 1 3	0.0000141 9.06000E-06 4.70000E-06	29296.7695 41053.3606 62883.3327
	100	≥300	0 1	6.06000E-12 7.36000E-13	147340.9125 147341.1366
	15	≥300	0 1 3	1.06000E-06 6.85000E-07 3.55000E-07	113086.2938 123220.9297 133770.6695

 $^{^{\}rm *5}$ child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-121 to A-129.

Table AI-8. ACENAPHTHENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION. HI=0.5, CLAY.

SOIL TYPE:	HALF LIFE	DIST FROM SITE	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
CLAY	700	0-100	0 1	0.14 0.0643	3.6826 8.0175
	100	0-100	0 1	0.14 0.000167	3.6826 2913.9316
	15	0-100	0 1	0.00208 0.000943	246.7077 541.0654
	700	100-300	0 1	0.00374 0.00169	137.6347 303.9790
_	100	100-300	0 1	0.0000282 3.6300E-08	14993.6446 82833.8878
	15	100-300	0 1	0.000166 0.0000754	2994.4289 6319.6035
	700	≥300	0 1	0.0000141 6.3800E-06	29296.7695 52189.9698
	100	≥300	0 1	6.0600E-12 7.2100E-15	147340.9125 147341.1673
	15	≥300	0 1	1.6000E-06 4.8000E-07	113086.2938 129503.6079

 $^{^{\}rm a}5$ child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-121 to A-129.

Table AI-9. NAPHTHALENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION. HI=0.5, SAND.

		, IIII(O 1	ORATION . III-	U.S, BAND.	
SOIL TYPE:	HALF LIFE	DIST FROM SITE	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
SAND	700	0-100	0	0.334	1.1431
			1	0.214	1.7841
			3	0.15	2.5453
			6	0.0961	3.9729
		•	9	0.0681	5.6063
	100	0-100	0	0 227	1 1676
	100	0-100	0	0.327	1.1676
			1	0.18	2.1211
			3	0.102	3.7431
			6	0.049	7.7915
			9	0.026	14.6832
	15	0-100	0	0.00496	76.9365
			1	0.0032	119.2178
			3	0.0022	173.3448
			6	0.0014	272.2185
	700	100-300	0	0.00891	42 0422
	700	100-300			42.8433
			1	0.0057	66.9641
			3	0.00401	95.1747
			6	0.00257	148.4693
			9	0.00182	209.5985
	100	100-300	0	0.0000678	5502.5835
			. 1	0.0000363	10077.6735
			3	0.0000206	17209.2079
			6	9.9000E-06	33240.9167
	-		9	5.2400E-06	55934.3030
	15	100-300	0	0 001	201 1071
	15	100-300	0	0.001	381.1971
			1	0.000598	636.7756
			3	0.000299	1270.1916
			6	0.000269	1411.0184
	700	≥300	0	0.0000336	11068.1337
			1	0.0000215	17048.0827
			3	0.0000115	30801.4402
			6	9.6700E-06	36136.3714
			9	6.8500E-06	49292.8533
	100	>200	•	1 41000 11	100011 0100
	100	≥300	0	1.4100E-11	426311.6408
			1	7.8000E-12	426314.6397
			3	4.4000E-12	426316.2582
			6	2.1000E-12	426317.3530
			9	1.1300E-12	426317.8148
	15	≥300	0	0.0000409	9134.9777
			1	0.0000253	14575.0427
			3	0.0000203	18013.2698
			6	0.0000101	34723.1998
			<u> </u>	0.000101	J=,2J+1JJ0

 $^{^{\}rm a}5$ child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-130 to A-138.

Table AI-10. NAPHTHALENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION. HI=0.5, SILT.

SOIL TYPE:	HALF LIFE	DIST FROM SITE	DEPTH TO GROUND WATER	SESOIL GW MULTIPLIERS	SOIL CONC. (mg/kg)
SILT	700	0-100	0 1 3	0.314 0.274 0.137	1.2159 1.3934 2.7868
			6 9	0.0621 0.034	6.1479 11.2286
	100	0-100	0	0.314 0.053	1.2159 7.2035
			1 3	0.0073	52.2833
			6	0.000867	439.0766
			9	0.0001	3722.8604
	15	0-100	0	0.00466	81.8868
			1	0.004 0.002	95.3895
			3 6	0.002	190.6572 423.0227
	700	100-300	0	0.00837	45.6069
			1	0.0073	52.2902
			3	0.00365	104.5578
			6	0.00166	229.7815
			9	0.000908	419.7533
	100	100-300	0	0.0000632	5893.2840
			1	0.0000108	30825.5221
			3 6	1.48000E-06 1.75000E-07	124531.8836 216822.5130
			9	2.02000E-08	237720.4829
	15	100-300	o	0.000943	404.2001
			1	0.000889	428.7084
			3	0.000299	1270.1916
			6	0.000179	2114.2387
	700	≥300	0	0.0000316	11749.3423
			1	0.0000275	13445.8143
			3 6	0.0000138 6.24000E-06	25980.7174 53506.7568
			9	3.42000E-06	88470.5614
	100	≥300	0	1.36000E-11	426311.8788
			1	2.31000E-12	426317.2531
			3	3.17000E-13	426318.2018
			6	3.75000E-14	426318.3348
			9	4.33000E-15	426318.3506
	15	≥300	0	0.0000384	9716.1485
			1	0.0000305	12161.0015
			3 6	0.0000167 7.60000E-06	21698.7281 44888.3831
			0	/ • 600000E=06	44000.3031

^{*5} child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-121 to A-129.

Table AI-11. NAPHTHALENE, RESIDENTIAL. SOIL AND GROUNDWATER EXPOSURE, 9 YEARS DURATION*. HI=0.5, CLAY.

SOIL	HALF	DIST FROM	DEPTH TO	SESOIL GW	SOIL CONC.
TYPE:	LIFE	SITE	GROUND WATER		(mg/kg)
					(9/ 7.29/
CLAY	700	0-100	О	0.314	1.2159
			1	0.214	1.7841
			3	0.0621	6.1479
	100	0-100	· o	0.307	1.2436
			1	0.000547	694.7457
			1 3 6	0.000015	21747.6436
			6	1.200E-07	142676.1457
	15	0-100	0	0.00466	81.8868
			1	0.00318	119.9670
			3	0.00092	413.8520
			6	0.000248	1523.8177
	700	100-300	0	0.00837	45.6069
			1	0.00573	66.6136
			3	0.0016	238.3898
	100	100-300	0	0.0000618	6023.4486
			1	1.170000E-07	224207.4110
			3	3.200000E-09	240263.5960
	15	100-300	0	0.000943	404.2001
			1	0.00064	595.0905
			3	0.000195	1942.1621
			6	0.00005	7401.2805
				F-1941-1941-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1	
	700	≥300	. 0	0.0000316	11749.3423
			1	0.0000215	17048.0827
			3	6.240000E-06	53506.7568
	100	≥300	0	1.330000E-11	426312.0217
			1	2.370000E-14	426318.3414
			3	6.490000E-16	426318.3524
	15	≥300	Ò	0.000384	9716.1485
			1	0.0000253	14575.0427
			3	7.610000E-06	44888.3831
			6	2.180000E-06	124139.7812

 $^{^{\}rm a}$ 5 child and 4 adolescent years; see spreadsheets for soil multipliers, pp AI-130 to A-138.

Soil Values (mg/kg) for Carcinogenic Polycyclic Aromatic Hydrocarbons Based on GW Pathway, 9 and 30 Years Exposure Duration ** Table AI-12.

			Distance fr	Distance from Site (m)		
	0	- 100	100	100 - 300	>300	300
	9 Years	30 Years	9 Years	30 Years	9 Years	30 Years
Benzo(a)pyrene	0.33077	0.13626	3.31×10^5	$3.31 \times 10^5 1.36 \times 10^5$	3.31×10^5	3.31 x 10 ⁵ 1.36 x 10 ⁵
Benzo(a)anthracene	0.15334	0.06503	1.53×10^5	6.5 x 10 ⁴	$1.53 \times 10^5 6.5 \times 10^4$	6.5 x 104
Chrysene	15.33412	6.50324	1.53×10^7	6.5 x 10 ⁶	1.53 x 10 ⁷ 6.5 x 10 ⁶	6.5 x 10 ⁶

See Calculations based on GW exposure only, applying an on-site mixing factor of 0.67 to soil pore water (complete mixing to 0.5 m depth, 0.1 m/d GW flow rate, 300d half-life). See Assessment assumed no migration of compounds to soil surface, based on SESOIL results. pages AI-139 to AI-192 for spreadsheets.

Soil Values (mg/kg) for Carcinogenic Polycyclic Aromatic Hydrocarbons Based on Surface Soil and GW Contamination, 9 and 30 Years Exposure Duration* Table AI-13.

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	The state of the s		Distance from Site (m)	m Site (m)		
	- 0	100	100 - 300	300	>300	00
	9 Years	30 Years	9 Years	30 Years	9 Years	30 Years
Benzo(a)pyrene	0.111060	0.056335	0.334398	0.192087	0.668796	0.384173
Benzo(a)anthracene	0.140459	0.060908	3.343914	1.920813	6.687683	3.841513
Chrysene	14.045940	6.090820	334.391427	192.081334	668,768271	384.151321

0.1 m/d GW flow rate, 300d half-life). There was no SESOIL transport. Spreadsheets for benzo(a)pyrene are given on pages AI-193 to AI-210. Assessment assumed contamination of surface soils and GW (complete mixing to 0.5 m depth,

References

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RESIDENTIAL CHILD, SOIL EXPOSURE E SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT ACENAPHTHENE RESIDEN 0 to 100 METERS FROM THE SITE,

Soil Ingestion	2-6 yrs.	7-18	18+			
				! 0 Transport	RfDo 0.06	
cont. [] (mg/kg)(ppm) c	4043.97/91	5	,	I Ka/Att. Fact.	KIDI U.U6	
(2-6 200, >6 100)	002	00 T	TOO	: on/off EXPOSURE		
exposure freq. (d/yr) EF	180					
duration of exp. (yrs) ED		4	0		****************	*
avg. body wt. (kg) BW	16	41	70		* Soil Concentration *	*
(2-6 16, 6-18 41, adult 70				! 1 inh. vap.	*	*
absorption factor (0-1) AF				! 0 shower derm.	* 4043.9779 mg/kg *	*
contaminated fraction (0-1)CF	F 0.5			! 0 inh. shower	*	*
Transport multiplier TR				! 0 inh. part.	***************	*
soil ingestion dose (mg/kg/d)	1.246E-02	mg/kg*day	lay	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	3-6)/(BW*ED*365)	
Soil Dermal Exposure						
cont [] (mg/kg) C 4043 9779	4043 97791					
skin surf. area (cm^2/d) SA	3910	3910	3120			
(child 3910 adult 3120)						
soil to skin adher. factor AD	.D 1					
(1) (mg/cm ²)						
absorption factor (0-1) AF	0.1					
exposure freq. (d/yr) EF	180					
exposure duration (yrs) ED	വ	4	0			
avg. body wt. (kg) BW		41	70			
(2-6 16, 6-18 41, adult 70)						
contaminated fraction (0-1)C	F 0.5					
Transport multiplier TR						
soil dermal dose (mg/kg/d)	2.437E-02	ma/ka*dav		=/C*SA*AD*AF*EF*ED*CF*#R*1E-6)//BW*ED*365	**1E-6)/(BW*ED*365)	
(n/64/64) 2000 tours 1100		Far / Fm	ŀ	T 10 07 17 17 11 01 11 11 11 11 11 11 11 11 11 11 11	(COC. 41 . W.A.) //C . 41 . V.	1

	= (CR*C/Kd*EF*ED*DF*AT*TR) / (BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	lay	20	lay	18150 0 70
4	mg/kg*day	20 4 4 41	mg/kg*day	13175 18 4 41
4043.97791 1.4 4571 0.005 350 350 16	1.113E+01	4043.97791 20 20) 25807.58 350 350 0.5	4.696E-02	4043.97791 22.855 7200 350 5 0.146
Groundwater Consumption soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kG) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 70 70 70 20 0 70	/ =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
ਜਜਜ	2.229E+00 mg/kg*day	mg/kg*day	0.000E+00 mg/kg*day
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose 2.2	Inhalation in Shower soil cont. [] (mg/kg) C 4043.97791 Kd (L/kg) inhalation rt. (0.6) (m³/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 shower length (hrs/day) (.2) SL 0.2 avg. body wt. (kg) BW 16 volat. factor (K) (.5 L/m³) 0.5 absorption factor AT 11 Transport multiplier TR 11 shower inhalation exposure 3.181E-01 Inhalation of Particulates inhalation rate (m³/day) IR 20 (child<18 20 adult 20) air particulate [] (mg/m³) AP 0 respirable part. fraction RF part. cont [] (mg/kg) C 4043.97791 exposure freq. (days/yr) EF exposure duration (yrs) ED avg. Lkg) BW Transport multiplier TR 11	part. inhalation exposure 0

RESIDENTIAL CHILD, SOIL EXPOSURE ITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT ACENAPHTHENE RESTOR 100 to 100 METERS FROM SITE,

ОH	Transport RfDo 0.06 Kd/Att. Fact. RfDi 0.06 No Attenuation EXPOSURE	<pre>soil ingest. soil derm. ************************************</pre>	inh. vap. * shower derm. * 667.2564 mg/kg * inh. shower * inh. part. ************************************	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)	= (C*SA*AD*AF*EP*ED*CF*TR*1E-6) / (BW*ED*365)
	! 0 Tra ! 1 Kd/ ! 0 No ! on/off EXF		! 1 inh. ! 0 showe ! 0 inh. ! 0 inh.	= (C*CR*EF*EI	= (C*SA*AD*A
18+	100	0 20		3120 0 70	Veb
7-18	100	4 4 1 4 1		mg/kg*day 3910 312 4	ma/ka*dav
2-6 yrs.	667.256356	180 5 16	0) 1 CF 0.5	2.057E-03 667.256356 3910 1 180 180 16 0.1	4.021E-03.1
Soil Ingestion	<pre>cont. [] (mg/kg) (ppm) C consumption rt. (mg/day) CR (2-6 200, >6 100)</pre>	exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW	(2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF contaminated fraction (0-1)CF Transport multiplier TR	soil ingestion dose (mg/kg/d) Soil Dermal Exposure cont. [] (mg/kg) C skin surf. area(cm²/d) SA (child 3910 adult 3120) soil to skin adher. factor AD (1) (mg/cm²) absorption factor (0-1) AF exposure freq. (d/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) contaminated fraction (0-1) CF Transport multiplier TR	soil dermal dose (mg/kg/d)

	= (CR*C/Kd*EF*ED*DF*AT*TR) / (BW*ED*365)			=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	lay	20	70	lay	18150 0 70
41	mg/kg*day	20	4 1	mg/kg*day	13175 18 4 41
667.256356 1.4 4571 0.005 350 0.75 16	1.837E+00	20) 25807	350 16 0.5 0.5	7.748E-03	57.256356 22.855 7200 350 350 16 0.146
soil cont. [] (mg/kg) C 667 Consumption rate (L/day) CR Koc (L\kG) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	ŭ	exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C 6/ Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 70 =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)	20	=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
	mg/kg*day	4 41 mg/kg*day	20 2 4 4 4 1 1 1 1	mg/kg*day
ਜਜਜ	3.679E-01 mg	667.256356 22.855 0.6 350 5.249E-02	20 20 667.256356 180 16	0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower	Inhalation of Particulates	part. inhalation exposure

ACENAPHTHENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

1 0.06 0.06 0.06 ************************)*365)	(BW*ED*365)
HQ 1 RfDo 0.06 RfDi 0.06 on ***********************************	/ (Bi	٦,
on/oTRANSPORT 0 Transport 1 Kd/Att. Fact. 0 No Attenuation on/oEXPOSURE 1 soil ingest. 1 soil derm. **** 1 gwater cons.* So 1 inh. vap. * 1 shower derm.* 1 inh. shower * 0 inh. part. ****	= (C*CR*EF*ED*AF*CF*TR*1E-6)	=(C*SA*AD*AF*EF*ED*CF*T'K*LE-6)
8+ 1100 1100 1100 1100 1100 1100 1100 11		"
н	*day 3120	*aay
7-18 100 4	mg/kg*day 3910 312 4 41	mg/кд*day
2-6 yrs. pp23.4317685 3/ 200 /r 180 /r 180 /r 160 (0 1 io 0.5	-05 685 10 110 1180 1180 105 105	- 1
Soil Ingestion 2-6 yrs cont. [] (mg/kg) (pp23.43176 consumption rt. (mg/ (2-6 200, >6 100) exposure freq. (d/yr duration of exp. (yr avg. body wt. (kg) B (2-6 16, 6-18 41, adult 70 absorption factor (0 contaminated fractio Transport multiplier	soil ingestion dose 7.222E-05 Soil Dermal Exposure	soll dermal dose (mg 1.412E-04
Soi con con dur avg avg avg con	soil cont. skin cont. skin (ch soil (1) absor expos expos avg. (2- conta	SOI

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CONTEST !

					0		41 70	-	
.4317685	1.4	4571	0.005	350	ស	0.75	16	Н	Т
soil cont. [] (mg/k23.4317685	Consumption rate (L/	Koc (L\kG)	Organic Carbon Fract	exp. freq. (365) (day	exposure duration (y	diet fraction (.75-1	avg. body wt. (kg) B	Attenuation factor	Transport multiplier

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Inhalation of Vapors				
• • • • • • • • • • • • • • • • • • • •				
soil cont. [] (mg/K23.4	1317685			
inhalation rt. (m3/d 20	20	2.0	20	
(child<18 20 adult 20 occ.	0000.	20)		
/kg)	25807.58			
exposure freq. (days	350			
exposure duration (y	വ	4	0	
avg body wt. (kg) BW	16	41	70	
absorption factor AF	0.5			
contaminated fractio	0.5			
Transport multiplier	-			

/(BW*ED*365)	
(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365	
lay =	
vapor inhalation do	
	Į

vapor	vapor inhalation dos 2.721E-04 mg/kg*day =(IR*C*1/VF*E	,721E-04	mg/kg*	'day	=(IR*C*1/VF*E
	· · · · · · · · · · · · · · · · · · ·				
Dermal	Dermal Contact in Shower	3r			
soil c	ont. [] (mg/k23.	4317685			
Kd (L,	Kd (L/kg) Kd 22.855	22.855			
skin s	skin surface area (c	7200	7200 13175 18150	18150	
(<2 4((<2 4000 2-6 7200 6-12 13175	2 13175			
15-0	15-18 17000 adult 18150)	3150)			
exposm	re freq. (days	350			
exposn	exposure duration (y	വ	4	0	
avg boc	avg body wt (kg) BW	16	41	7.0	
Kp derr	Kp(derm. perm.) (cm/h	0.146			
length	length of shower (hr	0.5			

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)														(320+40+110)/ (40+00+40+41+14+14+14+14+14+14+14+14+14+14+14+14+	= (C/KQ*IK*EF*ED*SD*K*AF*AT*TK)/(bW*ED*303)												=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)	
	mg/kg*day							4 0		41 70						mg/kg*day			20 20						4 0	41 70		ma/ka*dav	7 G., 1C.
ਜਜਜ	1.292E-02 m		•	3.4317685	22.855	0 0 • 1	068	ഥ	0.2	16	0.5	0.5	н	Т	(((1.843E-03 m	lates	• • • • • • • • • • • • • • • • • • • •	20	20)	0	0	(mg/k23.4317685	180	വ	16	Н	0.000E+00 m	`
absorption factor AF Attenuation factor Transport multiplier	shower dermal dose	Inhalation in Shower		•	$K\alpha (L/Kg)$	inhalation rt. (0.6) (exposure fred. (days	exposure duration (Y	hrs	(kg)	volat. factor (K) (.5	tor	Attenuation factor	Transport multiplier	•	shower inhalation ex	Inhalation of Particulates	•	rate (m ³ /	adult	air particulate [](m	respirable part. fra	part. cont [] (mg/k2	exposure freq. (days	exposure duration (y	avg. body wt. (kg) B	Transport multiplier	nart inhalation exp	<u>.</u>

CHILD, SOIL AND GROUNDWATER EXPOSURE 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT RESIDENTIAL CHILD, ACENAPHTHENE RESIDENTIAL 0 to 100 METERS FROM SITE,

TRANSPORT	0 17 0	100 100 ; 0 NO ACCENDACION ! on/off EXPOSURE	soil ingest.	! 1 soil derm. **	41 70! 1 gwater cons. * Soil Concentration	! 1 inh. vap. *	 ! 1 inh. shower *	! 0 inh. part. *************	mg/kg*day =(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)		3910 3120				4 0	41 70				
Soil Ingestion 2-6 yrs.	cont. [] (mg/kg) (ppm) C 3.86624181		18	duration of exp. (yrs) ED 5	Н	(2-6 16, 6-18 41, adult 70)	_		soil ingestion dose (mg/kg/d) 1.192E-05 m	Soil Dermal Exposure	 3910	soil to skin adher. factor AD (1) (mg/cm ²)	stor (0-1) AF	exposure freq. (d/yr) FF 180			•	contaminated fraction (0-1)CF 0.5	Transport multiplier TR	30 H000 0 (E)(1) E

•	(CK*C/KG*EF*ED*DF*AT*TK)/(BW*ED*365)		C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 02	mg/kg*day =(ck*d	20 20 4 0 ·	mg/kg*day =(IR*C*1	13175 18150 4 0 41 70
.86624181 4571 0.005 350 0.75	1.065E-02 m	3.86624181 20 0cc. 20) 25807.58 EF 350 5 16 0.5	4.489E-05 m	.86624181 22.855 7200 350 16 0.146
Groundwater Consumption soil cont. [] (mg/kg) C 3 Consumption rate (L/day) CR Koc (L/kG) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure Inhalation of Vapors	y) C y) IR t 20 VF (/yr) J rs) El n (0-:	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C 3 Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

absorption factor AF Attenuation factor AT Transport multiplier TR	ਜਜਜ		
shower dermal dose	2.131E-03 mg	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C 3.866	3.86624181		
inhalation rt. (0.6) (m ³ /hr) IR	R 0.6		
exposure ireq. (days/yr) Er exposure duration (vrs) ED	30 20 21 21	4	0
shower length(hrs/day)(.2) S	SL 0.2	ı	
avg. body wt. (kg) BW	16	41	70
-	0.5		
absorption factor AF	0.5		
Y	Η,		
Transport multiplier TR	Н		
shower inhalation exposure	3.041E-04 n	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
(child<18 20 adult 20)	0%	0.3	
air particulate [](mg/m ³) AP	0		
respirable part. fraction RF			
part. cont [] (mg/kg) C	3.86624		
exposure freq. (days/yr) EF	180	•	
exposure duration (yrs) ED	<u>ب</u> م		0
avg. body wt. (Kg) Bw mranenort multiplior mb	16	4.1	7.0
	-1		
part. inhalation exposure	0.000E+00 n	mg/kg*day	=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
			1.1111

ANTHRACENE RESIDENTIAL CHILD, SOIL EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

Soil Ingestion	2-6 yrs.	7-18	18+	! on/off TRANSPORT	
cont. [] (mg/kg) (ppm) C 415	41589.7449			! 0 Transport ! 1 Kd/Att. Fact.	RfDo 0.3 RfDi 0.3
consumption rt. (mg/day) CR	200	100	100		5
(2-6 200, >6 100)				! on/off EXPOSURE	
exposure freq. (d/yr) EF	180			! 1 soil ingest.	
duration of exp. (yrs) ED	5	4	0	! 1 soil derm.	***************
avg. body wt. (kg) BW	16	41	70	gwate	* Soil Concentration *
(2-6 16, 6-18 41, adult 70)	_			! 1 inh. vap.	*
absorption factor (0-1) AF	-			-	* 41589.7449 mg/kg *
contaminated fraction (0-1)CF	F 0.5			! 0 inh. shower	*
Transport multiplier TR	1			! 0 inh. part.	****************
soil ingestion dose (mg/kg/d) 1.282E-01	1.282E-01	mg/kg*day	lay	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	3-6)/(BW*ED*365)
Soil Dermal Exposure					
/ va/va/ [] /wa/va/ va/va/ va/va/ va/va/ va/va/ va/va/ va/va/ va/va/va/ va/va/va/va/va/va/va/va/va/va/va/va/va/v	41500 7440				
	7.007.440		6		
Skin Sufi: afed(cm/d) SA (child 3910 adult 3120)	39.10	3910	3120		
soil to skin adher. factor AD) 1				
(1) $(mg/cm2)$					
absorption factor (0-1) AF	0.1				
exposure freg. (d/yr) EF	180	180			
exposure duration (yrs) ED	ស	4	0		
avg. body wt. (kg) BW	16	41	70	,	
(2-6 16, 6-18 41, adult 70)					
contaminated fraction (0-1)CF	0.5				
Transport multiplier TR					
(5/24/2000 (50)	2 EOEE 01	*****/***		18+40+44+40+440++40+0/-	\
(n/hy/hm) acom Thurst Too	. І	IIIy/ ry "day		-(C.SA.AD.AF.AF.AD.CF.TK*IE=6)/(BW*ED*369	(*IE-6)/(BW*ED*365)

	= (CR*C/Kd*EF*ED*DF*AT*TR) / (BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 70	lay	20 0 70	lay	18150 0 70
41	mg/kg*day	20 4 4 41	mg/kg*day	13175 1
11589.7449 14125 0.005 350 350 0.75 16	3.706E+01	41589.7449 20 20 259752.96 350 350 350 350	4.798E-02	41589.7449 70.625 7200 350 350 0.225
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L\kG) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 70 y = (C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)20 20 70 y = (IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)	
	mg/kg*day	4 41 20 2 4 4 4 41	
ਜਜਜ	1.143E+01 mc	41589.7449 70.625 0.6 350 16 0.5 0.5 1 1.059E+00 20 41589.7449 180 5 16	
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 41589.7449 Kd (L/kg) Inhalation rt.(0.6) (m³/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 shower length(hrs/day)(.2) SL 0.2 avg. body wt. (kg) BW 0.5 absorption factor AF 1 1 Transport multiplier TR 1 1 Shower inhalation exposure 1.059E+00 Inhalation rate (m³/day) IR 20 (child<18 20 adult 20) air particulate [] (mg/m³) AP 0 respirable part. fraction RF 9 part. cont [] (mg/kg) C 41589.7449 exposure freq. (days/yr) EF 5 avg. body wt. (kg) BW 16 Transport multiplier TR 1 part. inhalation exposure 0.000E+00	

ANTHRACENE RESIDENTIAL CHILD, SOIL EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	lay	20 20 70	lay	18150 0 70
41	mg/kg*day	20 4 4 4 1 1	mg/kg*day	13175 18
6862.30791 1.4 14125 0.005 350 0.75 0.75	6.114E+00	6862.30791 20 259752.96 350 5 16 0.5	7.917E-03	350 7200 7200 350 350 950 0.225
soil cont. [] (mg/kg) C 6 Consumption rate (L/day) CR Koc (L\kG) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C 6 inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)			0	7.0			$\mathbf{Y} = (C/Kd*IR*EF*ED*SL*K*AF*AT*TR) / (BW*ED*365)$		20			0	70	1y = (IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
н п п	00 mg/kg*day		0791 .625 0.6	350 5 4	16 41	0.5	n	ı ∑-01 mg/kg*day		20 20	00)791 190	180 5	16 41	± 3+00 mg/kg*day
	1.887E+00		6862.30 70	EF ED 2) ST	_	3)		re 1.747E-01	es	•	AP n RF	6862.30791	ED E		e 0.000E+0C
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower	soil cont. [] (mg/kg) C 6862.30791 Kd (L/kg) 70.625 inhalation rt.(0.6)(m³/hr) IR 0.6	exposure freq. (days/yr) EF exposure duration (yrs) ED	avg. body wt. (kg) BW	volat. factor (K) (.5 L/m³)	Attenuation factor AT	shower inhalation exposure	Inhalation of Particulates	inhalation rate (m³/day) IR (child<18 20 adult 20)	air particulate [](mg/m³) AP respirable part. fraction RF	part. cont [] (mg/kg) C	exposure ireq. (days/yr) exposure duration (vrs)]	μ	in I

ANTHRACENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

	RfDo 0.3 RfDi 0.3		مد	Soil Concentration *		* 9x/6m 02c/./2c	***************	·6)/(BW*ED*365)													1E-6)/(BW*ED*365)
! on/off TRANSPORT		نډ		l gwater cons. *	i I inn. vap.	: I inh. shower **	part.	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365													=(C*SA*AD*AF*EF*ED*CF*TR+1E-6)/(BW*ED*365
7-18 18+	100 100			41 70				mg/kg*day =			3910 3120				180	4 0	41 70				ma/ka*dav =
2-6 yrs.	327.751955	180		16	-	- N. O				327 751955			1	0.1	180		16		0.5	Н	1.975E-03 m
Soil Ingestion	cont. [] (mg/kg) (ppm) C 327.751955 consumption rt. (mg/day) CR 200	(2-6.200, >6.100) exposure freq. (d/yr) EF	duration of exp. (yrs) ED	avg. body wt. (kg) BW	(2-6 16, 6-18 41, adult /0)	contaminated fraction (0-1) CF	Transport multiplier TR	soil ingestion dose (mg/kg/d) 1.010E-03	Soil Dermal Exposure	•		(child 3910 adult 3120)	soil to skin adher. factor AD (1) (mg/cm ²)	absorption factor (0-1) AF	exposure freq. (d/yr) EF	exposure duration (yrs) ED	avg. body wt. (kg) BW	(2-6 16, 6-18 41, adult 70)	contaminated fraction (0-1)CF	Transport multiplier TR	soil dermal dose (ma/ka/d)

	= (CK*C/KQ*EF*ED*DF*AI*IK)/(F	=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365) 50 0 0 70
7	20 20 70	18150
. 41	20 2 4 4 4 1 4 1 4 1 4 1 4 1 1 4 1 1 1 1 1	mg/kg*day 13175 1815 4
	7 . 6	3.781E-04 27.751955 70.625 7200 350 350 5 16 0.225
Groundwater Consumption soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L\kG) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	Inhalation of Vapors Soil cont. [] (mg/Kg) C 3 inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose Dermal Contact in Shower soil cont. [] (mg/kg) C 3 Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 20	/ =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)	20 20 20 20	/ =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
	mg/kg*day	4 T	mg/kg*day	20 4 4 4 11	mg/kg*day
ннн	9.011E-02 mc	327.751955 70.625 0.6 350 5 6 0.2 16 0.5	8.344E-03	20 0 0 0 0 0 0 0 1 1 1 1 1	0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6)(m³/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW volat. factor (K)(.5 L/m³) absorption factor AF Attenuation factor AT Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates inhalation rate (m³/day) IR (child<18 20 adult 20) air particulate [](mg/m³) AP respirable part. fraction RF part. cont [] (mg/kg) C exposure freq. (days/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW Transport multiplier TR	part. inhalation exposure

ANTHRACENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)												=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)												=(IR*C*RF*PC*EF*ED*TR*1E-6)//BW*ED*365)	(COC GT) / (C TT)
						0		70								20						0	70			
	ıg/kg*day					4		41					mg/kg*day			20						4	41		ma/ka*dav	21.5
ਜਜਜ	1.487E-02 mg		54.0790726			ß	L 0.2	16	0.5	0.5		-	1.377E-03		• • • • • • • • • • • • • • • • • • • •	20				54.0790726	180	ស	16	1	0.000E+00	
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower	soil cont. [] (mg/kg) C 54.079	Kd (L/kg) inhalation rt (0.6) (m^3/kr) TB	exposure freq. (days/yr) EF	exposure duration (yrs) ED	shower length(hrs/day)(.2) SL	avg. body wt. (kg) BW	ن	absorption factor AF	Attenuation factor AT	Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates		inhalation rate (m3/day) IR	(child<18 20 adult 20)	air particulate [](mg/m³) AP	ĹT.,	part. cont [] (mg/kg) C) EF	딥		Transport multiplier TR	part. inhalation exposure	

FLUORANTHENE RESIDENTIAL CHILD, SOIL EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

CH.	RfDo 0.04	•			***************	Soil Concentration *	*	6277.1417 mg/kg *	*	***************)/(BW*ED*365)															E-0)/(BW*ED*365)
On off TRANSPORT			ONO Attenuation		soil derm.	O)	0 inh. vap. *	0 shower derm. *	0 inh. shower *	inh. part.	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365				-											=(C*SA*AD*Af*Ef*ED*CF*TK*1E-6)/(BW*ED*36S
+ 8 -		(100		0	70			_,					3120]]					0	70					
7-18) 	\$ {	100		4	41					mg/kg*day			3910						4	41				E. 4. 20. 4. 20.	IIIg/kg, day
2-6 Vrs.	· · · · · · · · · · · · · · · · · · ·	6277.14168	200	180	2	16		Н	0.5	Ħ	1.935E-02			3910)	н		0.1	~	വ	16		0.5	ī	1000	3./02E-U2 III
Soil Indestion			consumption rt. (mg/day) CK (2-6 200, >6 100)	exposure freq. (d/yr) EF	duration of exp. (yrs) ED	avg. body wt. (kg) BW	(2-6 16, 6-18 41, adult 70)	absorption factor (0-1) AF	contaminated fraction (0-1)CF	Transport multiplier TR	soil ingestion dose (mg/kg/d)	Soil Dermal Exposure	•	skin surf. area(cm^2/d) sA	(child 3910 adult 3120)	soil to skin adher. factor AD	(1) (mg/cm²)	absorption factor (0-1) AF	exposure freq. (d/yr) EF	exposure duration (yrs) ED	avg. body wt. (kg) BW	(2-6 16, 6-18 41, adult 70)	contaminated fraction (0-1)CF	Transport multiplier TR		soft definat dose (my/ny/a)

(CR*C/Kd*EF*ED*DF*AT*TR) / (BW*ED*365)	(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
4 0 41 70 mg/kg*day =	20 20 $41 70$ $41 70$ $13175 18150$ $6 41 70$ $6 6$
Groundwater Consumption soil cont. [] (mg/kg) C 6277.14168 consumption rate (L/day) CR 38000 Koc (L/kg) Organic Carbon Fraction expo freq. (365) (days/yr) EF 350 exposure duration (yrs) ED 5 exposure duration (yrs) ED 75 diet fraction (.75-1.0) DF 16 Attenuation factor AT 1 Transport multiplier TR Transport multiplier TR	Inhalation of Vapors Inhalation of Vapors soil cont. [] (mg/Kg) C 6277.14168 soil cont. [] (mg/Kg) VF 1621188.50 (child<18 20 adult 20 occ. 20) (child<18 20 adult 20 occ. 20) (child<18 20 adult 20 occ. 20) exposure freq. (days/yr) EF 5 exposure duration (yrs) ED 16 avg body wt. (kg) BW 0.5 absorption factor AF 0.5 contaminated fraction (0-1) CF 1 Transport multiplier TR 1.160E-03 vapor inhalation dose 1.160E-03 vapor inhalation dose 1.160E-03 soil contact in Shower 1.6 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 6-12 13175 (<2 4000 2-6 7200 2-6 7200 6-12 13175 (<2 4000 2-6 7200 2-0 2000 2-0 2000 2-0

FLUORANTHENE RESIDENTIAL CHILD, SOIL EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

! on/off TRANSPORT HQ C	! 0 Transport RfDo 0.04 ! 1 Kd/Att. Fact. RfDi 0.04 0 No Attenuation	! on/off	: I SOII INGEST.	! 0 gwate	! 0 inh. vap. *		! 0 inh. shower *	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)
18+	100		0	70				day
7-18	100		4	41				mg/kg*day
2-6 yrs.	1035.72838		180 5	-			0°.0	3.192E-03
Soil Ingestion	consumption rt. (mq/day) CR 1035.72838	(2-6 200, >6 100)	exposure ireq. (α/yr) Er duration of exp. (yrs) ED	avg. body wt. (kg) BW	(2-6 16, 6-18 41, adult 70)	absorption factor (0-1) AF	contaminated fraction (0-1)CF Transport multiplier TR	soil ingestion dose (mg/kg/d)

0 0 2.0	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
7	day	20 70 70	day	18150 70
4 4 1	mg/kg*day	20 4 4 411	mg/kg*day	13175 3
1035.72838 1.4 38000 0.005 350 350 16	3.430E-01	1035.72838 20 20 1621188.50 350 350 5 16	1.914E-04	1035.72838 190 7200 350 5 16 0.36
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C 1 inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF 1(exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C 1 Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	/ = (C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001) / (BW*ED*365)	0 20	ay = $(C/Kd*IR*EF*ED*SL*K*AF*AT*TR) / (BW*ED*365)$	20	ay =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
	mg/kg*day	4 1	mg/kg*day	20 4 4 4 1	mg/kg*day
ਜਜਜ	1.694E-01 mg	1035.72838 190 0.6 350 5 0.2 16 0.5	9.801E-03	20 0 1035.72838 180 5	0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 1035.72838 Kd (L/kg) inhalation rt.(0.6)(m³/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 shower length(hrs/day)(.2) SL 0.2 avg. body wt. (kg) BW 16 volat. factor (K)(.5 L/m³) 0.5 absorption factor AF 17 Transport multiplier TR 1	shower inhalation exposure	Inhalation of Particulates inhalation rate (m³/day) IR (child<18 20 adult 20) air particulate [](mg/m³) AP respirable part. fraction RF part. cont [] (mg/kg) C exposure freq. (days/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW Transport multiplier TR	part, inhalation exposure

D, SOIL AND GROUNDWATER EXPOSURE 9-YEAR EXPOSURE (HI=1), NO TRANSPORT FLUORANTHENE RESIDENTIAL CHILD, 0 to 100 METERS FROM THE SITE, 9-

<pre>cont. [] (mg/kg) (ppm) C</pre>				_		ი ვ
consumpcion ft. (mg/day) tr (2-6 200, >6 100) exposure freq. (d/yr) FF	2.417928	,	6		KIDO 0.04 RfDi 0.04	4 4
exposure freq. (d/yr) FF	200	100	OOT	: on/off EXPOSURE		
	180			! 1 soil ingest.		
duration of exp. (yrs) ED	വ	4	0	i 1 soil derm.	***************	*
avg. body wt. (kg) BW	16	41	70	i 1 gwater cons.	* Soil Concentration	*
(2-6 16, 6-18 41, adult 70)				! 0 inh. vap.	*	*
absorption factor (0-1) AF	-			i shower derm.	* 102.4179 mg/kg	*
contaminated fraction (0-1)CF	0.5			! 0 inh. shower	*	*
Transport multiplier TR	т			! 0 inh. part.	**************	*
soil ingestion dose (mg/kg/d) 3.157E-04		mg/kg*day	lay	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	E-6)/(BW*ED*365)	
Soil Dermal Exposure						
:	102.417928					
	3910	391.0	3120			
(child 3910 adult 3120)						
soil to skin adher. factor AD	-					
(I) (IIII)	•					
absorption factor (0-1) AF	1.0					
exposure freq. (d/yr) EF	180					
exposure duration (yrs) ED	വ	4	0			
avg. body wt. (kg) BW	. 16	41	70			
(2-6 16, 6-18 41, adult 70)						
contaminated fraction (0-1)CF	0.5					
Transport multiplier TR	T					
	_) 4 20 A 1		8+40+44+44+44+46+6		
soll dermal dose (mg/kg/d) b.	0.1/1E-04	тб/кд∗αау		=(C*SA*AD*AF*EF*ED*CF*TR*IE=6)/(BW*ED*365	K*1E-6)/(BW*EU*365)	I

0 0	=(CR*C/KA*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	day	20	lay	18150
4 T	mg/kg*day	20 4 411	mg/kg*day	13175 1
102.417928 1.4 38000 0.005 350 350 16	3.392E-02	102.417928 20 2.20) 1621188.50 350 5 16 0.5	1.893E-05	102.417928 190 7200 350 350 6.36
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C 1 inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF 16 exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C 1 Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

absorption factor AF Attenuation factor AT Transport multiplier TR	ਜਜਜ		
shower dermal dose	1.675E-02 m	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C 102.4	17		
inhalation rt. $(0.6) (m^3/hr)$ II	190 R 0.6		
exposure freq. (days/yr) EF		,	
	SL 0.2	₽*	0
		41	7.0
volat. factor (K) (.5 L/m3)	0.5		
absorption factor AF	0.5		
AT	-		
Transport multiplier TR			
shower inhalation exposure	9.692E-04	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
	• • • • • • • • • • • • • • • • • • • •		
inhalation rate (m³/day) IR (child<18 20 adult 20)	20	20	20
_	0		
respirable part. fraction RF	_		
part. cont [] (mg/kg) C	102.417		
exposure freq. (days/yr) EF		•	
exposure duration (yrs) ED	3 Y	4.	0
Transport multiplier TR	р г	- i	
part. inhalation exposure	0.000E+00	mg/kg*day	=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

FLUORANTHENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

cont. [] (mg/kg)(ppm) C 16.8989581 consumption rt. (mg/day) CR 200 (2-6 200, >6 100) exposure freq. (d/yr) EF 180 duration of exp. (yrs) ED 5 avg. body wt. (kg) BW 16 (2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF 1	•	100 1 4 41 mg/kg*day	100 0 70 day	O Transport 1 Kd/Att. Fact. O No Attenuation O No Attenuation O No Attenuation Soil ingest. Soil derm. Ginh. vap. O inh. vap. O inh. shower O inh. part. O inh. part.	0 Transport
cont. [] (mg/kg)(ppm) C 16 consumption rt. (mg/day) CR (2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF		100 4 41 mg/kg*c	100 70 day	1 Kd/Att. Factory on No Attenuary on No Attenuary on Street on 1 soil ingestrong of 1 soil derm. I swater control of 1 shower derming of 1 shower	tion ttion st. ************************************
consumption rt. (mg/day) CR (2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF		100 4 41 mg/kg*c	100 0 70 day	ONO Attenual On/Off EXPOSURE 1 Soil inges' 1 Soil derm. 1 Swater con: 0 inh. vap. 1 Shower deri 0 inh. showe: 0 inh. part. 0 inh. part.	tion ***********************************
(2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF		4 41 ng/kg*c		on/off EXPOSURE 1 soil inges' 1 soil derm. 1 gwater con: 0 inh. vap. 1 shower deri 0 inh. showe: 0 inh. part. 0 inh. part.	st. ************************************
exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF		4 41 ng/kg*c	_	1 soil inges 1 soil derm. 1 gwater con: 0 inh. vap. 1 shower deri 0 inh. showe: 0 inh. part. 0 inh. part.	st. ************************************
duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF	 	41 41 ng/kg*c	_	1 soil derm. 1 gwater con: 0 inh. vap. 1 shower der: 0 inh. showe: 0 inh. part. 0 inh. part. = (C*CR*EF*ED*AF*CF*	<pre>************************************</pre>
avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF	امر بمرت مر	41 ng/kg*c	70 day	<pre>1 gwater cons 2 0 inh. vap. 1 1 shower deri 2 0 inh. shower 3 0 inh. part. =(C*CR*EF*ED*AF*CF**</pre>	<pre>is. * Soil Concentration</pre>
absorption factor (0-1) AF	امر بمبد	ng/kg*c	day	0 inh. vap. 1 shower der! 0 inh. showe! 0 inh. part. =(C*CR*EF*ED*AF*CF*	m. * 16.8990 mg/kg **********************************
absorption factor (0-1) AF	امر رمرت	ng/kg*c	day	1 shower deri 1 0 inh. showei 2 0 inh. part. =(C*CR*EF*ED*AF*CF*	m. * 16.8990 mg/kg ***********************************
TO THE TANK OF THE PROPERTY OF	امر رما	ng/kg*c	day	: 0 inh. shower : 0 inh. part. =(C*CR*EF*ED*AF*CF*	**************************************
CONTRAMILATING CONTROLLON (OLI) OF		ıg/kg*c	day	0 inh. part. 	**************************************
Transport multiplier TR		ıg/kg*c	day	=(C*CR*EF*ED*AF*CF*	TR*1E-6)/(BW*ED*365)
(mg/kg/d)					
Soil Dermal Exposure					
•	•				
	16.8989581				
skin surf. area (cm^2/d) SA	3910	3910	3120		
(child 3910 adult 3120)					
u	H				
(1) (mg/cm ²)					
absorption factor (0-1) AF	0.1				
exposure freq. (d/yr) EF	180				
exposure duration (yrs) ED	വ	4	0		
avg. body wt. (kg) BW	16	41	70		
(2-6 16, 6-18 41, adult 70)					
contaminated fraction (0-1)CF	0.5				
Transport multiplier TR	н				
noil dermal dose (ma/ka/a)	1 018E-01 #	* * 2 4 / 2		\+CQ+66+68+C8+80+0\-	\U\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\
l	- 1	my/ vg "day		- (C"SA"AD"AF "EF "ED"(-(C.SA.AU.AF.EF.ED.CF.TK*IE-6)/(BW*ED*365)

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)			=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	lay	20	70	lay	18150 0 70
4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	mg/kg*day	20	4 4	mg/kg*day	13175 1 4 4
16.8989581 38000 0.005 350 350 0.75 16	5.597E-03	16.8989581 20 2. 20) 1621188.50		3.124E-06	16.8989581 190 7200 350 350 5 16
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure Inhalation of Vapors	ម	exposure freq. (days/YI) Er exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 0 2.0	1y = (C/Kd*IR*EF*ED*SL*K*AF*AT*TR) / (BW*ED*365)	20 0 70	IY = (IR*C*RF*PC*EF*ED*TR*1E-6) / (BW*ED*365)
	mg/kg*day	4 1	mg/kg*day	20 4 4 41	mg/kg*day
ਜਜਜ	2.763E-03 m	16.8989581 190 0.6 350 5 0.2 16 0.5	1.599E-04	20 20 16.8989581 180 16	0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 16.8989581 Kd (L/kg) inhalation rt.(0.6) (m³/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 shower length(hrs/day)(.2) SL 0.2 avg. body wt. (kg) BW 16 volat. factor (K)(.5 L/m³) 0.5 absorption factor AF Attenuation factor AT 1 Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates inhalation rate (m³/day) IR (child<18 20 adult 20) air particulate [](mg/m³) AP respirable part. fraction RF part. cont [] (mg/kg) C exposure freq. (days/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW Transport multiplier TR	part. inhalation exposure

FLUORENE RESIDENTIAL CHILD, SOIL EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

	2-6 yrs.	7-18	18+	•		-
	•			! 0 Transport		4
cont. [] (mg/kg)(ppm) C	5405.20894			! 1 Kd/Att. Fact.	RfDi 0.04	4
consumption rt. (mg/day) CR	200	100	100			
(2-6 200, >6 100)				! on/off EXPOSURE		
exposure freq. (d/yr) EF	180			! 1 soil ingest.		
duration of exp. (yrs) ED	S	₩	0	! 1 soil derm.	***************	*
avg. body wt. (kg) BW	16	41	7.0	! 0 gwater cons.	* Soil Concentration	*
(2-6 16, 6-18 41, adult 70)				! 1 inh. vap.	*	*
absorption factor (0-1) AF	-			U 2	* 5405.2089 mg/kg	*
contaminated fraction (0-1)CF	F 0.5			! 0 inh. shower	*	*
Transport multiplier TR				! 0 inh. part.	************	*
soil ingestion dose (mg/kg/d) 1.666E-02		mg/kg*day	day	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	3-6)/(BW*ED*365)	
Soil Dermal Exposure						
:	5405.20894					
	3910	3910	3120			
(child 3910 adult 3120)						
soil to skin adher. factor AD	0					
(1) (mg/cm2)						
absorption factor (0-1) AF	0.1					
exposure freg. (d/yr) EF	180					
exposure duration (yrs) ED		4	0			
avg. body wt. (kg) BW	16	41	70			
(2-6 16, 6-18 41, adult 70)						
contaminated fraction (0-1)CF	F 0.5					
Transport multiplier TR	Ħ					
soil dermal dose (mg/kg/d)	3.257E-02	mq/ka*dav		=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365	<pre><*1E-6) / (BW*ED*365)</pre>	
1-10-16-1		5 16			, , , , , , , , , , , , , , , , , , , ,	

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	day	20 20 70	lay	18150
4 1 4	mg/kg*day	20 4 4 411	mg/kg*day	13175 3
5405.20894 7225 0.005 350 0.75	9.416E+00	5405.20894 20 20 212511.56 350 5 16 0.5	7.622E-03	5405.20894 36.125 7200 350 350 16 0.171
soil cont. [] (mg/kg) C 5 Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C 5 inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. volat.factor(m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C 5. Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 20	y =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)	20 0 20	<pre>y =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)</pre>
	ng/kg*day	4 T	mg/kg*day	20 4 41	mg/kg*day
ਜਜਜ	2.208E+00 mc	5405.20894 36.125 R 0.6 350 50.2 L 16 0.5	2.690E-01	20 0 5405.20894 180 5	0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 5405.20894 Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 shower length(hrs/day)(.2) SL 16 volat. factor (K)(.5 L/m3) 0.5 absorption factor AF 1 Transport multiplier TR 1	shower inhalation exposure	Inhalation of Particulates	part. inhalation exposure

FLUORENE RESIDENTIAL CHILD, SOIL EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

TRANSPORT HQ 0.165	RfDo	act. RfDi	No Attenuation	DAFOSURE 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	ingest.	SOII Germ. ***************	gwater cons. * Soil Concentration	inh. vap. *	shower derm. * 891.8595 mg/kg	*	inh. part. **************	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)															
! on/off		디	1 02/06	. .	·		o -:	-ਜ ਜ -	is 0	1 0 1	i 0 i	=(C*CR*EF*)				0						•	•				
.8 18+			100			4	1 70					mg/kg*day				0 3120						4	1 70				
7-18	:		100	ç	ו כ	വ	6 4		1	വ	п			•	9	0 3910		-		—	0	വ	6 4		5	-	:
2-6 yrs.		891.859	200		7			(0		CF 0.		d) 2.749E-03			ED.	3910		AD		0.	180		16		CF 0.5		1
Soil Ingestion		cont. [] (mg/kg) (ppm) c	consumption rt. (mg/day) CR	(8-0 400' (31))	ra (ık/n) - harr armandıra	duration of exp. (yrs) ED	avg. body wt. (kg) BW	(2-6 16, 6-18 41, adult 7	absorption factor (0-1) AF	contaminated fraction (0-1)	Transport multiplier TR	soil ingestion dose (mg/kg/d)	Soil Dermal Exposure		cont. [] (mg/kg) C	skin surf. area(cm2/d) SA	(child 3910 adult 3120)	soil to skin adher. factor AD	(1) (mg/cm2)	absorption factor (0-1) AF	exposure freq. (d/yr) EF	exposure duration (yrs) ED	avg. body wt. (kg) BW	(2-6 16, 6-18 41, adult 70	contaminated fraction (0-1)(Transport multiplier TR	

								=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)												=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365	
			C		70			lay			20				0	70				lay	
			4	I	41			mg/kg*day			20				4	41				mg/kg*day	
	891.859476 1.4	0.005	350	0.75	16		+	1.554E+00		• 0	0	. 20)	212511.56	350	വ	16	0.5	0.5	ਜ	1.258E-03	
Groundwater Consumption	soil cont. [] (mg/kg) C Consumption rate (L/day) CR	organic Carbon Fraction	exp. freq. (365)(days/yr) EF exposure duration (vrs) ED	diet fraction (.75-1.0) DF	avg. body wt. (kg) BW	Attenuation factor AT	Transport multiplier TR	water consumption exposure	Inhalation of Vapors		inhalation rt. (m3/day) IR	(child<18 20 adult 20 occ.	volat.factor(m3/kg) VF	exposure freq. (days/yr) EF	exposure duration (yrs) ED	avg body wt. (kg) BW	absorption factor AF	contaminated fraction (0-1)CF	Transport multiplier TR	vapor inhalation dose	

=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)										
day			18150				0	70		
mg/kg*			13175 18150				4	41		
1.258E-03 mg/kg*day		91.859476 36.125	7200			350	വ	16	0.171	0.2
1		• 00	Ą	3175	0)	田子	Ð			SI
vapor inhalation dose	Dermal Contact in Shower	soil cont. [] (mg/kg) C Kd (L/kg) Kd	skin surface area (cm2) S	(<2 4000 2-6 7200 6-12 13175	15-18 17000 adult 18150)	exposure freq. (days/yr)	exposure duration (yrs) ED	avg body wt (kg) BW	Kp(derm. perm.) (cm/hr)	length of shower (hr/day) SL

absorption factor AF Attenuation factor AT Transport multiplier TR	ннн		
shower dermal dose	3.643E-01 mg	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C	891.		
inhalation rt.(0.6)(m3/hr) IR exposure freq. (days/yr) EF	R 0.6		
		4	0
snower lengtn(nrs/day)(.z) sbaya, bodv wt. (kg) BW	16 16	41	7.0
volat. factor (K) (.5 L/m3)	0.5		
absorption factor AF	0.5		
ai	ਮ ਜ		
shower inhalation exposure	4.439E-02	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
inhalation rate (m3/day) IR	20	50	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF	0 100		
part. cont [] (mg/kg) C exposure freq. (days/yr) EF	891.8594/6		
exposure duration (yrs) ED	ប		0
avg. body wt. (kg) BW Transport multiplier TR	16	41	
part. inhalation exposure	0.000E+00	mg/kg*day	=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

FLUORENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

Soil Ingestion	2-6 yrs.	7-18	18+			
cont. [] (ma/ka)(bbm) C 2.	23.9497237			! 0 Transport ! 1 Kd/Att. Fact.	RfDo 0.04 RfDi 0.04	
consumption rt. (mg/day) CR	200	100	100	! 0 No Attenuation		
(2-0 200, 70 100) exposure fred (d/vr) RF	180					
duration of exp. (yrs) ED		4	0		********	*
avq. body wt. (kg) BW	ਜੋ	41	70	gwate	* Soil Concentration	*
(2-6 16, 6-18 41, adult 70	0)			! 1 inh. vap.	*	*
absorption factor (0-1) AF				i 1 shower derm.	* 23.9497 mg/kg	*
contaminated fraction (0-1)	CF 0.5			! 1 inh. shower	*	*
Transport multiplier TR				! 0 inh. part.	***************	*
soil ingestion dose (mg/kg/d) 7.382E-05 mg/kg*day	d) 7.382E-05	mg/kg*d		=(C*CR*EF*ED*AF*CF*TR*1E-6)	E-6)/(BW*ED*365)	
Soil Dermal Exposure						
cont. [] (mg/kg) C	23.949/23/					
skin surf. area(cm²/d) SA (child 3910 adult 3120)	3910	3910	3120			
	AD 1					
absorption factor (0-1) AF	0.1					
exposure freq. (d/yr) EF	180					
exposure duration (yrs) ED	ហ	4	0			
avg. body wt. (kg) BW		41	70		-	
(2-6 16, 6-18 41, adult 70)	(0					
contaminated fraction (0-1)	CF 0.5					
Transport multiplier TR	ਜ					
soil dermal dose (ma/ka/d)	1,443E-04	mq/ka*dav		=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365	R*1E-6)/(BW*ED*365)	
						-

exposure duration (yrs) ED 5 4 avg body wt. (kg) BW 16 4 absorption factor AF 0.5 contaminated fraction (0-1)CF 0.5 Transport multiplier TR 1 vapor inhalation dose 3.377E-05 mg/ko	20 20 4 0 41 70 mg/kg*day	=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
Dermal Contact in Shower soil cont. [] (mg/kg) C 23.9497237 Kd (L/kg) Kd 36.125 skin surface area (cm²) SA 7200 13175 (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 4 avg body wt (kg) BW Kp(derm. perm.) (cm/hr) 0.171 length of shower (hr/day) SL 0.2	75 18150 4 0 41 70	

absorption factor AF Attenuation factor AT Transport multiplier TR	ਜਜਜ		
shower dermal dose	9.784E-03 mg	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C Kd (L/kg)	23.949		
exposure freq. (days/yr) EF	350	<	
shower length(hrs/day)(.2) SL		۲ <u>.</u>	
avg. body wt. (kg) bw volat. factor (K) (.5 L/m ³)	0.5	1	
absorption factor AF Attenuation factor AT	0.5		
e L	T T		
shower inhalation exposure	1.192E-03	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
inhalation rate (m^3/day) IR	20	20	20
(child<18 20 adult 20) air particulate [](mg/m³) AP	0		
respirable part. fraction RF	•		
<pre>part. cont [] (mg/kg) C exposure freq. (days/yr) EF</pre>	23.9497237		
exposure duration (yrs) ED			0
avg. body wt. (kg) BW Transport multiplier TR	16	 7	70
part. inhalation exposure	0.000E+00	mg/kg*day	=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

FLUORENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

Soil Ingestion cont. [] (mg/kg)(ppm) C 3.95170441 consumption rt. (mg/day) CR 200 (2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF contaminated fraction (0-1) CF Transport multiplier TR soil ingestion dose (mg/kg/d) 1.218E-05	7-18 100 4 41 mg/kg*d	18+ 100 70 70	<pre>! on/off TRANSPORT !</pre>	HQ 0.165 RfDo 0.04 RfDi 0.04 *************** * Soil Concentration * * 3.9517 mg/kg * * ********************************
Soil Dermal Exposure	• .	3120		
soil dermal dose (mg/kg/d) 2.381E-05	5 mg/kg*day	lay	=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365	:*1E-6)/(BW*ED*365)

absorption factor AF Attenuation factor AT Transport multiplier TR	ਜਜਜ		
shower dermal dose	1.614E-03 mg	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C 3.95170441	3.95170441		
Kd (L/kg)			
inhalation rt.(0.6)(m3/hr) IR	R 0.6		
exposure duration (yrs) ED	n n	4	0
shower length(hrs/day)(.2) SL	L 0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT	1		
Transport multiplier TR	. ⊣		
shower inhalation exposure	1.967E-04	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
•			
inhalation rate (m3/day) IR	20	20	20
(CHIIIA ZO AULIC ZO) air particulate [1/mg/m3/ AD	c		
respirable part. fraction RF	0		
part. cont [] (mg/kg) C	3.95170441		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	വ		0
avg. body wt. (kg) BW Transport multiplier TR	16	T	0.
part. inhalation exposure	0.000E+00	mg/kg*day	=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SOIL EXPOSURE, 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

Soil Ingestion 2-6 yrs.	7-18	18+	! on/off TRANSPORT	HQ 1
				RfDo 0.04
2748.49			! 1 Kd/Att. Fact.	RfDi 0.04
consumption rt. (mg/day) CR 200	100	100		
			! on/off EXPOSURE	
exposure freq. (d/yr) EF 180			! 1 soil ingest.	
	4	0	! 1 soil derm.	***************
avg. body wt. (kg) BW	41	70	! 0 gwater cons.	* Soil Concentration *
(2-6 16, 6-18 41, adult 70)			! 1 inh. vap.	*
			! 0 shower derm.	* 2748.4917 mg/kg *
contaminated fraction (0-1)CF 0.5			! 0 inh. shower	*
Transport multiplier TR				**************
soil ingestion dose (mg/kg/d) 8.471E-03	mg/kg*day	day	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	6)/(BW*ED*365)
Soil Dermal Exposure				
Cont [] (mg/kg) C 2748 40173				
0.00 (1.02.02.02.03.03) (3.00.000.000.000.000.000.000.000.000.00	6	0		
SKIN SUFI. area(cm ⁻ /a) SA 3910	39.TU	3120		
(child 3910 adult 3120)				
soil to skin adher. factor AD 1				
absurption factor (UTI) Ar				
exposure duration (yrs) ED 5	4	0		
avg. body wt. (kg) BW	41	70		
(2-6 16, 6-18 41, adult 70)				
contaminated fraction (0-1)CF 0.5				
Transport multiplier TR 1				
		,	G	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
ZOTT METHING MOSE (ING/NG/N) TOOSE TOOS	IIIg/kg*day	day	=(C*SA*AU*Af*Ef*ED*Cf*TK*LE-6)/(BW*ED*369	*IE-6)/(BW*ED*365)

CR 1.4 930 0.005 0.005 DF 0.75 0.75 16 41 70	consumption exposure 3.720E+01 mg/kg*day = (CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)	Inhalation of Vapors soil cont. [] (mg/Kg) C 2748.49173 inhalation rt. (m³/day) IR 20 20 (child<18 20 adult 20 occ. 20) volat.factor(m³/kg) VF 26701.70 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 4 0 avg body wt. (kg) BW 16 41 70 absorption factor AF 0.5 contaminated fraction (0-1)CF 0.5 Transport multiplier TR 1	nalation dose 3.084E-02 mg/kg*day =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	Dermal Contact in Shower soil cont. [] (mg/kg) C 2748.49173 Kd (L/kg) Kd 4.65 skin surface area (cm²) SA 7200 13175 18150 (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF 350 exposure freq. (days/yr) EF 15 18150 exposure duration (yrs) ED 5 4 0 avg body wt (kg) BW 16 41 70 Kp(derm. perm.) (cm/hr) 0.069 length of shower (hr/day) SL 0.2
Groundwater Consumption soil cont. [] (mg/kg) C Consumption rate (L/day) Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr exposure duration (yrs) diet fraction (.75-1.0) avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption	Inhalation of Vapors soil cont. [] (mg/Kg) inhalation rt. (m³/day) (child<18 20 adult 2 volat.factor(m³/kg) VF exposure freq. (days/yr exposure duration (yrs) avg body wt. (kg) BW absorption factor AF contaminated fraction (Transport multiplier T	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm²) S (<2 4000 2-6 7200 6-12 15-18 17000 adult 181 exposure freq. (days/yr) exposure duration (yrs) avg body wt (kg) BW Kp(derm. perm.)(cm/hr) length of shower (hr/day)

absorption factor AF Attenuation factor AT Transport multiplier TR	ਜਜਜ		
shower dermal dose	3.520E+00 mg/kg*day	g*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C 2748.49173	2748.4		
Kd (L/kg) inhalation rt. $(0.6)(m^3/hr)$ IR	4.65 R 0.6		
exposure freq. (days/yr) EF			
exposure duration (yrs) ED shower length(hrs/dav)(.2) S	ST, 0.2	4	0
		41 7	02
ت ۔	0.5		
absorption factor AF	0.5		
Attenuation factor AT Transport multinlier TP	← -		
	-1		
shower inhalation exposure	1.063E+00 mg/	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
inbalation rate (m3/dav) TR	000	00 00	
(child<18 20 adult 20)	9		
air particulate [](mg/m³) AP	0		
respirable part. fraction RF			
part. cont [] (mg/kg) C exposure freq. (days/vr) EF	2748.49173		
exposure duration (yrs) ED	ស	4	0
avg. body wt. (kg) BW	16	41 7	70
Transport multiplier TR	FF.		
part. inhalation exposure	0.000E+00 mg/	mg/kg*day	=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SOIL EXPOSURE, 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

Soil Ingestion 2-6 yrs.	7-18	18+		0
cont. [] (mq/kq)(ppm) C 453.501135			! 0 Transport ! 1 Kd/Att. Fact.	RfDo 0.04 RfDi 0.04
consumption rt. (mg/day) CR 200 (2-6 200, >6 100)	100	100	! 0 No Attenuation on/off EXPOSURE	
18			soil	
		0	! 1 soil derm.	***************
avg. body wt. (kg) BW	41	70	o gwater cons.	* Soil Concentration *
(2-6 16, 6-18 41, adult 70)			! 1 inh. vap.	*
			: 0 shower derm.	* 453.5011 mg/kg *
contaminated fraction (0-1)CF 0.5			! 0 inh. shower	*
			! 0 inh. part.	**************
soil ingestion dose (mg/kg/d) 1.398E-03	mg/kg*day	day	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	E-6)/(BW*ED*365)
Soil Dermal Exposure				
cont [] (mg/kg) C 453,501135	•			
	3910	3120		
soil to skin adher. factor AD				
(1) (mg/cm ²)		-		
absorption factor (0-1) AF 0.1				
-П				
exposure duration (yrs) ED 5	4	0		
	41	70		
contaminated fraction (0-1)CF 0.5				
Transport multiplier TR				
soil dermal dose (mg/kg/d) 2.733E-03 mg/kg*day	mq/kg*c		= (C*SA*AD*AF*EF*ED*CF*TR*1E-6) / (BW*ED*365)	R*1E-6)/(BW*ED*365)
		l		

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	lay	20 70 70	lay	18150 0 70
41	mg/kg*day	20 4 4 4 11	mg/kg*day	13175 1
453.501135 1.4 930 0.005 350 0.75 16	6.137E+00	453.501135 20 20 26701.70 26701.70 350 350 350		3.501135 4.65 7200 350 5 16 0.069
soil cont. [] (mg/kg) C 453 Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors	a)	Dermal Contact in Shower soil cont. [] (mg/kg) C 45 Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	<pre>1*day = (C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001) / (BW*ED*365</pre>	4 0 41 70	mg/kg*day = (C/Kd*IR*EF*ED*SL*K*AF*AT*TR) / (BW*ED*365)	20 20 41 70	
ल्न स्न स्न	5.808E-01 mg/kg*day	453.501135 4.65 0.6 350 5 0.2 16 0.5 0.5	1.753E-01 mg/	20 20 0 453.501135 180 5 16	
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose 5	Inhalation in Shower soil cont. [] (mg/kg) C 453.501135 Kd (L/kg) inhalation rt.(0.6)(m³/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 shower length(hrs/day)(.2) SL 0.2 avg. body wt. (kg) BW 16 volat. factor (K)(.5 L/m³) 0.5 absorption factor AF 17 Transport multiplier TR 1	shower inhalation exposure	Inhalation of Particulates	

NAPHTHALENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1), NO TRANSPORT

HQ 0.04 RfDo 0.04 RfDi 0.04 ***************** * Soil Concentration * * 3.5462 mg/kg * * *********************************	6) / (BW*ED*365)	1E-6)/(BW*ED*365)
SPORT sport it. Fact. tenuation SURE ingest. derm. er cons. vap. sr derm.	Inn. part. F*ED*AF*CF*TR*1E	=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365
184	03	
7-18 100 4	mg/kg*day 3910 312 4	mg/kg*day
2-6 yrs54617434 200 180 5	3E-05 3E-05 17434 3910 1 180 16 0.5 0.5	2.137E-05 n
n - 1 (g)	soil ingestion dose (mg/kg/d) 1.093E-0 Soil Dermal Exposure	soil dermal dose (mg/kg/d)

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 70	day	20	day	18150 70
4 1	mg/kg*day	20 4 4 1 1	mg/kg*day	13175 1
3.54617434 1.4 930 0.005 350 0.75	4.799E-02	3.54617434 20 20 26701.70 350 350 6 16 0.5	3.980E-05	
soil cont. [] (mg/kg) C 3 Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C 3 inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C 3 Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365				4 0		41 /0				mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)		20 20						4 U			# 1
ਜਜਜ	4.541E-03 mg/		3.54617434	0.6))		16 0.5	0.5	e e	~	1.371E-03 mg		20			0	3.546I7	0 T	د د	F	-1	Jm 00+4000 0
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower	soil cont. [] (mg/kg) C 3.54 Kd (L/kg)	inhalation rt. (0.6) (m³/hr) IR	exposure duration (yrs) ED	shower length(hrs/day)(.2) SL	avg. body wt. (Kg) bw volat factor (K)(5 L/m³)	absorption factor AF	ΑŢ	Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates	inhalation rate (m³/dav) IR	(child<18 20 adult 20)	air particulate [](mg/m³) AP	respirable part, fraction RF	part. cont [] (mg/kg) C	$\overline{}$	exposure duration (yrs) ED	manda wr. (Ag) bw		orito contract

NAPHTHALENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

+ ! on/off TRANSPORT HQ 0.165	Transport Kd/Att. Fact. No Attenuation EXPOSURE	_	* * * * * * * * * * * * * * * * * * *	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)		0 2			0	70		396*U4*M4//\9=41*QH*43*Q4*44*44*4V**63*3/=
7-18 18+	100 10	4 4 L		mg/kg*day		3910 3120				41		1.0°C+204/200
Soil Indestion 2-6 yrs.	kg) (ppm) C 0 0 (mg/day) CR 100)	exposure freq. (d/yr) EF 180 duration of exp. (yrs) ED 5 avg. body wt. (kg) BW 16	(2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF contaminated fraction (0-1) CF Transport multiplier TR	soil ingestion dose (mg/kg/d) 1.803E-06 mg/kg*day	Soil Dermal Exposure	cont. [] (mg/kg) C 0.58511877 skin surf. area(cm²/d) SA 3910	(child 3910 adult 3120) soil to skin adher. factor AD) (exposure duration (yrs) ED 5	avg. body wt. (kg) BW 16 (2-6 16, 6-18 41, adult 70)	contaminated fraction (0-1)CF 0.5 Transport multiplier TR 1	**************************************

0 20	/ = (CR*C/Kd*EF*ED*DF*AT*TR) / (BW*ED*365)	20 0 70	/ =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	50 0 70
4 1 4	mg/kg*day	20 4 4 11	mg/kg*day	.3175 18150 4 (
0.58511877 930 0.005 350 0.75 16	7.918E-03	20 20 20 26701.70 350 350 5 16 0.5 0.5	6.566E-06	350 350 350 0.069
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C 0. inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

absorption factor AF Attenuation factor AT Transport multiplier TR	ਜਜਜ		
shower dermal dose	7.493E-04 mg/	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C 0.58511877	0.58511877		
inhalation rt. (0.6) (m3/hr) IR			
exposure ireq. (days/yr) Er exposure duration (yrs) ED	005 005	4	
hrs/day)(.2)	SL 0.2		
avg. body wt. (kg) BW	16	41 7	70
absorption factor AF	0.5		
Ç.	⊢		
Transport multiplier TR	н		
shower inhalation exposure	2.262E-04 mg	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
inhalation rate (m/day) IR (child<18 20 adult 20)	20	20 20	0
late [](mg/m^3)			
respirable part. fraction RF	0 58511877		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	សុ		0
avg. body wt. (kg) BW Transport multiplier TR	16 1	41 7	0
art treated action) OOTHOO	7.6°C*54/5m	
אמי היי דיווומדמריטוו בעלספתים	1	Il wa aa I	(COC. GET. AD. IV. TR. TR. D. (CO. T. D. CO.)

NO TRANSPORT PYRENE RESIDENTIAL CHILD, SOIL EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=1),

Soil Ingestion	2-6 yrs.	7-18	18+	! on/off TRANSPORT	HQ 1
1	• • • • • • • • • • • • • • • • • • • •			! 0 Transport	RfDo 0.03
cont. [] (mg/kg)(ppm) C	4573.5704				RfDi 0.03
consumption rt. (mg/day) CR	200	100	100		
(2-6 200, >6 100)				rn	
exposure freq. (d/yr) EF	18			! 1 soil ingest.	
duration of exp. (yrs) ED		4	0	! 1 soil derm.	****************
avg. body wt. (kg) BW	16	41	70	! 0 gwater cons.	* Soil Concentration *
(2-6 16, 6-18 41, adult 70)				! 1 inh. vap.	*
absorption factor (0-1) AF				! 0 shower derm.	* 4573.5704 mg/kg *
contaminated fraction (0-1)CF	7 0.5				*
Transport multiplier TR				! 0 inh. part.	****************
soil ingestion dose (mg/kg/d)	1.410E-02	mg/kg*day	day	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	E-6)/(BW*ED*365)
Soil Dermal Exposure					
cont [] (mg/kg) C 4573 5702	4573.5704				
skin surf. area(cm²/d) SA	3910	3910	3120		
(child 3910 adult 3120)			; []		
soil to skin adher. factor AD	1				
(1) (mg/cm²)					
absorption factor (0-1) AF	0.1				
exposure freq. (d/yr) EF	180				
exposure duration (yrs) ED	വ	4	0		
avg. body wt. (kg) BW		41	70		
(2-6 16, 6-18 41, adult 70)					
contaminated fraction (0-1)CF	0.5				
Transport multiplier TR	H				
soil dermal dose (mq/kq/d)	2.756E-02	mg/kg*day	day	=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)	R*1E-6)/(BW*ED*365)

0 0 0	= (CR*C/Kd*EF*ED*DF*AT*TR) / (BW*ED*365)	20	7.0	- =(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	0.9	0 20
7 4	mg/kg*day		4 1	mg/kg*day	18150	4. ←
. 4	mg/k	. 50	4	mg/k	13175	4
4573.5704 38000 0.005 350 50 0.75	1.515E+00	4573.5704 20 . 20) 167557.17	16 0.5 0.5	1.174E-03	4573.5704 190 7200	350 5 16 0.324 0.2
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure Inhalation of Vapors	soil cont. [] (mg/Kg) C 457 inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. 20 volat.factor(m³/kg) VF 1167E exposure freq. (days/yr) EF	exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150)	exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.)(cm/hr) length of shower (hr/day) SL

	' =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 70 ay =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365) 20 0	ay =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
	mg/kg*day	4 41 mg/kg*day 20 2	mg/kg*day
ਜਜਜ	6.731E-01 m	4573.5704 190 0.6 350 350 16 0.5 0.5 4.328E-02 20 4573.5704 180 16	0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 4573.5704 Kd (L/kg) inhalation rt.(0.6)(m³/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 0.2 avg. body wt. (kg) BW volat. factor (K)(.5 L/m³) 0.5 absorption factor AT Transport multiplier TR 1 shower inhalation exposure 4.328E-02 Inhalation of Particulates Inhalation rate (m³/day) IR 20 child<18 20 adult 20) air particulate [](mg/m³) AP 0 respirable part. fraction RF 0 part. cont [] (mg/kg) C 4573.5704 exposure freq. (days/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW Transport multiplier TR 15	part. inhalation exposure

PYRENE RESIDENTIAL CHILD, SOIL EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.165), NO TRANSPORT

Soil Ingestion	2-6 yrs.	7-18	18+		
	754.639117			! 0 Transport ! 1 Kd/Att. Fact.	RfDo 0.03 RfDi 0.03
೪	200	100	100	! 0 No Attenuation on/off EXPOSURE	
exposure freq. (d/yr) EF	180				
duration of exp. (yrs) ED	വ	4	0		***************
avg. body wt. (kg) BW	16	41	70	•	* Soil Concentration *
(2-6 16, 6-18 41, adult 70)				! 1 inh. vap.	*
absorption factor (0-1) AF				٧.	* 754.6391 mg/kg *
contaminated fraction (0-1)CF	0.5				*
Transport multiplier TR	П			! 0 inh. part.	*************
soil ingestion dose (mg/kg/d)	2.326E-03	mg/kg*day	day	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	E-6)/(BW*ED*365)
Soil Dermal Exposure					
cont [] (mg/kg)	754 639117				
skin surf. area (cm^2/d) SA	3910	3910	3120		
(child 3910 adult 3120)					
soil to skin adher. factor AD (1) (mq/cm²)	Н				
വ	0.1				
exposure freq. (d/yr) EF	180				
exposure duration (yrs) ED	വ	4	0		
avg. body wt. (kg) BW	16	41	70		
(2-6 16, 6-18 41, adult 70)					
contaminated fraction (0-1)CF Transport multiplier TR	0.5				
4					
soil dermal dose (mg/kg/d)	4.547E-03 n	mg/kg*day	day	= (C*SA*AD*AF*EF*ED*CF*TR*1E-6) / (BW*ED*365)	<pre><*1E-6) / (BW*ED*365)</pre>

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	lay	20 0 70	lay	18150 0 70
4 1	mg/kg*day	20 4 4 4 1	mg/kg*day	13175 1 4 41
754.639117 38000 0.005 350 0.75 16	2.499E-01 n	. 20) . 20) . 167557.17 350 . 5 . 16 0.5 0.5	1.937E-04 m	.639117 190 7200 350 5 16 0.324
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C 77 inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF 11 exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C 754 Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

absorption factor AF Attenuation factor AT Transport multiplier TR	ਜਜਜ		
shower dermal dose	1.111E-01 m	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C 754.639117	754.639117		
Kd (L/kg)	190		
inhalation rt. (0.6) (m3/hr) IR			
exposure freq. (days/yr) EF			
		4	0
	SL 0.2		, , , , , , , , , , , , , , , , , , ,
avy: body wt. (ky) bw volat. factor (K)(.5 I./m³)	L L L	4 T	0/
absorption factor AF	ָרָ כְּ		
τ.	•		
Transport multiplier TR	1		
shower inhalation exposure	7.141E-03	mg/kg*day	/ =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
	•	Ó	
child<18 20 adult 20)	0.7	0 %	70
air particulate [] (mg/m³) AP	0		
respirable part. fraction RF			
part. cont [] (mg/kg) C	754.639117		
exposure ireq. (days/yr) Er exposure duration (vrs) FD		5	c
2	ر ا	~	
Transport multiplier TR	р н	ť	
part. inhalation exposure	0.000E+00	mg/kg*day	/ = (IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

SOIL AND GROUNDWATER EXPOSURE 9-YEAR EXPOSURE (HI=1), NO TRANSPORT PYRENE RESIDENTIAL CHILD, 0 to 100 METERS FROM THE SITE,

Soil Ingestion	2-6 yrs.	7-18	18+			⊣ (
cont. [] (mg/kg)(ppm) C	79.7273082			: U Transport ! 1 Kd/Att. Fact.	RIDO 0.03 RfDi 0.03	ກຕ
consumption rt. (mg/day) CR	200	100	100	0 No Attenuation		
exposure fred. (d/yr) EF	180			, ,		
duration of exp. (yrs) ED		4	0	soil	***************	*
avg. body wt. (kg) BW	16	41	70	! 1 gwater cons.	* Soil Concentration *	*
(2-6 16, 6-18 41, adult 70)				! 0 inh. vap.	*	*
absorption factor (0-1) AF					* 79.7273 mg/kg *	*
contaminated fraction (0-1)CF	3.0.5			! 0 inh. shower	*	*
Transport multiplier TR	Н			! 0 inh. part.	***************	*
soil ingestion dose (mg/kg/d)	2.457E-04	mg/kg*day	ay	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	3-6)/(BW*ED*365)	I
Soil Dermal Exposure						
cont. [] (ma/kg) C	79.7273082					
skin surf. area(cm²/d) SA	3910	3910	3120			
(child 3910 adult 3120)						
soil to skin adher. factor AD	0 1					
(1) (mg/cm²)						
absorption factor (0-1) AF	0.1					
exposure freq. (d/yr) EF	180					
exposure duration (yrs) ED	ស	4	0			
avg. body wt. (kg) BW	16	41	70			
(2-6 16, 6-18 41, adult 70)						
contaminated fraction (0-1)CF	0.5					
Transport multiplier TR	ਜ					
soil dermal dose (mg/kg/d)	4.804E-04	mq/kq*day	a۷	=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365	<pre><*1E-6) / (BW*ED*365)</pre>	
		,	•			I

soil cont. [] (mg/kg) C Consumption rate (L/day) CR	79.7273082 1.4			
Koc (L/kg) Organic Carbon Fraction	38000			
exp. freq. (365) (days/yr) EF	350			
exposure duration (yrs) ED		4	0	
diet fraction (.75-1.0) DF	0.75			
avg. body wt. (kg) BW	16	41	70	
Attenuation lactor Al	F			
Transport multiplier TR	⊣			
water consumption exposure	2.641E-02	mg/kg*day		= (CR*C/KA*EF*ED*DF*AT*TR) / (BW*ED*365)
Inhalation of Vapors				
soil cont. [] (mg/Kg) C	79.7273082	00	20	
child<18 20 adult 20 occ.	20))]) 1	
volat.factor(m3/kg) VF 1	67557			
exposure freq. (days/yr) EF	350	~	c	
	ດ້	* *) C	
avg body wt. (kg) Bw	9T 6	7	?	
absorption factor AF	0 C			
Concaminated ifaction (0-1)Cf Transport multiplier TR	•			
vapor inhalation dose	2.046E-05	mg/kg*day		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)
Dermal Contact in Shower				
	• • • • • • • • • • • • • • • • • • • •			
soil cont. [] (mg/kg) C	79.7273082			
Ka (L/kg) Ka	190		, (
SKIN SULIACE area (CM²) SA	007/	8T G/TET	OCTRT	
<pre>(<2 4000 2-8 /200 8-12 131/3 15-18 17000 adult 18150}</pre>				
exposure fred. (days/yr) EF	350			
exposure duration (yrs) ED	ហ	4	0	
avg body wt (kg) BW	,	41	70	
<pre>Kp(derm. perm.)(cm/hr) lenath of shower (hr/dav) SL</pre>	0.324			
/ T /) ::				

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 20	- (C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)	00 00 7.00	= (IR*C*RF*PC*EF*ED*TR*1E-6) / (BW*ED*365)
	mg/kg*day	4 1	mg/kg*day	20 4 4 41	mg/kg*day
ਜਜਜ	1.173E-02 mg	79.7273082 190 0.6 350 5 0.2 16 0.5 0.5	7.544E-04	•	0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 79.7 Kd (L/kg) inhalation rt.(0.6)(m³/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW volat. factor (K)(.5 L/m³) absorption factor AF Attenuation factor AT Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates inhalation rate (m³/day) IR (child<18 20 adult 20) air particulate [] (mg/m³) AP respirable part. fraction RF part. cont [] (mg/kg) C exposure freq. (days/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW Transport multiplier TR	part. inhalation exposure

PYRENE RESIDENTIAL CHILD, SOIL AND GROUNDWATER EXPOSURE 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=:165), NO TRANSPORT

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		0.0	=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)		0 0
0 07		20	70	lay	18150	70
4 ,	mg/kg*day	20	4 4 4 1 1	mg/kg*day	13175	4 4 1 1
13.1550059 1.4 38000 0.005 350 5	1 1 4.357E-03		. -	3.376E-06	13.1550059 190 7200	350 16 0.324
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF	Attenuation factor AT Transport multiplier TR water consumption exposure	apors (mg/Kg) C (m³/day) IR	volat.factor(m³/kg) VF volat.factor(m³/kg) VF 1 exposure freq. (days/yr) EF exposure duration (yrs) ED avg body Wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175	exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.)(cm/hr) length of shower (hr/day) SL

absorption factor AF Attenuation factor AT Transport multiplier TR	ਜਿਜ		
shower dermal dose	1.936E-03 mg/kg*day	/ =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365	T*TR*0.001) / (BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C 13.1550059	13.1550		
Kd (L/kg) inhalation rt. $(0.6) (m^3/hr)$ IR	_		
exposure freq. (days/yr) EF exposure duration (vrs) ED		0	
_		i	
avg. body wt. (kg) BW volat. factor (k)(.5 L/m³)	16 41	70	
absorption factor AF	0.5		
Attenuation factor AT	⊢ -		
	- 1		
shower inhalation exposure	1.245E-04 mg/kg*day	ay =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)	:AT*TR) / (BW*ED*365)
Inhalation of Particulates			
	•	C	
(child<18 20 adult 20)	0.7	0 0 0	
air particulate [](mg/m³) AP	0		
respirable part. fraction RF	_		
part. cont [] (mg/kg) C exposure freq. (days/vr) EF	13.1550059		
exposure duration (yrs) ED		0	
avg. body wt. (kg) BW	16 41	70	
Transport multiplier TR	П		
part. inhalation exposure	0.000E+00 mg/kg*day	.ay =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365	:-6)/(BW*ED*365)

ACENAPHTHENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

Soil Dermal Exposure				
	• • • • • • • • •			
cont. [] (mg/kg) C 51	51845.8707			
skin surf. area(cm²/d) SA	3910	3910	3120	
(child 3910 adult 3120)				
soil to skin adher. factor AD	H			
(1) $(mg/cm2)$				
absorption factor (0-1) AF	0.1			
exposure freq. (d/yr) EF	180			
exposure duration (yrs) ED	വ	4	0	
avg. body wt. (kg) BW	16	41	70	
(2-6 16, 6-18 41, adult 70)				
contaminated fraction (0-1)CF	0.5			
Transport multiplier TR	0.039			

=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)

1.218E-02 mg/kg*day

soil dermal dose (mg/kg/d)

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 70	day	20	day	18150 0 70
41	mg/kg*day	20 4 41	mg/kg*day	13175 1
51845.8707 1.4 4571 0.005 350 350 16 16	3.263E+03	51845.8707 20 . 20) 25807.58 350 5 16 0.5	2.348E-02	51845.8707 22.855 7200 350 350 16 0.146
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L\kG) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C inhalation rt. (m³/day) IR (child<18 20 adult 20 occ volat.factor(m³/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 70 = (C/Kd*IR*EF*ED*SL*K*AF*AT*TR) / (BW*ED*365)	20 70 =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BV
	mg/kg*day	4 41 ma/ka*dav	20 24 4 41 mg/kg*day
ਜਜਜ	2.858E+01 mg,	51845.8707 22.855 0.6 350 5 0.2 16 0.5 4.079E+00	·
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt. (0.6) (m³/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day) (.2) SL avg. body wt. (kg) BW volat. factor (K) (.5 L/m³) absorption factor AF Attenuation factor AT Transport multiplier TR	

ACENAPHTHENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER 100 to 300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

Soil Ingestion 2-6 vrs.	7-18	18+	! on/off TRANSPORT	HO 0.5
		I	_	
cont. [] (mg/kg) (ppm) C 83319.7859				RfDi 0.06
consumption rt. (mg/day) CR 200	100	100	On One Attenuation On One Attenuation	
exposure freq. (d/vr) EF				
۵	4	0	soil	****************
avg. body wt. (kg) BW 16	41	70	! 0 gwater cons.	* Soil Concentration *
(2-6 16, 6-18 41, adult 70)			! 1 inh. vap.	*
			i 0 shower derm.	* 83319.79 mg/kg *
			! 0 inh. shower	*
Transport multiplier TR 0.039			! 0 inh. part.	*********
soil ingestion dose (mg/kg/d) 5.008E-03	mg/kg*day	day	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	E-6)/(BW*ED*365)
Soil Dermal Exposure			•	
	•			
cont. [] (mg/kg) C 83319.7859	4	6		
skin surf. area(cm²/d) SA 3910	3910	3120		
(child 3910 adult 3120)				
soil to skin adher. factor AD 1				
absorption factor (0-1) AF 0.1				
exposure duration (yrs) ED 5	4	0		
avg. body wt. (kg) BW 16	41	70		
(2-6 16, 6-18 41, adult 70)				
Transport multiplier TR 0.039				
soil dermal dose (mg/kg/d) 9.790E-03	mg/kg*dav		=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365	R*1E-6)/(BW*ED*365)
	- 1			

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 200	lay	20	lay	18150 0 70
41	mg/kg*day	20 4 4 1	mg/kg*day	13175 1
3319.7859 1.4 4571 0.005 350 0.75	5.243E+03	83319.7859 20 3. 20) 25807.58 250 250 5 16 0.5 0.5	2.695E-02	3319.7859 22.855 7200 350 5 16 0.146
soil cont. [] (mg/kg) C 83 Consumption rate (L/day) CR Koc (L\kG) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C 8: inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C 8: Kd (L/kg) Kd skin surface area (cm²) sA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 0 2 0 0	y = (C/Kd*IR*EF*ED*SL*K*AF*AT*TR) / (BW*ED*365)	20 0 70	<pre>/ =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)</pre>
	mg/kg*day	4 T	mg/kg*day	20 4 41	mg/kg*day
ਜਜਜ	4.593E+01 mc	83319.7859 22.855 0.6 350 350 5 16 0.5	6.555E+00	20 0 83319.7859 180 5	0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6)(m³/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW volat. factor (K)(.5 L/m³) absorption factor AF Attenuation factor AF Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates	part. inhalation exposure

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ACENAPHTHENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER >300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

Soil Ingestion	2-6 yrs.	7-18 18+		! on/off TRANSPORT	
:				1 Transport	RfDo 0.06
	14/341.168			o ha/Act. Fact.	
consumption rt. (mg/day) CR	200	100	100	! 0 No Attenuation	
(2-6 200, >6 100)				! on/off EXPOSURE	
exposure freq. (d/yr) EF	45			! 1 soil ingest.	
duration of exp. (yrs) ED	വ	4	0	i 1 soil derm.	****************
avg. body wt. (kg) BW	16	41	70	0 gwater cons.	* Soil Concentration *
(2-6 16, 6-18 41, adult 70)				! 1 inh. vap.	*
absorption factor (0-1) AF				o shower derm.	* 147341.17 mg/kg *
contaminated fraction (0-1)CF	0.5			o inh. shower	*
Transport multiplier TR	0.039			! 0 inh. part.	****************
soil ingestion dose (mg/kg/d) 4.428E-03 mg/kg*day	4.428E-03	mg/kg*c		=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365)	.E-6) / (BW*ED*365)

Soil Dermal Exposure				
• • • • • • • • • • • • • • • • • • • •	• • • • • • • • •			
	147341.168			
skin surf. area(cm²/d) SA	3910	3910 3910	3120	
(child 3910 adult 3120)				
soil to skin adher. factor AD	П			
(1) (mg/cm ²)				
absorption factor (0-1) AF	0.1			
exposure freq. (d/yr) EF	45	٠		
exposure duration (yrs) ED	വ	4	0	
avg. body wt. (kg) BW	16	41	70	
(2-6 16, 6-18 41, adult 70)				
contaminated fraction (0-1)CF	0.5			
Transport multiplier TR	0.039			

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	ay	20	ay	18150 0 70
41	mg/kg*day	20 4 4 1	mg/kg*day	13175 18
147341.168 1.4 4571 0.005 350 0.75 16	9.272E+03	147341.168 20 20 25807.58 150 16 0.5 0.5	2.859E-02	147341.168 22.855 7200 350 16 0.146
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kG) Organic Carbon Fraction exp. freq. (365)(days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

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	-(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 20	ay = (C/Kd*IR*EF*ED*SL*K*AF*AT*TR) / (BW*ED*365)	20	ay =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
ਜਜਜ	mg/kg*day	66 66 67 67 67 67 67 67 67 67 67 67 67 6	1 mg/kg*day	0 20 0 0 0 0 88 80 1 4 4	0 mg/kg*day
	8.123E+01	147341.168 22.855 0.6 350 350 16 0.5	1.159E+01		0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 147341.168 Kd (L/kg) inhalation rt.(0.6)(m³/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 shower length(hrs/day)(.2) SL 16 volat. factor (K)(.5 L/m³) 0.5 absorption factor AF 11 Transport multiplier TR 1	shower inhalation exposure	Inhalation of Particulates	part. inhalation exposure

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NAPHTHALENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

	<pre>1 EAPCOUKE 1 Soil ingest. 1 Soil derm.</pre>	= (C*CR*EF*ED*AF*CF*TR*1E-6) / (BW*ED*365)	=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)
18+ ! on/off ! 1 ! 0 100 ! 0	0 ! 1 1 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2 2	0 0 0 2	
7-18	4 1 4 4 1 4 4 1 4 4 4 4 1 4 4 4 1 4 4 1 4 4 1 4 4 1	mg/kg*c 3910 4	mg/kg*day
2-6 yrs. 149374.551 R	180 5 16 0) 1 CF 0.0092	d) 4.236E-03 149374.551 3910 AD 0.1 180 5 CF 0.0092	8.281E-03
soil Ingestion cont. [] (mg/kg)(ppm) C consumption rt. (mg/day) CR	(2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) absorption factor (0-1) AF contaminated fraction (0-1)CF Transport multiplier TR	soil ingestion dose (mg/kg/d) 4.236E-03 Soil Dermal Exposure cont. [] (mg/kg) C skin surf. area(cm²/d) SA (child 3910 adult 3120) soil to skin adher. factor AD (1) (mg/cm²) absorption factor (0-1) AF exposure freq. (d/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) contaminated fraction (0-1) CF Transport multiplier TR 0.0092	soil dermal dose (mq/kq/d)

41 70	mg/kg*day = (CR*C/Kd*EF*ED*DF*AT*TR) / (BW*ED*365)	20 20 4 0 41 70	mg/kg*day = (IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	75 18150 4 0 41 70
Groundwater Consumption soil cont. [] (mg/kg) C 149374.551 Consumption rate (L/day) CR 1.4 Koc (L/kg) Organic Carbon Fraction Organic Carbon Fraction Organic Garbon Organic Garbo	water consumption exposure 9.400E+03 mg/	Inhalation of Vapors soil cont. [] (mg/Kg) C 149374.551 inhalation rt. (m³/day) IR 20 (child<18 20 adult 20 occ. 20) volat.factor(m³/kg) VF 26701.70 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 avg body wt. (kg) BW 16 absorption factor AF 0.5 Contaminated fraction (0-1)CF 0.5 Transport multiplier TR 0.0092	vapor inhalation dose 1.542E-02 mg/	Dermal Contact in Shower soil cont. [] (mg/kg) C 149374.551 Kd (L/kg) Kd 4.65 skin surface area (cm²) SA 7200 13175 (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 avg body wt (kg) BW Kp(derm. perm.) (cm/hr) 0.069 length of shower (hr/day) SL 0.2

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	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 2 0	y = (C/Kd*IR*EF*ED*SL*K*AF*AT*TR) / (BW*ED*365)	20	<pre>y = (IR*C*RF*PC*EF*ED*TR*1E-6) / (BW*ED*365)</pre>
ਜਜਜ	+02 mg/kg*day	 .551 4.65 0.6 350 5 4 0.2 16 41 0.5	E+01 mg/kg*day	20 20 0 0 .551 180 5 4 16 41	E+00 mg/kg*day
RI	1.913E+02	/hr) IR /r) EF s) ED (.2) SL	sure 5.776E+01	ates (7) IR 20 (9) m ³) AP 0 ion RF 6 C 149374.551 r) EF 180) ED 5 TR 18	ure 0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 149374.551 Kd (L/kg) inhalation rt.(0.6)(m³/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 51 shower length(hrs/day)(.2) SL 0.2 avg. body wt. (kg) BW 16 volat. factor (K)(.5 L/m³) 0.5 absorption factor AF 17 Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates inhalation rate (m³/day) IR (child<18 20 adult 20) air particulate [](mg/m³) AP respirable part. fraction RF part. cont [] (mg/kg) C exposure freq. (days/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW Transport multiplier TR	part. inhalation exposure

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NAPHTHALENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER 100 to 300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

0 ОН	0				****************	* Soil Concentration	*	* 240748.40 mg/kg	*	****************	.E-6) / (BW*ED*365)														R*1E-6)/(BW*ED*365)
! on/off TRANSPORT			! 0n/off EXPOSURE		soil	! 0 gwater cons.	! 1 inh. vap.	i o shower derm.	! 0 inh. shower	! 0 inh. part.	=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365								2						=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365
18+	•		100		0	70					lay			3120						0	70				
7-18	; I		100		4	41					mg/kg*day			3910						な	41				ma/ka*ċ
2-6 Vrs.		40748.397	200	90	Ŋ	16		-	0.5	0.0092	1		705 872076	3910	1 	Т		0.1	06	ហ	16		0.5	0.0092	6.673E-03 mg/kg*dav
Soil Ingestion		cont. [] (mg/kg)(ppm) C 2	consumption rt. (mg/day) CR 200 (2-6 200, >6 100)	exposure freq. (d/yr) EF	duration of exp. (yrs) ED	avg. body wt. (kg) BW	(2-6 16, 6-18 41, adult 70)	absorption factor (0-1) AF	contaminated fraction (0-1)CF	Transport multiplier TR	soil ingestion dose (mg/kg/d) 3.413E-03	Soil Dermal Exposure	C (24/24) [] +407		(child 3910 adult 3120)	soil to skin adher. factor AD	$(1) (mg/cm^2)$	absorption factor (0-1) AF	exposure freq. (d/yr) EF	exposure duration (yrs) ED	avg. body wt. (kg) BW	(2-6 16, 6-18 41, adult 70)	contaminated fraction (0-1)CF	Transport multiplier TR	soil dermal dose (ma/ka/d)

	(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 02	- Y	20	= <u>V</u> 1	18150 0 70
41	mg/kg*day	20 4 4 411	mg/kg*day	13175 18
soil cont. [] (mg/kg) C 240748.397 Consumption rate (L/day) CR 1.4 Koc (L/kg) Organic Carbon Fraction 0.005 exp. freq. (365) (days/yr) EF 350 exposure duration (yrs) ED 5 diet fraction (.75-1.0) DF 0.75 avg. body wt. (kg) BW 16 Attenuation factor AT 1	water consumption exposure 1.515E+04	Inhalation of Vapors soil cont. [] (mg/Kg) C 240748.397 inhalation rt. (m³/day) IR 20 (child<18 20 adult 20 occ. 20) volat.factor(m³/kg) VF 26701.70 exposure freq. (days/yr) EF 250 exposure duration (yrs) ED 5 avg body wt. (kg) BW 16 absorption factor AF 0.5 Transport multiplier TR 0.0092	e 1.775E-02	Dermal Contact in Shower soil cont. [] (mg/kg) C 240748.397 Kd (L/kg) Kd skin surface area (cm²) SA 7200 1 (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL 0.069

absorption factor AF Attenuation factor AT Transport multiplier TR	러 ল 러	
shower dermal dose	3.083E+02 mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower		
soil cont. [] (mg/kg) C 240748.397 Kd (L/kg) 4.65	240748.397 4.65	
inhalation rt. $(0.6) (m^3/hr)$ IR exposure freq. $(davs/vr)$ EF	0.6 350	
exposure duration (yrs) ED		0
shower length(hrs/day)(.2) shave, body wt. (kg) BW	16 41	7.0
ٺ	0.5	
Æ,	o. v.	
Attenuation ractor Ar Transport multiplier TR	ਜ ਜ	
shower inhalation exposure	9.309E+01 mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates		
inhalation rate (m³/day) IR	20 20	20
(child<18 20 adult 20)		
air particulate [](mg/m³) AP respirable part fraction RF	o ^o	
part. cont [] (mg/kg) C	240748.397	
exposure freq. (days/yr) EF	180	C
Ω	4	7.0
Transport multiplier TR	₽	
part. inhalation exposure	0.000E+00 mg/kg*day	=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SOIL EXPOSURE ONLY WITH SURFACE MULTIPLIER >300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=.5)

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 70	ay	20 0 70	ay	0 20 0 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20 0 20
41	mg/kg*day	20 4 41	mg/kg*day	3175 18150 4 41 7
426318.353 1.4 930 0.005 350 0.75 1	2.683E+04 r	26318.353 20) 26701.70 150 5 16 0.5 0.5	1.886E-02 r	26318.353 4.65 7200 1 350 0.069
soil cont. [] (mg/kg) C 4 Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C 4: inhalation rt. (m³/day) IR (child<18 20 adult 20 occ. volat.factor(m³/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C 4 Kd (L/kg) Kd skin surface area cm²) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

absorption factor AF Attenuation factor AT Transport multiplier TR	ਜਜਥ		
shower dermal dose	5.459E+02 mg	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C	426318.353		
	8 0.6		
exposure ireq. (days/yr) Er exposure duration (yrs) ED	350 5	4	0
_	SL 0.2		
avg. body wt. (kg) BW	16	41	70
volat. factor (K)(.5 L/m')	ر د د		
H) H		
Transport multiplier TR	П		
shower inhalation exposure	1.648E+02	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
inhalation rate (m³/day) IR	20	20	20
	0		
respirable part. fraction RF	0		
part. cont [] (mg/kg) C	426318,353		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	, ໝ		0 0
avg. body wt. (kg) bw Transport multiplier TR	1 1	ት	
•		5	
part. inhalation exposure	0.43000.0	mg/кд*аау	=(TX*C*KF*FC*EF*EC*TK*IE-6)/(BW*EC*365)

Secretary Secret

ACENAPHTHENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL) 0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE, SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

Soil Ingestion	2-6 yrs.	7-18	18+	on/off TRANSPORT	HQ 0.5	
cont. [] (mg/kg)(ppm) C 8.0425203	.04252033			: I Transport ! 0 Kd/Att. Fact	KIDO REDi	
consumption rt. (mg/day) CR	200	100	100	0	ion	
$(2-6\ 200, >6\ 100)$	1			תי		
exposure freq. (d/yr) EF	180	•	Ć			4.4.4.
duration of exp. (yrs) ED	2	4	0		* * * * * * * * * * * * * * * * * * *	* * * *
avg. body wt. (kg) BW	16	41	70	! 1 gwater cons	 * Soil Concentration 	*
(2-6 16, 6-18 41, adult 70)				! 1 inh. vap.	*	*
absorption factor (0-1) AF	⊣			**	. * 8.0425 mg/kg	*
contaminated fraction (0-1)CF	0.5			! 1 inh. shower	*	*
Transport multiplier TR	0.039			! 0 inh. part.	*******	***
soil ingestion dose (mg/kg/d) 9	9.668E-07	mg/kg*day	lay	=(C*CR*EF*ED*AF*CF*TR*1E-6)	R*1E-6)/(BW*ED*365)	
Soil Dermal Exposure						
•	0.000000000000000000000000000000000000					
		,				
skin surf. area(cm2/d) SA (child 3910 adult 3120)	3910	3910	3120			
soil to skin adher. factor AD	H					
(1) (mg/cm2)						
absorption factor (0-1) AF	0.1					
exposure freq. (d/yr) EF	180					
exposure duration (yrs) ED	വ	4	0			
avg. body wt. (kg) BW	16	41	7.0			
(2-6 16, 6-18 41, adult 70)						
contaminated fraction (0-1)CF	0.5					
Transport multiplier TR	0.039					
soil dermal dose (mg/kg/d)	1.890E-06	6 mg/kg*dav	720	=/C*SA*AD*AF*EF*ED*C	=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)	
		6/6	7			

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)			=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)		
0 20		20	70	day	18150 0 70	
, 4 4 L		20	4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4	mg/kg*day	13175	
8.04252033 8.04252033 4571 0.005 350 5 0.75	-	8.04252033 20 20)	25807.58 350 350 5 16 0.5	3.642E-06	8.04252033 22.855 7200 350 16 0.146	
C ay) CR on (yr) EF s) ED	Attenuation factor AT Transport multiplier TR Water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ.	volat.factor(m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL	

	1Y = (C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)	0 2 .	day =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)	20 0 70 :day =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
1 1 0.0641	4.434E-03 mg/kg*day	8.04252033 22.855 ER 0.6 350 5 4 3L 0.2 16 41 0.5 0.5	6.327E-04 mg/kg*day	20 20 0 0 8.04252033 180 4 16 41 16 41 0.000E+00 mg/kg*day
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW volat. factor (K)(.5 L/m3) absorption factor AF Attenuation factor AF Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates

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ACENAPHTHENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL) 100 to 300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE, SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

Soil Ingestion	2-6 yrs.	7-18	18+	on/off TRANSPORT	HQ 0.5
cont. [] (ma/ka) (ppm) C	300.436464			: I Transport ! 0 Kd/Att. Fact.	
consumption rt. (mg/day) CR	200	100	100		
(2-6 200, >6 100)				t A	-
exposure freq. (d/yr) EF				soil	
duration of exp. (yrs) ED	5	4	0	! 1 soil derm.	***************
avg. body wt. (kg) BW		41	70	! 1 gwater cons.	* Soil Concentration *
(2-6 16, 6-18 41, adult 70)	0)			! 1 inh. vap.	*
absorption factor (0-1) AF				i 1 shower derm.	* 300.4365 mg/kg *
contaminated fraction (0-1)				! 1 inh. shower	*
Transport multiplier TR	0.039			! 0 inh. part.	****************
soil ingestion dose (mg/kg/d) 1.806E-05 mg/kg*day	d) 1.806E-05	mg/kg*da		=(C*CR*EF*ED*AF*CF*TR*1E-6)	E-6)/(BW*ED*365)
Soil Dermal Exposure					
COURT [] (IIII) C	****		(
skin surf. area(cm2/d) SA (child 3910 adult 3120)	3910	3910	3120		
	AD 1				
(1) (mq/cm2)					
absorption factor (0-1) AF	0.1				
exposure freq. (d/yr) EF	06				
exposure duration (yrs) ED	വ	4	0		
avg. body wt. (kg) BW	16	41	70		
(2-6 16, 6-18 41, adult 70)	(0				
contaminated fraction (0-1)					
Transport multiplier TR	0.039				
soil dermal dose (ma/ka/d)	3.530E-05 mg/kg*dav	ma/ka*da		=(C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365)	R*1E-6)/(BW*ED*365)
1-16-16-1 ACON TANK TOO	The second secon	C == 1 C			

0 20	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)	20 0 70	=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365) 50 0 70
·	day		
4 1	mg/kg*day	2	mg/kg*day 13175 181 4
300.436464 1.4 4571 0.005 350 5 0.75 16	3.233E-02	300.436464 20 20) 25807.58 250 250 250 0.5	9.718E
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	(mg/Kg) C (m3/day) IR o adult 20 occ. m3/kg) VF (days/yr) EF tion (yrs) ED (kg) BW ctor AF fraction (0-1)CF	

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absorption factor AF Attenuation factor AT Transport multiplier TR	1 1 0.00171	
shower dermal dose	1.656E-01 mg/kg*day	/ =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower		
soil cont. [] (mg/kg) C 300.43	300.	
<pre>Kd (L/kg) inhalation rt (0.6)(m3/hr) TR</pre>	22.	
exposure freq. (days/yr) EF		
exposure duration (yrs) ED	5 5 4	0
snower lengtn(nrs/day)(.2) Sava. bodv wt. (kg) BW	25 U.2 16 41	70
volat. factor (K) (.5 L/m3)		
absorption factor AF	0.5	
ΑT		
Transport multiplier TR	0.00171	
shower inhalation exposure	2.363E-02 mg/kg*day	ay =(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates		
	• (• (• • • • • • • • • • • • • • • •	
inhalation rate (m3/day) וא (קב) (מכ †ניקה)		0.7
air particulate [](mg/m3) AP	0	
respirable part. fraction RF	0	
part. cont [] (mg/kg) C 30	300.436464	
exposure ireq. (ddys/yr) br exposure duration (yrs) FD		
	4	20
Transport multiplier TR	H	
part. inhalation exposure	0.000E+00 mg/kg*day	lay =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

RECORD RE

ACENAPHTHENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL)

>300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE,

SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)	20 0 70	=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	50 0 70
0 70	day	2 6	day	18150 0 70
4 4	mg/kg*day	20 4 4 411	mg/kg*day	13175
51874.9207 1.4 4571 0.005 350 0.75 0.75 6.440E-06	2.102E-02	51874.9207 20) 20) 25807.58 150 16 0.5	1.007E-02	51874.9207 22.855 7200 350 16 0.146
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C 5 inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. 2 volat.factor(m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

absorption factor AF Attenuation factor AT Transport multiplier TR	1 1 6.440E-06		
shower dermal dose	2.860E+01 mg/kg*day		=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C 51874.9207	51874.9207		
<pre>Kd (L/kg) inhalation rt. (0.6)(m3/hr) IR</pre>	22.855 R 0.6		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED		0	
shower length(hrs/day)(.2) S avg body wt (kg) RW	SL 0.2 16 41	70	
volat. factor (K)(.5 L/m3)			
absorption factor AF	0.5		
r AT			
Transport multiplier TR	6.440E-06		
shower inhalation exposure	4.081E+00 mg/kg*day	y*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
	• • • • • • • • • • • • • • • • • • • •		
inhalation rate (m3/day) IR	20 20	20	
alr particulate [](mg/ms) Ar			
respirable pair. iracrion or	51874.920		
exposure fred. (days/yr) EF	180		
exposure duration (yrs) ED			
avg. body wt. (kg) BW	16 41	1 70	
Transport multiplier TR	.		
part. inhalation exposure	0.000E+00 mg/kg	mg/kg*day	=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL)

0 to 100 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE,
SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

Soil Ingestion 2-6 yrs.	7-18	18+	! on/off TRANSPORT	6.0 ОН
•	•	•		RfDo 0.04
cont. [] (mg/kg)(ppm) C 1./8409869 consumption rt. (mg/day) CR 200	0 100	100	: 0 Na/Art. Fact.	
			! on/off EXPOSURE	
exposure freq. (d/yr) EF 180	0			
Ω	5 4	0		**************
-	6 41	70	! 1 gwater cons.	* Soil Concentration *
(2-6 16, 6-18 41, adult 70)				*
	ı		i 1 shower derm.	* 1.7841 mg/kg *
	5		! 1 inh. shower	*
Transport multiplier TR 0.0092	2		o inh. part.	**************
soil ingestion dose (mg/kg/d) 5.059E-08 mg/kg*day	8 mg/kg*		=(C*CR*EF*ED*AF*CF*TR*1E-6)/(BW*ED*365	E-6)/(BW*ED*365)
Soil Dermal Exposure				
1.7840	• 0			
skin surf. area(cm2/d) SA 3910	0 3910	3120		
(child 3910 adult 3120)				
soil to skin adher. factor AD	T			
	н			
exposure freq. (d/yr) EF 180	0			
	5 4	0		
	6 41	70		
contaminated fraction (0-1)CF 0.5	5			
Transport multiplier TR 0.0092	2			
soil dermal dose (mg/kg/d) 9.890E-08 mg/kg*day	8 mg/kg*		= (C*SA*AD*AF*EF*ED*CF*TR*1E-6) / (BW*ED*365)	R*1E-6) / (BW*ED*365)

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)		=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	аУ	20 0 70	аÿ	18150 0 70
4 T	mg/kg*day	20 4 4 1	mg/kg*day	13175 1
1.78409869 1.4 930 0.005 350 350 16 16	2.403E-02	1.78409869 20) 20) 26701.7 350 5 16 0.5	1.842E-07	1.78409869 4.65 7200 350 350 16 0.069
soil cont. [] (mg/kg) C Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/Kg) C 1 inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. 2 volat.factor(m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

absorption factor AF Attenuation factor AT Transport multiplier TR	1 1 0.214		
shower dermal dose	2.285E-03 mg	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C	1.78409869		
<pre>Kd (L/kg) inhalation rt.(0.6)(m3/hr) I</pre>	4		
exposure freq. (days/yr) EF	350		
exposure duration (yrs) ED		4	0
shower length(hrs/day)(.2) S	SL 0.2	7	O'E
avg. body wt. (rg) bw volat. factor (K)(.5 L/m3)	0.5	 	
absorption factor AF	0.5		
Attenuation factor AT	Н		
Transport multiplier TR	0.214		
shower inhalation exposure	6.898E-04 n	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)
Inhalation of Particulates			
inhalation rate (m3/day) IR	20	20	20
(child<18 20 adult 20)			
respirable part. fraction RF			
part. cont [] (mg/kg) c exposure freq. (days/yr) EF	1./6409669		
exposure duration (yrs) ED	ເດ	4	0
avg. body wt. (kg) BW	16	41	70
Transport multiplier TR	H		
part. inhalation exposure	0.000E+00 r	mg/kg*day	- (IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

NAPHTHALENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL) 100 to 300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE, SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

ÕH		\ <i>T</i> \	ingest.	soil derm. ******	<pre>1 gwater cons. * soll concentration 1 inh. vap. *</pre>		1 inh. shower * 0 inh. part. ************************************
+ 8 +		00T			0/	·•	
2-6 yrs. 7-18	9641196	007 002			16 41	Н	0.5
Soil Ingestion	:	consumption rt. (mg/day) CK (2-6 200, >6 100)	exposure freq. (d/yr) EF	duration of exp. (yrs) ED	avg. body wt. (kg) BW $(2-6.16.6-18.41.30)$	absorption factor (0-1) AF	contaminated fraction (0-1)CF Transport multiplier TR

	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)			=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	
0 20	lay	20	70	lay	18150 0 70
4 41	mg/kg*day	20	4 4	mg/kg*day	13175 1
66.9641196 1.4 930 0.005 350 350 0.75 0.75	2.402E-02	66.9641196	26701.7 250 250 5 16 0.5 0.5	4.938E-06	66.9641196 4.65 7200 350 0.069
soil cont. [] (mg/kg) C 66. Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365)(days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure	soil cont. [] (mg/Kg) C 6 inhalation rt. (m3/day) IR	volat.factor(m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

	' =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)					0	70					ay = $(C/Kd*IR*EF*ED*SL*K*AF*AT*TR)/(BW*ED*365)$			20					0	70		ay =(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)
	mg/kg*day					4	41					mg/kg*day			50					4	41		mg/kg*day
1 1 0.0057	8.575E-02 mg		66.9641196			T.		0.5	0.5	-	0.0057	2.589E-02		•	20	0		66.9641196	180	വ	16	Ħ	0.000E+00
absorption factor AF Attenuation factor AT Transport multiplier TR	shower dermal dose	Inhalation in Shower	soil cont. [] (mg/kg) C 66.9	na (47/89) inhalation rt.(0.6)(m3/hr) IR	exposure freq. (days/yr) EF	exposure duration (yrs) ED	avg. body wt. (kg) BW	volat. factor (K) (.5 L/m3)	absorption factor AF	ΑI	Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates		inhalation rate (m3/day) IR (child<18 20 adult 20)	air particulate [](mg/m3) AP	respirable part. fraction RF	part. cont [] (mg/kg) C	exposure freq. (days/yr) EF	exposure duration (yrs) ED	avg. body wt. (kg) BW	Transport multiplier TR	part. inhalation exposure

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NAPHTHALENE RESIDENTIAL CHILD, SAND, SOIL AND GROUNDWATER EXPOSURE (SESOIL)

2300 METERS FROM THE SITE, 9-YEAR EXPOSURE (HI=0.5) 700 DAY HALF-LIFE,

SOIL AND GROUNDWATER MULTIPLIERS, 1 METER GW MIXING DEPTH

Soil Indestion	2-6 Vrs.	7-18	18+	on/off TRANSPORT	ОН	0.5
	100000				RfDo	0.04
conc. [] (mg/kg)(ppm) C 1/046.0 consumption rt. (mg/day) CR	1/040.002/	100	100		1	, ,
(2-6 200, >6 100)				EXPOS		
exposure freq. (d/yr) EF	4					
duration of exp. (yrs) ED		4	0	! 1 soil derm.	*****	******
avg. body wt. (kg) BW	16	41	70	! 1 gwater cons.	* Soil Concentration	cration
(2-6 16, 6-18 41, adult 70)				! 1 inh. vap.	*	
absorption factor (0-1) AF					* 17048.08 r	mg/kg
contaminated fraction (0-1)CF				! 1 inh. shower	*	
Transport multiplier TR	0.0092			! 0 inh. part.	*********	*******
soil ingestion dose (mg/kg/d) 1.209E-04	1.209E-04	mg/kg*day		=(C*CR*EF*ED*AF*CF*TR*1E-6),	E-6)/(BW*ED*365	5)
Soil Dermal Exposure						
cont. [] (mg/kg) C 17048.0	17048.0827					
skin surf. area(cm2/d) SA	3910	3910	3120			
(child 3910 adult 3120)						
soil to skin adher. factor AD	0					
(1) (mg/cm2)						
absorption factor (0-1) AF	0.1					
exposure freq. (d/yr) EF	45					
exposure duration (yrs) ED		4	0			
avg. body wt. (kg) BW	16	41	70			
(2-6 16, 6-18 41, adult 70)	_					
contaminated fraction (0-1)CF						
Transport multiplier TR	0.0092					
soil dermal dose (mg/kg/d)	2.363压-04	mg/kg*day	lay	= (C*SA*AD*AF*EF*ED*CF*TR*1E-6)/(BW*ED*365	R*1E-6)/(BW*ED	k365)

* * * * * *

0 20	=(CR*C/Kd*EF*ED*DF*AT*TR)/(BW*ED*365)	20	0 2 0	=(IR*C*1/VF*EF*ED*AF*CF*TR)/(BW*ED*365)	50 0 70
7	lay	7	7	lay	18150 0 70
4 4	mg/kg*day	20	4 T	mg/kg*day	13175 1
17048.0827 1.4 930 0.005 350 350 16 0.75 16	2.307E-02	17048.0827 20 20) 26701.7 150	5 16 0.5 0.5 0.5	7.543E-04	17048.0827 4.65 7200 350 350 0.069
soil cont. [] (mg/kg) C 1 Consumption rate (L/day) CR Koc (L/kg) Organic Carbon Fraction exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW Attenuation factor AT Transport multiplier TR	water consumption exposure Inhalation of Vapors	C IR OCC.	exposure duration (yrs) ED avg body wt. (kg) BW absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW Kp(derm. perm.) (cm/hr) length of shower (hr/day) SL

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absorption factor AF Attenuation factor AT Transport multiplier TR	1 1 0.0000215		
shower dermal dose	2.183E+01 mg/	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*TR*0.001)/(BW*ED*365)
Inhalation in Shower			
soil cont. [] (mg/kg) C 170	17048.0827		
κα (L/Kg) inhalation rt.(0.6)(m3/hr) IR	4.63 R 0.6		
exposure freq. (days/yr) EF			,
exposure duration (yrs) ED	ST. 0.2	7	0
		41	70
volat. factor (K) (.5 L/m3)	0.5		
absorption factor AF	0.5		
Attenuation factor AT Transport multiplier TR	1 0.0000215		
	_	11eb*24/2m	(596*Q3*M8)/(4m*m6*36*X*15*Q3*43*45*A7/)/=
SHOWEL THINGTACTON EXPOSUTE	・シングを正すいい	9/ hy "day	
Inhalation of Particulates		•	
	• • • • • • • • • • • • • • • • • • • •	,	
inhalation rate (m3/day) IR (child<18 20 adult 20)	20	20	20
air particulate [](mg/m3) AP	0		
respirable part. fraction RF			
part. cont [] (mg/kg) C	17048.0827		
exposure freq. (days/yr) EF	180		
exposure duration (yrs) ED	្ន	4 ;	0
3	16	4.	70
Transport multiplier TR			
part. inhalation exposure	0.000E+00 m	mg/kg*day	=(IR*C*RF*PC*EF*ED*TR*1E-6)/(BW*ED*365)

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+	on/off	TRANSPORT	10.T
cont. [] (mg/kg)(ppm) C 0 consumption rt. (mg/day) CR	0.33077387	100	100	0 10		Inh. Slope 6.1
exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. bodv wt. (kg) BW	180 5 16	4 4	0 70	on/off 0 0	EXPOSURE soil ing.	**************************************
(2-6 16, 6-18 41, adult 70) avg. life expectancy (74.6) L				-0		* 0.33077 mg/kg * *
contaminated fraction (0-1) CF Transport multiplier TR	0 .51			400	inh.	**************
soil ingestion dose (mg/kg/d)	7.282E-08	mg/kg*day	day	=(c*cR	=(C*CR*EF*ED*AF*CF*1E-6)	·6)/(BW*L*365)
Soil Dermal Exposure						
•	0.33077387		•			
skin surf. area(cm2/d) SA (child 3910 adult 3120)	3910	3910	3120			
soil to skin adher. factor AD	Н					
absorption factor (0-1) AF						
exposure freq. (d/yr) EF	180 5		C			
exposure duración (713) 25 ava. bodv wt. (kg) BW	Н	4	70			
(2-6 16, 6-18 41, adult 70)						
lifetime (74.6) L						
contaminated fraction (0-1)CF Transport multiplier TR	0. 1					
soil dermal dose (mg/kg/d)	.424E-07	mq/kq*day	ʻday	=(C*SA	= (C*SA*AD*AF*EF*ED*CF*1E-6),	:1E-6)/(BW*L*365)

	= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
0 40	day	20 0 70	day	18150 0 70
4 7 4	mg/kg*day	20 4 4 411	mg/kg*day	13175
0.33077387 1.4 27500 350 350 0.75 0.65	3.514E-08	0.33077387 20 20) 5.48E+07 350 350 16 70 0.5	1.291E-10	0.33077387 27500 7200 5 350
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

2 1 5 1	8 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	7 0 0 5 4 0 6 41 70 5 5 5	9 $mg/kg*day = (C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)$	20 20 4 0 41 70	0 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)
Kp(derm. perm. const.)(cm/hr) 1.2 length of shower (hr/day) SL 0.2 absorption factor AF Attenuation factor (0-1) AT 0.65 Transport multiplier TR	shower dermal dose 5.783E-08	Inhalation in Shower soil cont. [] (mg/kg) C 0.33077387 Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 shower length(hrs/day)(.2) SL 0.2 avg. body wt. (kg) BW 16 lifetime (74.6) L 70 volat. factor (K)(.5 L/m3) 0.5 absorption factor AF 0.5 Attenuation factor (0-1) AT 0.65 Transport multiplier TR	shower inhalation exposure 1.004E-09	S AP AP O EFF O	part. inhalation exposure 0.000E+00

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BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

storene Gaptor

Risk Level 1.0E-06 Oral Slope 7.3 r Inh. Slope 6.1 ************ *Soil Concentration* * 3.31E+05 mg/kg * * ********************************	E-6)/(BW*L*365)	F*1E-6)/(BW*L*365)
on/off TRANSPORT 0 SESOIL 1 Kd/Att. Factor 0 No Attenuation on/off EXPOSURE 0 soil ing. 0 soil ing. 1 gwater cons. 0 inh. vap. 1 derm. gwater 0 inh. shower 0 inh. part.	\sim 1	=(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365
0 00	и	0)=
ત્ન	*day 3120	*day
7-18 100 4 41	mg/kg*day 3910 31	mg/kg*day
2-6 yrs 330773.87 200 90 5 16 70 70	.641E-02 30773.87 3910 1 0.1 90 90 90 70 70	.118E-02
soil Ingestion cont. [] (mg/kg)(ppm) C consumption rt. (mg/day) CR (2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) avg. life expectancy (74.6) L absorption factor (0-1) AF contaminated fraction (0-1) CF Transport multiplier TR	(mg/kg/d) d) SA 3120) factor AD -1) AF rs) ED w adult 70) n (0-1) CF	soil dermal dose (mg/kg/d)

	=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)		= (IR*C*1/VF*EF*ED*AF*CF) / (BW*L*365)	
70	day	20 20 20	day	18150 0 70
4 4	mg/kg*day	20 4 4 11	mg/kg*day	13175
330773.87 1.4 27500 350 350 6.75 16 70 6.500E-07	3.514E-08	330773.87 20 20) 5.48E+07 5.0 250 250 0.5 0.5	9.222E-05	330773.87 27500 7200 350
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. 2 volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	0 70 =(C/Kd*IR*EF*ED*SL*K*AF*AT)/0 0 70	mg/kg*day = (IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)
1.2 0.2 1 6.500E-07	5.783E-08 n	•	0.000E+00 r
<pre>Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR</pre>	shower dermal dose	SI S	part. inhalation exposure

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, ≥300 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300-DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+	on/off	TRANSPORT	Risk Level 1.0E-06
•	330773.87			0 1	SESOIL Kd/Att. Factor	Oral Slope 7.3 Inh. Slope 6.1
consumption rt. (mg/day) CR (2-6 200, >6 100)		100	100	0	No Attenuation	
exposure freq. (d/yr) EF	4			on/off		
duration of exp. (yrs) ED		4	0	0 (soil ing.	*
avg. body wt. (kg) BW	16	41	70	0 ,	soll derm.	*SOIL CONCENTRATION*
(2-6 16, 6-18 41, adult /0)				I C	Ψ	2 15 15 10 10 10 10 10 10 10 10 10 10 10 10 10
avg. life expectancy (/4.6) L) r	dorm diator	3.31E+U3 1119/A9
absorption factor (0-1) Ar	- C			- C	U.	*****
Transport multiplier TR				0		
soil ingestion dose (mg/kg/d)	1.821E-02	mg/kg*day	дау	=(C*CR	=(C*CR*EF*ED*AF*CF*1E-6)	·6)/(BW*L*365)
Soil Dermal Exposure						
:	•					
	330773.87					
skin surf. area(cm2/d) SA	3910	3910	3120			
(Cilian 3210 addic 3120)	•					
	1					
absorption factor (0-1) AF	0.1					
exposure freq. (d/yr) EF	45					
exposure duration (yrs) ED	S	4	0			
avg. body wt. (kg) BW	16	41	70			
(2-6 16, 6-18 41, adult 70)						
lifetime (74.6) L	70					
contaminated fraction (0-1)CF	0.5					
Transport multiplier TR	H					
soil dermal dose (mg/kg/d)	3.559E-02	mg/kg*day	day	= (C*SA	=(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365	1E-6) / (BW*L*365)
					•	

	=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
70	day	20 0 700	day	18150
4 4	mg/kg*day	20 4 4 11	mg/kg*day	13175
330773.87 1.4 27500 350 5 0.75 16 70 6.500E-07	3.514E-08	330773.87 20 20) 5.48E+07 150 5 16 70 0.5	5.533E-05	330773.87 27500 7200 350 5 16
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

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5.783E-08 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)
                                                                                                                                                                                                                                                                                                                                                                                                                                                           =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  70
                                                                                                                                                                                                                                                                                                                       70
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     0.000E+00 mg/kg*day
                                                                                                                                                                                                                                                                                                                                                                                                                                                               1.004E-09 mg/kg*day
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             20
                                                                                                                                                                                                                                          350
                                                                                                                                                                                                                                                                                                                                                             0.5
1.2
                                                         6.500E-07
                                                                                                                                                                                       330773.87
                                                                                                                                                                                                                        27500
                                                                                                                                                                                                                                                                                                                                                                                                   6.500E-07
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          330773.87
                                                                                                                                                                                                                                                       exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW lifetime (74.6) L
                                                                                                                                                                                                                                         inhalation rt.(0.6)(m3/hr) IR
 Kp(derm. perm. const.)(cm/hr)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   air particulate [](mg/m3) AP respirable part. fraction RF
                   length of shower (hr/day) SL
                                                          Attenuation factor (0-1) AT
                                                                                                                                                                                                                                                                                                                                                                                                     Attenuation factor (0-1) AT
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              inhalation rate (m3/day) IR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              (days/yr) EF
                                                                                                                                                                                                                                                                                                                                                                                                                                                              shower inhalation exposure
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      Inhalation of Particulates
                                                                                                                                                                                                                                                                                                                                                             volat. factor (K) (.5 L/m3)
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     part. inhalation exposure
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          part. cont [ ] (mg/kg) C
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               (child<18 20 adult 20
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                Pransport multiplier TR
                                                                            Transport multiplier TR
                                                                                                                                                                                                                                                                                                                                                                                                                       Fransport multiplier TR
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  exposure duration (yrs)
                                                                                                                                                                                                   soil cont. [ ] (mg/kg)
                                                                                                                                                                                                                                                                                                                                                                                  absorption factor AF
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    avg. body wt. (kg) BW
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          absorption factor AF
                                      absorption factor AF
                                                                                                                                                             Inhalation in Shower
                                                                                                                     shower dermal dose
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        lifetime (74.6) L
                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              exposure freg.
                                                                                                                                                                                                                      Kd (L/kg)
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BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

3.376E
contaminated fraction (0-1)CF 0.5 Transport multiplier TR 1

	= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)			=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
0 40 40 40 40 40 40 40 40 40 40 40 40 40	ay	20	70	ay	18150 0 70
4 1 4	mg/kg*day	20	4 4 1	mg/kg*day	13175 1
0.15334116 1.4 1000 350 350 0.75 16 70	4.480E-07	•40 41	350 16 70 0.5	4.551E-10	0.15334116 1000 7200 350 5
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Vapors (mg/kg) C (m3/day) IR adult 20 occ.	exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C 0. Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	4 0 41 70	mg/kg*day = (C/Kd*IR*EF*ED*SL*K*AF*AT) / (BW*L*365)	20 20 4 0 41 70	mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)
0.81 0.2 0.65	4.977E-07	0.15334116 1000 0.6 350 5 0.2 16 70 0.5 0.5	1.280E-08	0 0.15334116 180 16 70 0.5	0.000E+00
<pre>Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR</pre>	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6) (m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K)(.5 L/m3) absorption factor AF Attenuation factor TR	shower inhalation exposure	Inhalation of Particulates	part. inhalation exposure

BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Risk Level 1.0E-06 Oral Slope 0.73 r Inh. Slope 0.61	**************** *Soil Concentration* * 1.53E+05 mg/kg * * ********************************	E-6)/(BW*L*365)		F*1E-6)/(BW*L*365)
on/off TRANSPORT 0 SESOIL 1 Kd/Att. Factor 0 No Attenuation	on/off EXPOSURE 0 soil ing. 0 soil derm. 1 gwater cons. 0 inh. vap. 1 derm. gwater 0 inh. shower 0 inh. part.	=(C*CR*EF*ED*AF*CF*1E-6)		=(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365
18+	70	day	3120	day
7-18	41	mg/kg*day	3910 4 41	mg/kg*day
2-6 yrs 153341.157 200	90 5 16 70 70 0.5	1.688E-02	41.157 3910 0.1 90 5 16 70 70	3.300E-02
soil Ingestion cont. [] (mg/kg)(ppm) C 1 consumption rt. (mg/day) CR	(2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) avg. life expectancy (74.6) L absorption factor (0-1) AF contaminated fraction (0-1) CF Transport multiplier TR	soil ingestion dose (mg/kg/d)	AD AD (70)	soil dermal dose (mg/kg/d)

	. 0		= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)		0	70		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)			50	0 70	
	4 H		mg/kg*day	20 2	4			mg/kg*day			5 181	4 7	•
•	4		mg/k			4		mg/k		•	1317	4	
153341.157 14 1000	550 5 0.75 16	6.500E-07	4.480E-07	153341.157	20) 7212513.43 250 5	16 70 0.5	0	3.250E-04		153341.157 1000	7200	350 5 16	70
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd	exp. rreq. (365)(days/yr) Er exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW	Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vaporssoil cont. [] (mg/kg) C inhalation rt. (m3/day) IR	<pre>(child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (vrs) ED</pre>		contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower	soil cont. [] (mg/kg) C Kd (L/kg) Kd	17	exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW	lifetime (74.6) L

PRINCES - NAME OF THE PRINCES - NAME OF THE

Kp(derm. perm. const.)(cm/hr)length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	1r) 0.81 3L 0.2 1 1 F 6.500E-07		
shower dermal dose	4.977E-07	mg/kg*day	<pre>y =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)</pre>
Inhalation in Shower	:	_	
<pre>soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6)(m3/hr)</pre>	153341.157 1000 IR 0.6		
exposure freq. (days/yr) Elexposure duration (yrs) ED	<u>.</u>	4	0
avg. body wt. (kg) BW lifetime (74.6) I.		41	70
volat. factor (K) (.5 L/m3)	000		
Attenuation factor (0-1) AT Transport multiplier TR	9		
shower inhalation exposure	1.280E-08	mg/kg*day	y = (C/Kd*IR*EF*ED*SL*K*AF*AT) / (BW*L*365)
Inhalation of Particulates			
inhalation rate (m3/day) IR (child<18 20 adult 20)	3 20	. 20	20
[](mg/m3) fraction	AP 0		
part. cont [] (mg/kg) C	153341.1		
exposure ireq. (days/yr) Er exposure duration (vrs) ED		4	0
	16	41	70
lifetime (74.6) L	70		
·~) H		
part. inhalation exposure	0.000E+00	mg/kg*day	<pre>y =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)</pre>

BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, >300 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18 18+	+ on/off		Level 1.0
•	153341.157			1 Kd/Att. Factor	Inh. Slope 0.61
consumption rt. (mg/day) CR	200	100 1	100	0 No Attenuation	
exposure fred. (d/yr) EF	45)uo	on/off EXPOSURE	
duration of exp. (vrs) ED	ល	4	0		************
avg. body wt. (kg) BW	-	41	70	soil	*Soil Concentration*
(2-6 16, 6-18 41, adult 70)				1 gwater cons.	*
avg. life expectancy (74.6) L	7.0				* 1.53E+05 mg/kg *
absorption factor (0-1) AF				derm.	*
contaminated fraction (0-1)CF	•			inh.	*******
Transport multiplier TR	н			0 inh. part.	
soil ingestion dose (mg/kg/d)	8.440E-03	mg/kg*day)=	(C*CR*EF*ED*AF*CF*1E-6)/(BW*L*365	I-6)/(BW*L*365)
Soil Dermal Exposure					
:	• [•]				
cont. [] (mg/kg) c skin surf. area(cm2/d) SA	153341.157 3910	3910 31	3120		
(child 3910 adult 3120)					
soil to skin adher. factor AD	Н				
(1) (mg/cm2)					
absorption factor (0-1) AF	0.1				
exposure freq. (d/yr) EF	45				
exposure duration (yrs) ED		4	0		
avg. body wt. (kg) BW	16	41	70		
(2-6 16, 6-18 41, adult 70)					
lifetime (74.6) L					
contaminated fraction (0-1)CF	0.5				
Transport multiplier TR	Ħ				
soil dermal dose (mg/kg/d)	1.650E-02	mg/kg*day) =	= (C*SA*AD*AF*EF*ED*CF*1E-6) / (BW*L*365)	*1E-6)/(BW*L*365)
And the second s	The state of the s				

	= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)		
0 20	lay	20 20 70	lay	18150	0 20
4 4	mg/kg*day	20 4 4 411	mg/kg*day	13175 1	4 4 1
153341.157 1.4 1000 350 350 6.500E-07	4.480E-07	153341.157.20 20) 7212513.43 7212513.43 160 70 70 70 70	1.950E-04	153341.157 1000 7200 5	350 5 16 70
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors	vapor inhalation dose	Dermal Contact in Shower	exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+	on/off	TRANSPORT	Level 1
•	15.3341157			0 11	SESOIL Kd/Att. Factor	Oral Slope 0.0073 Inh. Slope 0.0061
consumption rt. (mg/day) CR (2-6 200, >6 100)	200	100	100	0	No Attenuation	
exposure freq. (d/yr) EF	18			on/off	rn -	
duration of exp. (yrs) ED		4	0	0		************
avg. body wt. (kg) BW	16	41	70	0 ,	soil derm.	Soil Concentration
(2-6 16, 6-18 41, adult 70)				Η,	gwater cons.	
avg. life expectancy (74.6) L	7			0	>	15.33412 mg/kg
absorption factor (0-1) AF				- l∫		*
contaminated fraction (0-1)CF	0			00	inh. shower	*************
ranspor mairibire in				•		
soil ingestion dose (mg/kg/d)	3.376E-06	mg/kg*day	day	=(C*CR;	=(C*CR*EF*ED*AF*CF*1E-6)	-6)/(BW*L*365)
Soil Dermal Exposure						
:						
	15.334115/	(
skin surf. area(cm2/d) SA האיז איזור איזור איזור איזור איזור איזור (כבולה)	3910	3910	3120			
(CILLA 3910 AUGIC 3120)	***					
	4					
absorption ractor (0-1) Ar	1.0					
exposure ired. (a/yr) Er	787 780	•	•			
exposure duration (yrs) ED	വ	4	-			
avg. body wt. (kg) BW	16	41	70			
(2-6 16, 6-18 41, adult 70)						
lifetime (74.6) L	70					
contaminated fraction (0-1)CF	0.5					
Transport multiplier TR	7					
soil dermal dose (mg/kg/d)	6.600E-06	mg/kg*day	day	=(C*SA)	=(C*SA*AD*AF*EF*ED*CF*1E-6)	*1E-6)/(BW*L*365)

	=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
0 20		20 20 70		18150
4 1	mg/kg*day	20 4 4 11	mg/kg*day	13175 4 41
15.3341157 1.4 1000 350 350 0.75 0.75	4.480E-05	15.3341157 20 20) 7038701.01 350 350 16 70 0.5	4.663E-08	15.3341157 1000 7200 5 350 16 70
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13179 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365	4 0 41 70	mg/kg*day = (C/Kd*IR*EF*ED*SL*K*AF*AT) / (BW*L*365)	20 20 4 4 0 41 70	mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)
0.81 0.2 0.65	4.977E-05 I	15.3341157 1000 R 0.6 350 5 IL 0.2 16 70 0.5 0.5	1.280E-06 r	20 20 15.3341157 180 16 70 0.5	0.000E+00 n
<pre>Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR</pre>	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K)(.5 L/m3) absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates inhalation rate (m3/day) IR (child<18 20 adult 20) air particulate [](mg/m3) AP respirable part. fraction RF part. cont [] (mg/kg) C exposure freq. (days/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW lifetime (74.6) L absorption factor AF Transport multiplier TR	part. inhalation exposure

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE, 9.5 GW METER MIXING DEPTH

cont. [] (mg/kg)(ppm) C 15334115 consumption rt. (mg/day) CR 2 (2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70)					OF SOTT	
<pre>consumption rt. (mg/day) CR (2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70)</pre>	4115./			1 K	Kd/Att. Factor	Inh. Slope 0.0061
exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70)	200	100	100		No Attenuation	
duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70)	90			on/off E		
avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70)	വ	4	0		soil ing.	*
(2-6 16, 6-18 41, adult 70)	16	41	70			*Soil Concentration*
				1 g	gwater cons.	*
avg. life expectancy (74.6) L	7.0				inh. vap.	* 1.53E+07 mg/kg *
absorption factor (0-1) AF	Н			_	derm. gwater	*
contaminated fraction (0-1)CF	0.5				inh. shower	************
Transport multiplier TR	Н			-T	inh. part.	
soil ingestion dose (mg/kg/d) 1.6	1.688E+00	mg/kg*day	day	=(C*CR*E	=(C*CR*EF*ED*AF*CF*1E-6),	·6)/(BW*L*365)
Soil Dermal Exposure						
cont. [] (mg/kg) C 153341	4115.7					
	3910	3910	3120			
(child 3910 adult 3120)	,					
soil to skin adher. factor AD	rI					
(1) (IIIG/CIIIZ)						
absorption ractor (U-1) Ar	- C					
exposure fred. (a/yr) er))	•	•			
exposure duration (yrs) ED	ດຸ	7 1) i			
avg. body wt. (kg) BW	16	41	7.0			
(2-6 16, 6-18 41, adult 70)						
lifetime (74.6) L	70					
contaminated fraction (0-1)CF	0.5		-			
Transport multiplier TR	Н					
soil dermal dose (mg/kg/d) 3.3	00E+00 mg/kg*day	mg/kg*	day	=(C*SA*A	D*AF*EF*ED*CF*	=(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)

	=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
0 20	ay	20 0 70	ay	18150 0 70
4 1 7	mg/kg*day	20 4 4 11	mg/kg*day	13175 1 4 41
15334115.7 1000 350 350 5 0.75 16 6.500E-07	4.480E-05	15334115.7 20 20) 7038701.01 250 250 65 16 70 0.5	3.331E-02	15334115.7 1000 7200 5 350
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365)(days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13179 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

Kp (derm. length o absorpti Attenuat Transpor	Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	0.81 0.2 1 6.500E-07		
shower d	dermal dose	4.977E-05 m	mg/kg*day	=(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)
Inhalati soil con Kd (L/kg inhalati exposure exposure exposure shower l avg. bod lifetime volat. f absorpti	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K)(.5 L/m3) absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	15334115.7 1000 0.6 350 5 0.2 16 70 0.5 6.500E-07	4 1 ,	0 0
shower i	inhalation exposure	1.280E-06 m	mg/kg*day	=(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)
Inhalation of	ticulates	20 20 15.7 90 90 5 16 70 0.5		•
part. in	part. inhalation exposure	0.000E+00 m	mg/kg*day	=(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, >300 METERS FROM THE SITE, 9 YEAR EXPOSURE, 300-DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Risk Level 1.0E-06 Oral Slope 0.0073 actor Inh. Slope 0.0061 ation ************************************	<pre>rap.</pre>	~	=(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365)
TRANS SESOI Kd/At No At EXPOS Soil Soil	0 inh. Vap. * 1 derm. gwater * 0 inh. shower ** 0 inh. part. = (C*CR*EP*ED*AF*CF*1F=6)	= (C×CK×EF×ED×AF)	=(C*SA*AD*AF*EF*
18+	> «	3120 70	day
7-18 100 4	ma/ka*dav	3910 3910 44 41	mg/kg*
2-6 Yr 334115 2	70 1 0.5 1 1	I • ←	1.650E+00 mg/kg*day
Soil Ingestion cont. [] (mg/kg)(ppm) C 15 consumption rt. (mg/day) CR (2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70)	avg. life expectancy (74.6) Labsorption factor (0-1) AF contaminated fraction (0-1) CF Transport multiplier TR	Soil Ingestion dose (mg/kg/d) Soil Dermal Exposure	soil dermal dose (mg/kg/d)

									=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)												=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)								
				0	70			٠	day			20			0	70					day				18150		0	70	
				4	41	!			mg/kg*day			20			4	41					mg/kg*day	•			13175		4	41	
•	15334115.7	. 0	350		0.75	70	6.500E-07	Н	4.480E-05		15334115.7	20		10.10.101	00T	16	70	0	0		1.998E-02		15334115.7	Н			m	16	2
	soil cont. [] (mg/kg) C	Kd (L/Kq) Kd	55) (days/yr	exposure duration (yrs) ED	alet Iraction (./5-1.0) Dr avg. bodv wt. (kg) BW	lifetime (74.6) L	Attenuation factor(0-1) AT	Transport multiplier TR	water consumption exposure	Inhalation of Vapors		inhalation rt. (m3/day) IR	(child<18 20 adult 20 occ.	Contact tactor (10)/Ag/ VE	exposure ireq. (days/yr) br exposure duration (vrs) ED	avg body wt. (kg) BW	lifetime (74.6) L	absorption factor AF	contaminated fraction (0-1)CF	Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower	soil cont. [] (mq/kq) C	Kd (L/kg) Kd	skin surface area (cm2) SA	15-18 17000 adult 18150)	exposure freq. (days/yr) EF exposure duration (yrs) ED	avg body wt (kg) BW	ייין (כייי) אייט אייט אייט אייט אייט אייט אייט

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	4 0 4 41 70	mg/kg*day = (C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)	20 20 4 4 0 41 70	mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)
0.81 0.2 1 6.500E-07	4.977E-05	15334115.7 1000 0.6 350 5 0.2 16 70 0.5 6.500E-07	1.280E-06	20 20 15334115.7 45 45 16 70 70	0.000E+00
Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 1: Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K)(.5 L/m3) absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates inhalation rate (m3/day) IR (child<18 20 adult 20) air particulate [](mg/m3) AP respirable part. fraction RF part. cont [] (mg/kg) C exposure freq. (days/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW lifetime (74.6) L absorption factor AF Transport multiplier TR	part. inhalation exposure

BENZO(A) PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE, 30 YEAR EXPOSURE, 300-DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

	= (CR*C/KA*EF*ED*DF*AT) / (BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
13	day	20 13 70	day	18150 13 70
12 41	mg/kg*day	20 12 41	mg/kg*day	13175 12 41
0.13626206 1.4 27500 350 350 0.75 0.75	1.448E-08	0.13626206 20 20 5.48E+07 350 5 16 70 0.5 CF	5.319E-11	0.13626206 27500 7200 5 350 16 70
Groundwater Consumption soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1)C Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 1317 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

11 11 11 11 11 11 11 11 11 11 11 11 11	38 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	06 00 .6 50 .2 .2 .4 16 41 70 .5 .5 .5	10 mg/kg*day = $(C/Kd*IR*EF*ED*SL*K*AF*AT) / (BW*L*365)$	20 20 20 20 13 141 70 41 70	mg/kg*day =(IK*C*KF*AF*EF*ED*AF*1E=0)/
<pre>Kp(derm. perm. const.)(cm/hr) 1. length of shower (hr/day) SL 0. absorption factor AF Attenuation factor (0-1) AT 0.6 Transport multiplier TR</pre>	shower dermal dose 2.382E-08	Inhalation in Shower soil cont. [] (mg/kg) C 0.13626206 Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED 5 shower length(hrs/day)(.2) SL 0.2 avg. body wt. (kg) BW 16 lifetime (74.6) L 0.5 volat. factor (K)(.5 L/m3) 0.5 absorption factor AF 0.5 Trnasport multiplier TR 1	shower inhalation exposure 4.136E-1	SAPAPEFE	part. Innalation exposure 0.000E+00

BENZO(A) PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE, 300-DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soll ingestion cont. [] (mg/kg) (ppm) C	7-18 18 18 9 100 1 0 12 6 41 5 41 5 1 3910 31 1 1 6 41 2 mg/kg*day 1 1 6 41 1 5 12 6 41 6 41 5 6 41 6 41 6 6 41 6 7-18 18 18 1 10 11 1 10 12 12 1 10 12 12 1 10 12 12 12 1 10 12 12 12 1 10 12 12 12 12 1 10 12 12 12 12 12 1 10 12	18+ 100 13 70 3120	on/off 0 1 0 0 1 1 0 0 0 0 0	on/off TRANSPORT R 0 SESOIL 1 Kd/Att. Factor I 0 No Attenuation 0 Soil ing. ** 0 soil derm. *S 0 inh. vap. * 1 derm. gwater ** 0 inh. part. 0 inh. part. 0 inh. part.	Risk Level 1.0E-06 Oral Slope 7.3 Inh. Slope 6.1 ********** *Soil Concentration* * 1.36E+05 mg/kg * * *********************************
lifetime (74.6) L contaminated fraction (0-1)CF 0.5 Transport multiplier TR 1 soil dermal dose (mg/kg/d) 2.932E-02	5 1 2 mg/kg*dav	da V	=(C*SA	=(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365	.1E-6)/(BW*L*365)

	= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
13	day	20 13 70	'day	18150 13 70
12 41	mg/kg*day	20 12 41	mg/kg*day	13175 12 41
136262.059 1.4 27500 350 5 0.75 16 70 6.500E-07	1.448E-08	136262.059 20 20 5.48E+07 5.08E+07 250 250 CF 0.5	3.799E-05	136262.059 27500 7200 350 5
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	12 13 41 70	mg/kg*day = (C/Kd*IR*EF*ED*SL*K*AF*AT) / (BW*L*365)	20 13 70	oc vrv Ma) /
1.2 0.2 1 6.500E-07	2.382E-08 m	136262.059 27500 R 0.6 350 5 IL 0.2 16 70 0.5 6.500E-07	4.136E-10 m	136262.059 136262.059 90 5 16 70 70	- 1
<pre>Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR</pre>	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K)(.5 L/m3) absorption factor AF Attenuation factor TR Transport multiplier TR	shower inhalation exposure	tion of Particulates ition rate (m3/day) IR Id<18 20 adult 20) rriculate [](mg/m3) AP rable part. fraction RF cont [] (mg/kg) C rre freq. (days/yr) EF rre duration (yrs) ED ody wt. (kg) BW Ime (74.6) L otion factor AF oort multiplier TR	part. Innalation exposure

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, ≥300 METERS FROM THE SITE, 30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

	= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
13	day	20	day	18150 13 70
12 41	mg/kg*day	20 12 41	mg/kg*day	13175
136262.059 1.4 27500 350 350 0.75 16 6.500E-07	1.448E-08	136262.059 20) 20) 5.48E+07 150 16 70 0.5	2.279E-05	136262.059 27500 7200 5
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

Kp 1e ab At	Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	1.2 0.2 1 6.500E-07			
sh	shower dermal dose	2.382E-08 m	mg/kg*day	Ш	(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)
so ex ex ex av vo li	Inhalation in Shower soil cont. [] (mg/kg) C 1 Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K)(.5 L/m3) absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	136262.059 27500 IR 0.6 350 5 SL 0.2 16 70 0.5 6.500E-07	12 41	13	
sh	shower inhalation exposure	4.136E-10 m	mg/kg*day	11	(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)
in re pa in a line con	Inhalation of Particulates	136262.059 136262.059 45 5 16 70 0.5	20 12 41 41	20 13 13	TD*C*D*AD*AF*1F-6)/(BW*1.*365)
Ž	Tilla ta c 1011	-	- 611/6		

BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE, 30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

TRISK Level 1.0E-06 Oral Slope 0.73 Factor Inh. Slope 0.61	**************************************	F*1E-6)/(BW*L*365)		D*CF*1E-6)/(BW*L*365)
on/off TRANSPORT 0 SESOIL 1 Kd/Att. Factor 0 No Attenuation	on/off EXPOSURE 0 soil ing. 0 soil derm. 1 gwater cons. 0 inh. vap. 1 derm. gwater 0 inh. shower 0 inh. part.	=(C*CR*EF*ED*AF*CF*1E-6)		=(C*SA*AD*AF*EF*ED*CF*1E-6)
18+	13	day	3120 13 70	day
7-18	12 41	mg/kg*day	3910 12 41	mg/kg*
2-6 yrs 0.06503238 200	180 16 70 70 0.5	1.432E-08	0.06503238 3910 D 1 D 1 180 . 16) 70 F 0.5	2.799E-08 mg/kg*day
soil Ingestion cont. [] (mg/kg)(ppm) C 0 consumption rt. (mg/day) CR	exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) avg. life expectancy (74.6) L absorption factor (0-1) AF contaminated fraction (0-1) CF Transport multiplier TR	soil ingestion dose (mg/kg/d)	Soil Dermal Exposure cont. [] (mg/kg) C skin surf. area(cm2/d) SA (child 3910 adult 3120) soil to skin adher. factor AD (1) (mg/cm2) absorption factor (0-1) AF exposure freq. (d/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) lifetime (74.6) L contaminated fraction (0-1) CF Transport multiplier TR	soil dermal dose (mg/kg/d)

2 13 1 70	mg/kg*day =(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)	0 20 2 13 1 70	mg/kg*day = (IR*C*1/VF*EF*ED*AF*CF) / (BW*L*365)	5 18150 2 13 1 70
238 1.4 000 350 .75 .65	-07	238 20 20 20 20 350 16 41 70 70 0.5	-10	238 000 200 13175 350 16 41 70
EF	1.900E	0.06503 c. 20) 7212513 F	1.930E	0.06503 0.06503 175 175
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr)] exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 oc volat. factor (m3/kg) VF exposure freq. (days/yr) E exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1 Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13 15-18 17000 adult 18150 exposure freq. (days/yr) E exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

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BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE, 30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+ 0	on/off	TRANSPORT SFSOTI.	Risk Level 1.0E-06	06 73
cont. [] (mg/kg) (ppm) C 6 consumption rt. (mg/day) CR	65032.3755 200	100	100	0 11 0	Kd/Att. Factor No Attenuation	Slope	0.61
(2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW	90 5 16	12	13 70	on/off 0 0	EXPOSURE soil ing.	**************************************	***
(2-6 16, 6-18 41, adult 70) avg. life expectancy (74.6) L absorption factor (0-1) AF contaminated fraction (0-1)CF Transport multiplier TR	70 1 0.5			0000	gwater cons. inh. vap. derm. gwater inh. shower	* 6.50E+04 mg/kg * * * * * * * * * * * * * * * * * * *	* * * * * *
soil ingestion dose (mg/kg/d)	.159E-03	mg/kg*day		= (C*CR:	=(C*CR*EF*ED*AF*CF*1E-6)	·6)/(BW*L*365)	
Soil Dermal Exposure							
cont. [] (mg/kg) C 6 skin surf. area(cm2/d) SA (child 3910 adult 3120)	65032.3755 3910	3910	3120				
soil to skin adher. factor AD	H						
absorption factor (0-1) AF exposure freq. (d/yr) EF	0.1						
exposure duration (yrs) ED avg. body wt. (kg) BW	16	12 41	13				
(2-6 16, 6-18 41, adult 70) lifetime (74.6) L	70						
contaminated fraction (0-1)CF Transport multiplier TR	0.5						
soil dermal dose (mg/kg/d)	1.400E-02	mg/kg*day		=(C*SA	=(C*SA*AD*AF*EF*ED*CF*1E-6),	(1E-6)/(BW*L*365)	

	= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)		
13	day	20 13 70	day	18150	13
12 41	mg/kg*day	20 12 41	mg/kg*da <u>y</u>	13175	12
g) C 65032.3755 ay) CR 1.4 1000 s/yr) EF 350 rs) ED 5 .0) DF 0.75 W 16 TO 70 TR T 6.500E-07	posure 1.900E-07	65032.375 c. 20) 7212513.4 F 7212513.4	n (0-1)CF 0.5 TR 1	ower g) C 65032.3755 m2) SA 7200 -12 13175	/yr) EF 350 rs) ED 5
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport mutliplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L	contaminated fraction (0-1 Transport multiplier TR vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13	exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	12 13 41 70	mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)	20 20 12 13 41 70	mg/kg*day = (IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)
0.81 0.2 1 6.500E-07	2.111E-07 m	65032.3755 1000 0.6 350 5 0.2 16 70 0.5 6.500E-07	5.429E-09 m	20 20 65032.3755 90 5 16 70 0.5	0.000E+00 m
<pre>Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport mutliplier TR</pre>	shower dermal dose	Inhalation in Shower	shower inhalation exposure	Inhalation of Particulates	part. inhalation exposure

BENZO(A)ANTHRACENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, ≥300 METERS FROM THE SITE, 300 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

		1					·
	9	81-/	+ ¤ T	on/ori	TKANSPOKT SESOTT,	Oral Slope 0.73	73
•	65032.3755			· ~	Kd/Att. Factor	Slope	61
consumption rt. (mg/day) CR	200	100	100	0	No Attenuation		
exposure fred: (d/vr) EF	45			on/off	EXPOSURE		
duration of exp. (yrs) ED		12	13	0			* * *
avg. body wt. (kg) BW		41	70	0		*Soil Concentration*	*uo
(2-6 16, 6-18 41, adult 70)				 1	a)		*
avg. life expectancy (74.6) L	7			0	-	* 6.50E+04 mg/kg	* •
absorption factor (0-1) AF				Τ,	•	*	* •
contaminated fraction (0-1)CF	· o			0 0	inh. shower	****************	* *
Transport multiplier in	-			>			
soil ingestion dose (mg/kg/d)	3.579E-03	mg/kg*day	day	=(C*CR	(C*CR*EF*ED*AF*CF*1E-6)	·6)/(BW*L*365)	
Soil Dermal Exposure							
cont. [] (ma/ka) C 6	65032.3755						
	3910	3910	3120				
(child 3910 adult 3120)							
soil to skin adher. factor AD	Н						
(1) (mg/cm2)							
absorption factor (0-1) AF	0.1						
exposure freq. (d/yr) EF	45		1				
exposure duration (yrs) ED	വ	12	13				
avg. body wt. (kg) BW	16	41	70				
(2-6 16, 6-18 41, adult 70)							
lifetime (74.6) L	70						
contaminated fraction (0-1)CF	0.5						
Transport multiplier TR	ਜ						
soil dermal dose (mg/kg/d)	6.998E-03 mg/kg*day	mg/kg*	day	=(C*SA	= (C*SA*AD*AF*EF*ED*CF*1E-6)	1E-6) / (BW*L*365)	

i. [] (mg/kg) C		=(CR*C/KA*EF*ED*DF*AT)/(BW*L*365)			=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)		
i. [] (mg/kg) C 65032.3755 on rt. (L/day) CR 1.04 f) Kd duration (yrs) ED 350 duration (yrs) ED 0.75 tion (75-1.0) DF 0.75 tion factor(0-1) AT 6.500E-07 i. [] (mg/kg) C 65032.3755 on of vapors on factor (m3/kg) C 65032.3755 on rt. (m3/kg) VF 7212513.43 freq. (days/yr) EF 7212513.43 inditiplier TR 72 0.5 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower ii. [] (mg/kg) C 65032.3755 j) Kd iii. []	13	day	20	13	day	18150	13
i. [] (mg/kg) C 65032.3755 on rt. (L/day) CR 1.04 f) Kd duration (yrs) ED 350 duration (yrs) ED 0.75 tion (75-1.0) DF 0.75 tion factor(0-1) AT 6.500E-07 i. [] (mg/kg) C 65032.3755 on of vapors on factor (m3/kg) C 65032.3755 on rt. (m3/kg) VF 7212513.43 freq. (days/yr) EF 7212513.43 inditiplier TR 72 0.5 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower i. [] (mg/kg) C 65032.3755 j) Kd inditiplier TR 7200 ontact in Shower ii. [] (mg/kg) C 65032.3755 j) Kd iii. []	12 41	mg/kg*	20	12	mg/kg*	က	12
(a) (mg/kg) C on rt. (L/day) CR f) Kd for (365) (days/yr) furation (yrs) ED tion (.75-1.0) DF wt. (kg) BW (74.6) L ton factor(0-1) AT multiplier TR sumption exposure n of Vapors n of Wayors n (mg/kg) C yr, (kg) BW (74.6) L n factor AF tred fraction (0-1 multiplier TR nalation dose ntact in Shower multiplier TR nalation dose ntact in Shower	5032.37 1 10 3	.500E-07 1 .900E-07	32.375	2513.4 15 1	0.5 0.5 1 8.271E-05	5032.	
		Attenuation factor(0-1) AT Transport multiplier TR water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR	(child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L	AF Lion (0-1) ier TR dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA	(<2 4000 2-6 7200 6-12 13178 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 0 to 100 METERS FROM THE SITE, 30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

	= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
13	ay	20 13 70	ay	18150 13 70
12	mg/kg*day	20 12 41	mg/kg*day	13175 1 12 41
6.50323755 1.4 1000 350 350 0.75 16 70	1.900E-05	6.50323755 20 20) 7038701.01 350 35 16 70 0.5		6.50323755 1000 7200 350 5 16 70
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	12 13 41 70	mg/kg*day = (C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)	20 20 12 13 41 70 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)	
0.81 0.2 0.65	2.111E-05 m	6.50323755 1000 0.6 350 5 0.2 16 70 0.5 0.5	5.429E-07 m	0 6.50323755 6.50323755 180 16 70 0.5	- 1
<pre>Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR</pre>	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 6 Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K)(.5 L/m3) absorption factor AF Attenuation factor TR Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates	

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, 100 to 300 METERS FROM THE SITE, 30 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+	on/off	TRANSPORT	-
:	6503237.55				SESOIL Kd/Att. Factor	Oral Slope 0.0073 Inh. Slope 0.0061
consumption rt. (mg/day) CR (2-6 200, >6 100)	200	100	100	0	No Attenuation	
exposure freq. (d/yr) EF	0		,	jjo/uo	EXPOS	
duration of exp. (yrs) ED		12	H 1	0 (soil ing.	***********
avg. body wt. (kg) BW	16	4 T	0/) -	Soll derm.	*SOIL CONCENTRACION*
(2-9 19, 8-19 41, addit (9) avg. life expectancy (74.6) L	70			10	inh. vap.	6.50E+06 mg/kg
absorption factor (0-1) AF				-	derm. gwater	*
contaminated fraction (0-1)CF	0.5			00	inh. shower	**************
Transport multiplier in	-			>	Limi. Par c.	
soil ingestion dose (mg/kg/d)	7.159E-01	mg/kg*day	day	=(C*CR	=(C*CR*EF*ED*AF*CF*1E-6)	·6)/(BW*L*365)
Soil Dermal Exposure						
	• 4					
	3	(4			
skin surf. area(cm2/d) SA (child 3910 adult 3120)	3910	3910	3120			
anil to akin adher factor AD	-					
(1) (mg/cm2)						
absorption factor (0-1) AF	0.1					
exposure freq. (d/yr) EF	06					
exposure duration (yrs) ED		12	13			
avg. body wt. (kg) BW	16	41	70			
(2-6 16, 6-18 41, adult 70)						
lifetime (74.6) L						
contaminated fraction (0-1)CF	0.5					
Trasnport multiplier TR	П					
soil dermal dose (mg/kg/d)	1.400E+00 mg/kg*day	mg/kg*	day	=(C*SA	=(C*SA*AD*AF*EF*ED*CF*1E-6)	1E-6)/(BW*L*365)

	=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)			=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)		
13	day	20	13	rday	18150	13
12 41	mg/kg*day	. 50	12 41	mg/kg*day	13175	12
6503237.555 1.4 1000 350 350 6.500E-07	1.900E-05	6503237.55 20 20)	25 25 25 25 25 25 25 25 25 25 25 25 25 2	1.413E-02	6503237.55 1000 7200	350 5 16 70
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	IR occ.	(days/yr) EF tion (yrs) ED (kg) BW 6) L ctor AF fraction (0-1)CF	Transport multiplier TR vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175	0 E E E

.81 0.2 1 1-07	-05 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365	7.55 1000 0.6 350 5 12 13 0.2 16 41 70 0.5 0.5 E-07	-07 mg/kg*day = $(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)$	20 20 20 0 0 .55 90 12 13 16 41 70).5 10 mq/kq*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)	
<pre>Kp(derm. perm. const.)(cm/hr) 0.81 length of shower (hr/day) SL 0.2 absorption factor AF Attenuation factor (0-1) AT 6.500E-07 Transport multiplier TR 1</pre>	shower dermal dose 2.111E-05	Inhalation in Shower soil cont. [] (mg/kg) C 6503237.55 Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure duration (yrs) ED shower length(hrs/day)(.2) SL 0.2 avg. body wt. (kg) BW 16 lifetime (74.6) L 70 volat. factor (K)(.5 L/m3) 0.5 absorption factor AF 6.500E-07 Transport multiplier TR	shower inhalation exposure 5.429E-07	Inhalation of Particulates inhalation rate (m3/day) IR (child<18 20 adult 20) air particulate [](mg/m3) AP respirable part. fraction RF part. cont [] (mg/kg) C 6503237.55 exposure freq. (days/yr) EF avg. body wt. (kg) BW lifetime (74.6) L absorption factor AF Transport multiplier TR part. inhalation exposure 0.000E+00	

CHRYSENE RESIDENTIAL CHILD, SAND, GROUNDWATER EXPOSURE, >300 METERS FROM THE SITE, 300 YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

•				110/110	TYPO TONIONIT	ביי היי	
	6503237.55			0	SESOIL Kd/Att. Factor	Oral Slope 0.0073 Inh. Slope 0.0061	
consumption rt. (mg/day) CR (2-6 200, >6 100)	200	100	100	0	No Attenuation		
exposure freq. (d/yr) EF	45			on/off	EXPOSURE		
duration of exp. (yrs) ED	വ	12	13	0	soil ing.	*	*
avg. body wt. (kg) BW	16	41	70	0	soil derm.	*Soil Concentration*	*
(2-6 16, 6-18 41, adult 70)				1	gwater cons.		*
avg. life expectancy (74.6) L	70			0	~	* 6.50E+06 mg/kg	*
absorption factor (0-1) AF	Н			 1	derm. gwater	*	*
contaminated fraction (0-1)CF	0.5			0		********	*
Transport multiplier TR	Н			0	inh. part.		
	3.579E-01	mg/kg*day	ay	=(C*CR*	(C*CR*EF*ED*AF*CF*1E-6)	-6)/(BW*L*365)	ı
Soil Dermal Exposure							
:	•						
	6503237.55						
skin surf. area(cm2/d) SA	3910	3910	3120				
(child 3910 adult 3120)							
soil to skin adher. factor AD	н						
(1) (mg/cm2)							
absorption factor (0-1) AF	0.1						
exposure freq. (d/yr) EF	45						
exposure duration (yrs) ED	വ	12	13				
avg. body wt. (kg) BW	16	41	70				
(2-6 16, 6-18 41, adult 70)							
lifetime (74.6) L	70						
contaminated fraction (0-1)CF	0.5						
Transport multiplier TR	-						
א (ה/אא/אש) ספסף (בשאסה 1 נוספ		ազ/բα*վ	٨٨	* \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \	*40*40*40*40*4		
		5 6 3 7 6 m	7	7	*	٦.	1
exposure duration (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) lifetime (74.6) L contaminated fraction (0-1)CF Transport multiplier TR soil dermal dose (mg/kg/d) 6.9		12 41 mg/kg*da <u>y</u>	13 70 70	= (C*SA*	=(C*SA*AD*AF*EF*ED*CF*1E-6)	:1E-6)/(BW*L*365)	

	=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
13	day	20 13 70	day	18150 13 70
12 4 1 1 2	mg/kg*day	20 17 411	mg/kg*day	13175
6503237.55 1.4 1000 350 350 6.500E-07	1.900E-05 r	6503237.55 20 20) 7038701.01 150 16 70 0.5 F	8.475E-03 1	6503237.55 1000 7200 350 5 16
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT 6.500E-07 Transport multiplier TR Inhalation in Shower Soil cont. [] (mg/kg) C 6503237.55 Kd (L/kg) Inhalation rt.(0.6)(m3/hr) IR 0.6 exposure freq. (days/yr) EF 350 exposure freq. (days/yr) EF 512 13 shower length(hrs/day)(.2) SL 0.2 shower length(hrs/day)(.2) SL 0.5 shower len	shower inhalation exposure 5.429E-07 mg/kg*day = (C/kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365) Inhalation of Particulates inhalation rate (m3/day) IR 20 20 20 child<18 20 adult 20) air particulate [](mg/m3) AP 0 respirable part. fraction RF 0 part. cont [](mg/kg) C 6503237.55 exposure freq. (days/yr) EF 45 45 exposure freq. (days/yr) EF 5 12 13 avg. body wt. (kg) BW 70 lifetime (74.6) L 70 absorption factor AF 0.5 Transport multiplier TR 1 Transport multiplier TR 1 Inhalation concerns 0 000F100 mg/kg/day = (TP*C*PF*AD*FFF*ED*AFFFFFF)
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BENZO(A) PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, 0 to 100 METERS FROM SITE, 9-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+	on/off	TRANSPORT	Level 1.0E
•	0.11106			100	SESOIL Kd/Att. Factor	Oral Slope 7.3 Inh. Slope 6.1
consumption rt. (mg/day) CR (2-6 200, >6 100)	200	100	100	0	No Attenuation	
exposure freq. (d/yr) EF	H		•	on/off	U)	
duration of exp. (yrs) ED	വ	4	0	Η.		*
avg. body wt. (kg) BW		41	70		soil derm.	Soil Concentration
(2-6 16, 6-18 41, adult 70)				-	gwater cons.	:
avg. life expectancy (74.6) L				0	~	0.11106 mg/kg
absorption factor (0-1) AF					•	*
contaminated fraction (0-1) CF	e. 0			0 0	inh. shower	**************
Transport multiplier ik	-			>	Tilli parc.	
soil ingestion dose (mg/kg/d)	2.445E-08	mg/kg*day	day	=(C*CR	=(C*CR*EF*ED*AF*CF*1E-6)	6)/(BW*L*365)
Soil Dermal Exposure						
cont. [] (mg/kg) C	0.11106055					
skin surf. area(cm2/d) SA	3910	3910	3120			
(CILLA 3910 AUGUT 3120)	-					
SOII CO SAIN AUNEI: LACCOL AD (1) (mg/cm2)	+					
absorption factor (0-1) AF	0.1					
exposure freq. (d/yr) EF	180					
exposure duration (yrs) ED		4	0			
avg. body wt. (kg) BW	16	41	70			
(2-6 16, 6-18 41, adult 70)						
lifetime (74.6) L						
contaminated fraction (0-1)CF	۳ 0.5					
Transport multiplier TR						
soil dermal dose (mg/kg/d)	4.780E-08	mg/kg*day	day	=(C*SA	=(C*SA*AD*AF*EF*ED*CF*1E-6),	1E-6)/(BW*L*365)

	=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
0 20	lay	20 20 20	lay	18150 0 70
4 1 4	mg/kg*day	20 4 4 411	mg/kg*day	13175 : 4
0.11106055 1.4 27500 350 5 0.75 0.75	1.180E-08	0.11106055 20) 20) 5.48E+07 350 350 16 70 0.5	4.335E-11	0.11106055 27500 7200 5 350 16 70
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	4 0 41 70	mg/kg*day =(C/Kd*IR*EF*ED*SL*K*AF*AT)/(BW*L*365)	20 20 4 0 41 70 mq/kq*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)	
1.2 0.2 0.65	1.942E-08	0.11106055 27500 350 350 5 0.2 16 70 0.5 0.5	3.371E-10	20 20 106055 180 180 70 0.5	
<pre>Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR</pre>	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K)(.5 L/m3) absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates	

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, 100 to 300 METERS FROM SITE, 9-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+	on/off	TRANSPORT	Level 1.0E
•	0.33439838			0	SESOIL Kd/Att. Factor	Oral Slope 7.3 Inh. Slope 6.1
consumption rt. (mg/day) CR	200	100	100	0	No Attenuation	
exposite fred (d/vr) EF	06			on/off	EXPOSURE	
duration of exp. (yrs) ED		4	0	1	soil ing.	
avg. body wt. (kg) BW	16	41	70	ਜ '	soil derm.	Soil Concentration
(2-6 16, 6-18 41, adult 70)					a)	
avg. life expectancy (74.6) L				0 1	,>	3.34E-01 mg/kg
absorption factor (0-1) AF				⊣	•	* * * * * * * * * * * * * * * * * * * *
contaminated iraction (0-1)CF Transport multiplier TR	ດ.⊣ ວ			00	inh. part.	
soil ingestion dose (mg/kg/d)	3.681E-08	mg/kg*day	day	= (C*CR	=(C*CR*EF*ED*AF*CF*1E-6)	6)/(BW*L*365)
Soil Dermal Exposure						
cont. [] (mg/kg) C 0	33439838	1	7			
skin surf. area(cm2/d) sA	39T0	3910	3120			
(CILLIA 3910 AURIC 3120)	•					
(1) (mg/cm2)	4					
(T) (IIIIG) (T) (T)	~					
absorption factor (UTI) Ar	- C					
exposure lied. (u/yl) ar	у О R	5	C			
exposure duracton (yrs) an	י ר	† ,	,			
avg. body wt. (kg) Bw	QT	4	2			
(0/ JIMP 'T' 9-18 41' MUTC '0)	1					
lifetime (74.6) L	07					
contaminated fraction (0-1)CF	0.0					
Transport multiplier TR	⊣					
soil dermal dose (mg/kg/d)	7.196E-08	mg/kg*day	day	=(C*SA	=(C*SA*AD*AF*EF*ED*CF*1E-6)/(BW*L*365	1E-6)/(BW*L*365)
		٠				

	=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
70	lay	20 20 70	lay	18150 0 70
4 1	mg/kg*day	20 4 4 4 11	mg/kg*day	13175 1
0.33439838 1.4 27500 350 350 6.500E-07	3.553E-14	0.33439838 20 20) 5.48E+07 5.48E+07 0.5 0.5	9.323E-11	0.33439838 27500 7200 350 16
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	4 0 41 70	mg/kg*day = (C/Kd*IR*EF*ED*SL*K*AF*AT) / (BW*L*365)	20 20 4 0 41 70 mg/kg*day =(IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)	
1.2 0.2 1 6.500E-07	5.847E-14 n	0.33439838 27500 0.6 350 5 0.2 16 70 0.5 6.500E-07	1.015E-15 n	0 0.33439838 0.5 0.000E+00 n	ı
Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6)(m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day)(.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K)(.5 L/m3) absorption factor AF Attenuation factor TR	shower inhalation exposure	Inhalation of Particulates inhalation rate (m3/day) IR (child<18 20 adult 20) air particulate [](mg/m3) AP respirable part. fraction RF part. cont [] (mg/kg) C exposure freq. (days/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW lifetime (74.6) L absorption factor AF Transport multiplier TR	

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, >300 METERS FROM SITE, 9-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+	on/off	TRANSPORT	Level 1.0E
cont. [] (mg/kg) (ppm) C	0.66879609			1	SESOIL Kd/Att. Factor	Oral Slope 7.3 Inh. Slope 6.1
consumption rt. (mg/day) CR 200 (2-6 200, >6 100)	200	100	100	0	No Attenuation	
exposure freq. (d/yr) EF	45			on/off	rn.	
duration of exp. (yrs) ED		4	0	el		*
avg. body wt. (kg) BW	1	41	70	떠	soil derm.	*Soil Concentration*
(2-6 16, 6-18 41, adult 70	_			↤	gwater cons.	
avg. life expectancy (74.6)				0	>	6.69E-01 mg/kg
absorption factor (0-1) AF				⊣	derm. gwater	*
contaminated fraction (0-1)C	F 0.5			0	inh. shower	************
Transport multiplier TR				0	inh. part.	
soil ingestion dose (mg/kg/d)) 3.681E-08	mg/kg*day	lay	=(C*CR	=(C*CR*EF*ED*AF*CF*1E-6)	6)/(BW*L*365)
Soil Dermal Exposure						
0 4 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7 7						
	000000000000000000000000000000000000000	0,00	,			
SKin Suri. area(Cm2/α) SA	3910	3910	3120			
(CUITA 3910 AUUL 3120)	•					
soil to skin adher. tactor A	1					
(1) (mg/cm2)	,					
absorption factor (0-1) AF	0					•
exposure freq. (d/yr) EF	45					
exposure duration (yrs) ED		4	0			
avg. body wt. (kg) BW	16	41	70			
(2-6 16, 6-18 41, adult 70	_					
lifetime (74.6) L						
contaminated fraction (0-1)C	F 0.5					
Transport multiplier TR						
soil dermal dose (mg/kg/d)	7.196E-08	mg/kg*day	lay	=(C*SA:	=(C*SA*AD*AF*EF*ED*CF*1E-6)/	1E-6)/(BW*L*365)

	=(CR*C/Kd*EF*ED*DF*AT)/(BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
0 20	lay	20 0 70	lay	18150 0 70
4 4	mg/kg*day	2 4 4 4	mg/kg*day	13175
0.66879609 1.4 27500 350 350 0.75 0.75 16 70	7.105E-14 n	0.66879609 20, 20) 5.48E+07 150 150 0.5	1.119E-10 n	0.66879609 27500 7200 350 5
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1)CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT 6.500E-07 Transport multiplier TR Transport multiplier TR Shower dermal dose I.169E-13 mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365) Inhalation in Shower soil cont. [] (mg/kg) C 0.66879609 Kd (L/Kg) Inhalation rt.(0.6)(m3/hr) IR 0.6 exposure duration (yrs) ED 5 4 0 shower length(hrs/day)(.2) SL 0.2 shower length(hrs/day)(.2) SL 0.2 shower length(hrs/day)(.2) SL 0.5 shower length(hrs/day) 0.5
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BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, 0 to 100 METERS FROM SITE, 30-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil Ingestion	2-6 yrs	7-18	18+	on/off	TRANSPORT	Level 1.0E
:				0 ,		
cont. [] (mg/kg)(ppm) C consumption rt. (mg/day) CR	0.05633565	100	100	Н О	Kd/Att. Factor No Attenuation	Inn. Slope 6.1
(2-6 200, >6 100)						
exposure freq. (d/yr) EF	180			on/off	EXPOSURE	
duration of exp. (yrs) ED		12	13	1	ing.	
avg. body wt. (kg) BW	Н	41	70	1	•	*Soil Concentration*
(2-6 16, 6-18 41, adult 70)				1	gwater cons.	*
avg. life expectancy (74.6) L	, 70			0	inh. vap.	* 0.05634 mg/kg *
absorption factor (0-1) AF				Н	derm. gwater	*
contaminated fraction (0-1)CF	0.5			0	VJ.	*************
Transport multiplier TR				0	inh. part.	
soil ingestion dose (mg/kg/d)	1.240E-08	mg/kg*day	day	= (C*CR	=(C*CR*EF*ED*AF*CF*1E-6)	6)/(BW*L*365)
Soil Dermal Exposure						
cont. [] (ma/ka) C	0.05633565					
	3910	3910	3120			
(child 3910 adult 3120)						
soil to skin adher. factor AD	-					
(1) (mg/cm2)						
absorption factor (0-1) AF	0.1					
exposure freq. (d/yr) EF	180					
exposure duration (yrs) ED		12	13			
avg. body wt. (kg) BW	16	41	70			
(2-6 16, 6-18 41, adult 70)						
lifetime (74.6) L						
contaminated fraction (0-1)CF	0.5					
Transport multiplier TR						
(6/20/1/2m) 0006 [cmmob [con	4.0 A.0 C.	******/ ***	ر د د	*	\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\\	1 1 2 2 4 1 4 M 2 7 7 7 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
מאלאעלאיין מספר ניישל אלאלאלא	- 1	- 64 / 6m	day		: IO:: OF:: TU:: TU:: OU:	٦.

	= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
13	day	20 13 70	day	18150 13 70
12 41	mg/kg*day	20 12 41	mg/kg*day	13175
0.05633565 1.4 27500 350 350 0.75 0.65	5.985E-09	0.05633565 20 20) 5.48E+07 350 16 70 0.5 F	2.199E-11	0.05633565 27500 7200 5 350 16 70
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365)(days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	12 13 41 70	mg/kg*day = (C/Kd*IR*EF*ED*SL*K*AF*AT) / (BW*L*365)	20 13 70	mg/kg*day = (IR*C*RF*AP*EF*ED*AF*1E-6)/(BW*L*365)
1.2 0.2 1 0.65	9.850E-09 m	0.05633565 27500 TR 0.6 350 5 16 70 0.5 0.5	1.710E-10 m	•	0.000E+00 m
Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C Kd (L/kg) inhalation rt.(0.6) (m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day) (.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K) (.5 L/m3) absorption factor AF Attenuation factor TR	shower inhalation exposure	ticulates m3/day) IR ult 20) [umg/m3) AP fraction RF ng/kg) C lays/yr) EF (yrs) ED (yrs) ED (yrs) ED (yrs) ED (yrs) EF	part. inhalation exposure

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, 100 to 300 METERS FROM SITE, 30-YEAR EXPOSURE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

Soil In	Soil Ingestion	2-6 yrs	7-18	18+	on/off	TRANSPORT	Level 1.0E-0
cont. [] (mg/kg) (ppm) C	0.19208674			0 +1	SESOIL Kd/Att. Factor	Oral Slope 7.3 Inh. Slope 6.1
consumb (2-6	consumption rt. (mg/day) CR (2-6 200, >6 100)	200	100	100	0	No Attenuation	
exposur	re freg. (d/yr) EF	σ			on/off	EXPOSURE	
duratic	on of exp. (yrs) ED		12	13	Н		*
avg. bc	ody wt. (kg) BW	16	41	7.0	Н	soil derm.	*Soil Concentration*
(2-6	16, 6-18 41, adult 70)				⊣	gwater cons.	
avg. li	[fe expectancy (74.6) L	7			0	inh. vap.	1.92E-01 mg/kg
absorpt	ion factor (0-1) AF				⊣		*
contami	<pre>inated fraction (0-1)CF int miltingion mb</pre>	0.5			0 0	inh. shower	**********
ranspo	ore multiplier in				>	Tilli. par c.	
soil in	soil ingestion dose (mg/kg/d)	2.114E-08	mg/kg*day	day	= (C*CR	(C*CR*EF*ED*AF*CF*1E-6)	6)/(BW*L*365)
Soil De	Soil Dermal Exposure						
• • • • • •	_	•					
cont. [0.19208674					
skin su	skin surf. area(cm2/d) SA	3910	3910	3120			
(chi)	d 3910 adult 3120)						•
soil to	skin adher. factor AD	 -					
(1) ((mg/cm2)						
absorpt	absorption factor (0-1) AF	0.1			•		
Insodxa	exposure freq. (d/yr) EF	06					
Insodxe	e duration (yrs) ED		12	13			
avg. bc	ody wt. (kg) BW	16	41	70			
(3-6	16, 6-18 41, adult 70)						
lifetim	ne (74.6) L	70					
contami	nated fraction (0-1)CF	0.5					
Transpo	Transport multiplier TR						
soil de	soil dermal dose (mg/kg/d)	4.134E-08	mq/kq*day	day	=(C*SA	= (C*SA*AD*AF*EF*ED*CF*1E-6)	1E-6)/(BW*L*365)
	and a subsequent of the subseq						
*.							-

·	= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
13	day	20 13 70	ıday	18150 13 70
12	mg/kg*day	20 12 41	mg/kg*day	13175
0.19208674 1.4 27500 350 5 0.75 6.500E-07	2.041E-14	0.19208674 20) 5.48E+07 5.48E+07 0.5 0.5	5.356E-11	0.19208674 27500 7200 350 5
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors soil cont. [] (mg/kg) C inhalation rt. (m3/day) IR (child<18 20 adult 20 occ. volat. factor (m3/kg) VF exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt. (kg) BW lifetime (74.6) L absorption factor AF contaminated fraction (0-1) CF Transport multiplier TR	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 13175 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

Groundwater Consumption

	mg/kg*day =(C/Kd*SA*Kp*EF*ED*SL*AF*AT*.001)/(BW*L*365)	12 13 41 70	mg/kg*day = (C/Kd*IR*EF*ED*SL*K*AF*AT) / (BW*L*365)	20 13 70	mg/Kg*day = (1K*C*KF*AP*EF*ED*AF*1E-6)/(BW*L*365)
1.2 0.2 1 6.500E-07	3.359E-14 mg	0.19208674 27500 0.6 350 5 0.2 16 70 0.5 6.500E-07	5.831E-16 mg	•	0.000E+00 mc
Kp(derm. perm. const.)(cm/hr) length of shower (hr/day) SL absorption factor AF Attenuation factor (0-1) AT Transport multiplier TR	shower dermal dose	Inhalation in Shower soil cont. [] (mg/kg) C 0.192 Kd (L/kg) inhalation rt.(0.6) (m3/hr) IR exposure freq. (days/yr) EF exposure duration (yrs) ED shower length(hrs/day) (.2) SL avg. body wt. (kg) BW lifetime (74.6) L volat. factor (K) (.5 L/m3) absorption factor AF Attenuation factor (0-1) AT 6.50 Transport multiplier TR	shower inhalation exposure	Inhalation of Particulates inhalation rate (m3/day) IR (child<18 20 adult 20) air particulate [](mg/m3) AP respirable part. fraction RF part. cont [] (mg/kg) C exposure freq. (days/yr) EF exposure duration (yrs) ED avg. body wt. (kg) BW lifetime (74.6) L absorption factor AF Transport multiplier TR	part. Inhalation exposure

BENZO(A)PYRENE RESIDENTIAL CHILD, SAND, GROUNDWATER AND SOIL EXPOSURE, >300 METERS FROM SITE, 300 DAY HALF-LIFE, 0.5 GW METER MIXING DEPTH

2-6 yrs 7-18 18+ on/off TRANSPORT Risk Level 1.0E-06 0 SESOIL 0 O.38417293 7.3 1 Kd/Att. Factor Inh. Slope 7.3 1 Kd/Att. Factor Inh. Slope 6.1 5 0 100 100 0 No Attenuation 6.1 ED 5 12 13 1 soil ing. ************************************	.114E-08 mg/kg*day = (C*CR*EF*ED*AF*CF*1E-	2.114E-U8 mg/kg*ady = (C*CK*EF*ED*AF*CF*1E-b), 0.38417293 3910 3910 3120 1 0.1 45 5 12 13 5 12 13 70 0.5
Soil Ingestion cont. [] (mg/kg)(ppm) C consumption rt. (mg/day) CR (2-6 200, >6 100) exposure freq. (d/yr) EF duration of exp. (yrs) ED avg. body wt. (kg) BW (2-6 16, 6-18 41, adult 70) avg. life expectancy (74.6) L absorption factor (0-1) AF	Transport multiplier TR soil inqestion dose (mq/kq/d)	d) SA 3120) factor -1) AF) EF rs) ED W adult 7

	= (CR*C/Kd*EF*ED*DF*AT) / (BW*L*365)		=(IR*C*1/VF*EF*ED*AF*CF)/(BW*L*365)	
13	lay	20 20 13 70	lay	18150 13 70
12 4 1	mg/kg*day	20 12 41	mg/kg*day	13175 1
0.38417293 1.4 27500 350 350 6.500E-07	4.082E-14 1	0.38417293 20 20 5.48E+07 150 70 CF 0.5	6.427E-11 r	0.38417293 27500 7200 3 75 350 5 16 70
soil cont. [] (mg/kg) C consumption rt. (L/day) CR Kd (L/kg) Kd exp. freq. (365) (days/yr) EF exposure duration (yrs) ED diet fraction (.75-1.0) DF avg. body wt. (kg) BW lifetime (74.6) L Attenuation factor(0-1) AT Transport multiplier TR	water consumption exposure	Inhalation of Vapors	vapor inhalation dose	Dermal Contact in Shower soil cont. [] (mg/kg) C Kd (L/kg) Kd skin surface area (cm2) SA (<2 4000 2-6 7200 6-12 1317 15-18 17000 adult 18150) exposure freq. (days/yr) EF exposure duration (yrs) ED avg body wt (kg) BW lifetime (74.6) L

Groundwater Consumption

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RISK ASSESSMENT PLAN FOR PETROLEUM UNDERGROUND STORAGE TANKS IN KENTUCKY PART II: DIESEL, HEATING OIL, OTHER MIDDLE DISTILLATES AND WASTE OIL

D.P. Keogh, M.D. Kercher, and W.J. Birge

APPENDIX II

ENVIRONMENTAL HALF-LIFE AND ECOLOGICAL EFFECTS OF PAHS

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Introduction and Objectives

Information on the environmental fate and ecological toxicity of polynuclear aromatic hydrocarbons (PAHs) in diesel fuel is essential to develop accurate fate models and risk-based assessment programs, to undertake remediation protective of human health and biota, and to comply with existing regulations. This document presents information concerning the PAHs considered to be most important and representative among those occurring in diesel fuel (Birge et al., 1995). Discussed are six non-carcinogenic compounds (naphthalene, acenaphthene, anthracene, fluorene, fluoranthene, and five carcinogenic compounds (benzo(a)pyrene, benzo(a) anthracene, benzo(b) fluoranthene, benzo(k) fluoranthene, chrysene).

The principal objectives of this document are: 1) to present information regarding the physical and chemical characteristics; environmental half-lives in air, surface water, soil and ground water, ecotoxicology, and bioaccumulation tendencies of these PAHs; 2) to assess the potential environmental and ecological effects of these compounds upon the aquatic ecosystems of surface waters and wetlands subsequent to UST leakage of diesel; and 3) to provide appropriate recommendations based upon the information available.

PAHs in the Environment

PAHs comprise a group of over one hundred aromatic chemical compounds having two or more rings which are formed during the

incomplete combustion of coal, oil, gas, garbage, or other organic substances (ATSDR, 1994a,b). Chemically pure PAHs are crystalline solids. Naphthalene is used extensively as a moth repellant and as an intermediate in the synthesis of phthalic anhydride, carbaryl, dispersants and wetting agents, dyes, and resins. Likewise, anthracene is used in the synthesis of medicines, dyes, smoke scintillation counter crystals, screens, and in semiconductor research. Acenaphthene is used in dyes, plastics, insecticides and fungicides. Fluorene serves as a chemical intermediate in many chemical processes and in the formation of polyradicals, while fluoranthene is used to line iron and steel water pipes and storage tanks. For pyrene, benzo(a)anthracene, benzo(a) pyrene, benzo(b) fluoranthene and benzo(k) fluoranthene there is no known use except as research chemicals.

PAHs occur ubiquitously within the environment, usually as mixtures of two or more compounds (ATSDR, 1994a,b). They enter into the atmosphere primarily from pyrolysis of wood and fuels, and may be found in vehicle exhausts, coal tar pitch, creosote, road roofing tar, and hazardous waste sites. Natural sources of PAHs include volcanoes, forest fires, coal, crude oil and shale oil. Once released into the atmosphere, they may exist as vapors or sorbed to suspended particles. Subsequently, PAHs may undergo photooxidation, chemical oxidation, and extensive transport and removal through precipitation and dry deposition, as evidenced by the occurrence of PAHs in soils remote from heavy automobile traffic and industry (Wild et al., 1991). PAHs enter into surface

waters in industrial effluent discharges, municipal wastewater, spills, and by atmospheric deposition. Subsequently, they may undergo volatilization, transformation by photooxidation, chemical oxidation, microbial metabolism, and sorption to sediments. Branson (1978) noted that chemicals most likely to be associated with sediments were those with low vapor pressures and low water solubilities. These properties are especially evident among the higher molecular weight PAHs having four or five rings. sorption to particles in the water column, microbial degradation and photolysis are important removal processes for these compounds; whereas volatilization, microbial degradation and photolysis are more important for naphthalene and the substituted PAHs. enter into soil from atmospheric deposition, sludge, irrigation using effluents, composts and fertilizers, and spills. sediments and soils, the principal removal process is microbial degradation. Volatilization may also be important for naphthalene and the substituted PAHs. PAHs enter groundwater by spills and migration from contaminated surface waters and soils. Partitioning into the particulate soil phase and microbial degradation are the principal removal processes (Wilson and Jones, 1993; Kan et al., 1994).

Inhalation of air containing PAHs is a principal route of exposure. The primary sources for exposure are factories, auto exhausts, and hazardous waste sites (ATSDR, 1994a,b). Other avenues for exposure include various foods (e.g. grilled or charred meats, refined fats and oils, processed or pickled foods, produce

grown in contaminated soil or air, cereals, grains, flour, bread, vegetables, fruits, beverages), contaminated dust or drinking water, tobacco smoke, smoke from burning wood used in home heating, creosote-treated wood products, and dermal contact with soot or tars. Total PAHs in the typical American diet are less than two parts per billion parts of food (ATSDR, 1994b).

Physical/Chemical Characteristics

Ultimately, the environmental fates of the PAHs (i.e. half-life, ecotoxicity, and bioaccumulation) will depend greatly upon their intrinsic physical and chemical characteristics. These tend to vary according to number of rings and molecular weight (Table AII-1). Compounds comprised of two or three rings have properties intermediate between those of BTEX and the higher molecular weight PAHs. As a group, the PAHs with four and five rings tend to be more lipid soluble, less water soluble and less volatile than the low molecular weight compounds or BTEX. Four important physical/chemical properties are considered below (Table AII-1):

Water Solubility

Water solubilities of naphthalene, acenaphthene, and fluorene (32, 3.8 and 1.9 mg/L, respectively; U.S. EPA, 1986) are more similar to those of BTEX than of the higher molecular weight PAHs. The latter compounds are only slightly soluble or insoluble in water (0.26 mg/L for fluoranthene to 8.1 x 10⁴ mg/L for benzo(k)fluoranthene; U.S. EPA, 1986).

Henry's Law Constant, H

The tendency of a compound to volatilize from water into air is expressed by the magnitude of Henry's Law constant (H). Smith et al. (1980) considered chemicals to have high volatility if H > 4.6 x 10⁻³ atm-m³/mol. Lyman et al. (1982) associated values from 10⁻³ to 10⁻⁵ with significant volatilization and values <10⁻⁵ with limited volatilization. Accordingly, volatility of naphthalene, acenaphthene, fluorene, and anthracene from water would be significant (Table AII-1). Values of Henry's Law constant for fluoranthene, benzo(a) anthracene, chrysene, and benzo(a) pyrene are one or two orders of magnitude less (10⁻⁶ to 10⁻⁷), indicating that volatilization of these PAHs from water would be limited.

Soil Sorption Coefficient, Koc

According to Kenaga (1980a,b), compounds with a K_{∞} <100 are considered moderately to highly mobile. The K_{∞} values for naphthalene and the PAHs exceed 100 (Table AII-1). The K_{∞} of 930 L/kg for naphthalene is more similar to the K_{∞} s for BTEX than to the other PAHs, whose K_{∞} values increase greatly with ring number and molecular weight (from 4,571 L/kg for acenaphthene to 5,495,409 L/kg for benzo(a)pyrene). Therefore, PAHs in soils would be considered slightly mobile to immobile with little tendency to leach and a strong tendency to bind to organic carbon. Sorption of PAHs to organic carbon would increase as organic carbon content increases and soil particle size decreases (Karickhoff et al., 1979).

Octanol-Water Partition Coefficient, Kow

The n-octanol-water partition coefficient of naphthalene is 1900, similar to that for o-xylene (Table AII-1). However, K_{ow} values for the other PAHs are considerably greater, ranging from 9,550 for acenaphthene to 1,148,154 for benzo(a)pyrene and benzo(k)fluoranthene. These high K_{ow} values indicate that the other PAHs, especially the higher molecular weight compounds, strongly partition from water into lipids in agreement with their low water solubilities. This indicates the potential for PAHs to bioaccumulate within the tissue lipids of biota as discussed below.

In summary, the combined properties of low water solubility, moderate volatility, high soil sorption, and high lipid solubility have the greatest influence upon the environmental transport, partitioning and fate of PAHs. These include half-lives in air, soil and water, ecotoxicology, and bioaccumulation, which are treated below.

Environmental Half-life

Introduction

An important parameter related to environmental persistence of BTEX is environmental half-life, the time it takes for half an initial concentration of a compound to disappear following release into the environment. A short environmental half-life can minimize the deleterious effects of a toxic compound, while a long environmental half-life can potentiate possible effects of less toxic compounds. The measured half-life would take into account

all degradative processes, both chemical and biological, and factors of dilution/attenuation.

Tables AII-2 through AII-12 present a compilation of half-life values in soil, groundwater, surface waters, and air obtained from a survey of the literature for representative PAHs. Literature sources and experimental conditions accompany the tabular values. The half-life values are derived from five categories: 1) measured half-lives observed in the field under natural, adverse (metal contamination) or enhanced remediating conditions (e.g. microbes, surfactant, nutrient enriched); 2) half-lives derived from laboratory biodegradation studies under a variety of circumstances (e.q. natural, varied temperature regimes, aerobic, anaerobic, enhanced conditions); 3) calculated values projected degradation rate constants measured during field or laboratory studies; 4) scientific judgement derived from half-lives estimated in another medium; and 5) estimated values from calculated reaction Greatest emphasis was given to the first category, and whenever possible field studies were used in selecting values appropriate for geological conditions in Kentucky.

Two different methods were commonly used in PAH half-life determinations. The first was the measurement of complete mineralization. This process involved spiking the medium with a known quantity of radio-labelled PAH and calculating the half-life by quantifying the amount of labelled CO₂ produced. One study which incorporated measurements of metabolic intermediates and cellular

bound ¹⁴C fractions in addition to labelled CO₂ determined that halflife values based on ¹⁴CO₂ evolution grossly underestimated transformation rates of PAHs (Herbes and Schwall, 1978). The second method measured the percent of PAH recovered over time. The accuracy of this procedure may be questionable because of the ability of PAHs to complex with soil or sediment components and therefore avoid detection during chemical analysis. Additional problems arose in field evaluations because of further deposition from uncontrolled sources (Wild et al., 1991). The variety of test conditions and methods noted above resulted in a wide range of half-life estimations (Wild and Jones, 1993).

PAH Half-life Duration and Molecular Size

PAHs can be classified into two distinct categories based on their half-lives and molecular size. The lower molecular weight two and three-ringed PAHs (i.e. naphthalene, acenaphthene and fluorene) are characterized by relatively short half-lives (approximately two years or less under the most adverse conditions tested); while the larger four through six-ringed PAHs (i.e. benzo(a)pyrene, benzo(a)anthracene, the benzofluoranthenes, and chrysene) are more persistent in the environment. Half-lives of these compounds may approach twenty years under certain adverse soil conditions (Wild et al., 1991). Differences between the low and high molecular weight groups may be attributed primarily to two interrelated factors: solubility and bioavailability.

It is well established that there is a general decrease in water solubility as molecular weight and ring number increase (Srivastava et al., 1990; Wilson and Jones, 1993). Driving this partitioning are the hydrophobic forces associated with the higher molecular weight PAHs (Kan et al., 1994). In terms of potential environmental hazard posed by soil contamination, the extremely low solubility of the four to six-ringed PAHs is beneficial because it inhibits migration of these compounds into groundwater (Srivastava et al., 1990). However, insolubility contributes directly to the persistence of the larger PAHs. It is known that, like BTEX compounds, two and three-ringed PAHs are readily degraded by microorganisms. PAHs of four or more rings are more resistant, especially when adsorbed onto soil (Sherman et al., 1990; Srivastava et al., 1990; Wilson and Jones, 1993). essentially lack the capability to break down the non-aqueous phase complexes and, therefore, the higher molecular weight PAHs are relatively unavailable to biodegradation unless first solubilized. Because biodegradation of PAHs often is limited by low water solubility and dissolution rates, recent research has emphasized the use of surfactants to increase bioavailability (Srivastava et al., 1990; Wilson and Jones, 1993; Tiehm, 1994). The enhanced bioavailability is reflected in the short half-life estimates observed in some studies using surfactants. These values should not be considered appropriate for use in PAH fate modeling under ambient conditions, but would be of value in planning remedial measures.

An additional factor contributing to variation in soil and groundwater half-life values is previous exposure of the microbial flora to PAHs (Wilson et al., 1985; Herbes and Schwall, 1978; Heitkamp and Cerniglia, 1988; Heitkamp et al., 1988; Sherman et al., 1990). Soil organisms inhabiting pristine conditions prior to contamination must undergo an acclimatization period that may last from two weeks for two and three-ringed PAHs to several months for four to six-ringed PAHs. Projected half-life values resulting from studies which used acclimated soils or groundwater may be inappropriate for some environmental fate models, while estimates based on degradation rates during the initial acclimatization period (e.g. Herbes and Schwall, 1978) are invalid predictions of PAH transformation in nature.

An area of concern in evaluating half-life estimates based on scientific judgement for soil and groundwater (i.e. Howard et al., 1991) is the assumption that predominantly anaerobic conditions slow biodegradation rates, thus increasing the half-life as observed for the BTEX compounds. While some studies indicate this may be the case for two and three-ringed PAHs (Mihalcic and Luthy 1988a), other studies suggest that oxygen availability may not be a big factor. In a study specifically designed to examine factors affecting biodegradation of phenanthrene, soil aeration was noted to enhance the mineralization rate only slightly (Manilal and Alexander, 1991). Additionally, the anaerobic degradation of naphthalene in sulfate reducing groundwater was approximately five times faster than that predicted in a computer model (Thierrin et

al., 1993). McFarland and Sims (1991) used a method to evaluate redox conditions during mineralization of PAHs in soil and groundwater based on free energy liberated from heterotrophic PAH metabolism. The resulting microbial yields determined that Mn^{+4} was a preferred electron acceptor over O_2 , and that NO_3^{-1} and Fe^{+3} approximated O_2 in energy yield from PAH oxidation. A study of PAH degradation in soil following chemical oxidant pretreatment supported the concept that manganese is a favorable electron acceptor (Srivastava et al., 1990). This is one area where further research is necessary.

Evaluation of a Soil Study

The British study by Wild et al. (1991) warrants examination prior to further discussion of soil half-lives because the resulting estimates were extraordinarily higher than those of other studies (by a factor of 1 to >10). This was a long-term project examining the effects of four metals (Cu, Cr, Ni, Zn) on PAH degradation in municipal waste-fertilized soils. PAH and metal laden sludge was applied to pristine (Luddington) and previously exposed (Lee Valley) soils. Though metals (especially nickel) inhibited PAH degradation at both sites, the magnitude of inhibition differed sharply. While the Lee Valley half-lives were reported to be comparable to values from a literature data base, those from Luddington ranged from 1 to >10 years longer. The authors noted that several complicating variables were involved (Wild et al., 1991; Wild and Jones, 1993).

First, total PAH concentrations at both control sites more than doubled between the initial (1968) and the final (1988) measurement as a result of atmospheric deposition. Their calculations of half-life estimates factored this out, therefore uncontrolled contamination probably did not contribute to PAH longevity. A follow-up study demonstrated that the four year duration between post-treatment sample analyses was a major cause of the high estimates. The use of spatial moments analysis in calculating half-lives from the twenty-year data set was most likely a major contributor to the overestimation of half-life This method fails to factor out the persistence of residual amounts of PAHs. Though the authors ruled out differences in microbial degradative competency, they did believe differences in physical/chemical parameters between soil types to be major contributors to the variations in the overall degradation rates of PAHs (Wild and Jones, 1993).

As a result, the 1991 study was considered anomalous and was not utilized in determining appropriate expected PAH half-life estimates for Kentucky soil contaminated by UST leaks. However, two observations from this research should be considered important to the initial location and ultimate remediation of UST sites: 1) metals or other non-PAH contaminants may adversely affect environmental conditions, compounding problems resulting from UST leakage; and 2) unrecognized ambient conditions may drastically alter the longevity of these compounds.

Half-lives for Two and Three-Ringed PAHs

The two and three-ringed PAHs (Tables AII-2 to AII-5) naphthalene, acenaphthene, anthracene, and fluorene are considered together in this document because of similarities in water solubility, half-life, and non-carcinogenicity. Half-life values in air and surface water are typically short (hours to days), and the degradation rate is influenced primarily by abiotic processes. Values in soil and groundwater are longer (weeks), and microbial degradation is the principal determinant of half-life duration. Volatilization of PAHs from soils appears to be a negligible process for all compounds except naphthalene and the substituted PAHs (Park et al., 1990; Wild et al., 1991).

Air and Surface Water

Atmospheric half-lives of two and three-ringed PAHs are influenced by rapid degradation, which occurs primarily by photo-oxidation with hydroxyl radicals or through photolysis. Half-life values for the representative compounds ranged from 0.58 hours for the photolytic rate of anthracene (Mackay et al., 1992) to 68.1 hours for the photooxidation of fluorene (Howard et al., 1991).

Half-life estimates for these compounds in surface water ranged from 0.58 hours for the photolysis of anthracene to 60 days for the biodegradation of fluorene. Values for naphthalene ranged from <1 day for field observation data in the Rhine River (Zoeteman et al., 1981), to 53 days for a biodegradation study using filtered harbor and river water inoculated with acclimated bacteria

(Vaishnav and Babeu, 1987). Considering that the accepted volatilization half-life for this compound is 16 hours (Mackay et al., 1992), a one day estimate for fifty percent degradation is reasonable. Based on the literature for acenaphthene and anthracene (Tables AII-3 and AII-4), a half-life estimate of 1 week would be considered conservative. Because of the paucity of information for fluorene, the 32-60 day estimate based on a soil die-away test (Howard et al., 1991) should be adopted.

Soil

Given that underground storage tanks typically leak diesel fuel directly into soil, and that movement of PAHs in soil is inhibited by low water solubility, soil half-life estimates of PAHs are most relevant. Biodegradation is the primary transformation mechanism of two and three-ringed PAHs. Half-life values of the representative two and three-ringed PAHs in soil ranged from a low value of 0.02 weeks to a maximum of 6 months. The low value was determined for the degradation of naphthalene in stream sediments that had been previously exposed to PAHs (Shiaris et al., 1989). The high estimate was calculated from the December transformation rate constant of naphthalene degradation in stream sediments that had no prior contamination history (Herbes and Schwall, 1978). Most values for naphthalene, acenaphthene, anthracene, and fluorene fell between 2 days for acclimated soil and 102 days for unacclimated soil.

Environmental half-life estimates for naphthalene in soil

(Table AII-2) ranged from approximately 5 hours in acclimated stream sediments in October and November (Herbes and Schwall, 1978) to approximately 6 months for pristine stream sediments based on the mineralization rate constant in December (Herbes and Schwall, 1978). One estimate of 46 weeks (Wild et al., 1991) apparently was a typographical error in the journal article and pertained to the 6 month rate mentioned above. The majority of values noted in the literature were less than two months. The 35 ± 17 day value from a data base (Sherman et al., 1990) appears to be an appropriate half-life for most circumstances encountered.

Reported half-life estimates for acenaphthene (Table AII-3) ranged from 0.04 week for a contaminated soil column pretreated with a chemical oxidant (Sherman et al., 1990; Wild et al., 1991) to a maximum between 2 and 3.2 years averaged from 5 unacclimated sandy loam fields, 4 of which were contaminated by metals (Wild et al. 1991). The Sherman et al. (1990) value of 51 ± 19 days, a mean value of studies through 1988, appears to be a representative half-life estimate for acenaphthene.

Soil half-life estimates for anthracene (Table AII-4) ranged from 2.3 days in acclimated stream sediment during October (Herbes and Schwall, 1978) to <7.9 years for unacclimated fields contaminated with heavy metals (Wild et al., 1991). Though most soil half-life estimates were less than 90 days, it should be noted that the value obtained from a 0.5% organic matter sandy loam static flask test was 134 days with 95% confidence interval between

106-182 days (Park et al., 1990). Overall, anthracene appears to be more persistent than other two and three ring PAHs, so use of the latter half-life estimate for predicting the environmental fate of this compound is conservatively appropriate.

Soil estimates for fluorene (Table AII-5) were least variable of all PAHs, and ranged from >1 day for an acclimated soil column pretreated with chemical oxidants to a maximum of 2.3 years for copper contaminated soil (Wild et al., 1991). In the latter study, fluorene was almost completely degraded in the nine other fields when they were first sampled two years after application. The only half-life value >60 days for fluorene was that for the copper contaminated soil. The 41 day half-life (with a 95% confidence interval of 35-52 days) taken from a data base (Sherman et al., 1990) appears inclusive for all except the most adverse conditions.

Groundwater

The half-life estimates for naphthalene in groundwater (Table AII-2) ranged from less than one week for a biologically remediated acclimated aquifer (Wilson et al., 1985) and for an aerobic static flask test (Tabak et al., 1981) to 258 days for a theoretical estimate based on the mineralization rate constant for pristine sediments in December noted previously (Howard et al., 1991). Upon considering three studies which actually measured naphthalene degradation in aquifers (Wilson et al., 1985; Boggs et al., 1993; Thierrin et al., 1993), the half-life of 76 ± 23 days (Boggs et al., 1993) would be an appropriate predictive estimate for most

circumstances.

PAHs adsorb to the soil phase of the subsurface environment in so strong a manner that the measured desorption rate may be twenty-fold less than that predicted by their water solubility values (Wilson and Jones, 1993; Kan et al., 1994). The few available studies of PAHs in groundwater reflect the limited occurrence of and/or the lack of importance that has been placed on this phenomenon. Despite this, the possibility of PAH groundwater contamination exists, especially by the more soluble two and three-ringed PAHs. Biodegradation is the primary transformation process in groundwater (Srivastava et al., 1990; Wilson and Jones, 1993). Half-life values for the low molecular weight PAHs ranged from less than 1 week for naphthalene, acenaphthene and fluorene to 900 days for anthracene.

The half-life estimates for acenaphthene presented in Table AII-3 ranged from less than 1 week (Wilson et al., 1985) in an acclimated aquifer to 204 days estimated from a Derby soil column (Howard et al., 1991). The only reported field values of untreated groundwater were 5.5 - 7.5 weeks for an unacclimated aquifer (Wilson et al., 1985). The fact that this estimate is for an aquifer without either previous exposure to PAHs or enhanced conditions for biodegradation makes it a good representative half-life for predicting acenaphthene transformation rates.

Groundwater estimates presented in Table AII-4 for anthracene

were 1-4 weeks for 5-10 mg/L of compound in an inoculated aerobic static flask test (Tabak et al., 1981) and 100 - 900 days representing scientific judgements based on the results of a dieaway test for soil (Howard et al., 1991). Given that anthracene soil half-life values and those observed in the static flask test above were longer than those observed for the other two and three-ringed PAHs, it is expected that anthracene may be degraded at a slower rate than comparably sized PAHs. The lower transformation rates predicted by Howard et al. (1991) typically were more comparable to the observed norm than were high estimates. Therefore, it is reasonable to anticipate natural groundwater anthracene values ranging between 100-250 days.

Half-life estimates presented in Table AII-5 for fluorene ranged from <1 week for a biologically treated aerobic aquifer (Wilson et al., 1985) to 120 days calculated from a soil die-away test (Howard et al., 1991). In the sole field study of a contaminated unacclimated aquifer, half-lives of 5 to 8 weeks were observed (Wilson et al., 1985). This 5 to 8 week range seems appropriate for use in predicting environmental fate for fluorene under most natural circumstances.

Half-lives for Four and Five-Ringed PAHs

The representative four and five-ringed PAHs considered in this document are fluoranthene, pyrene, chrysene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, and benzo(k)fluoranthene (Tables AII-6 through AII-12). With the

exceptions of fluoranthene and pyrene, these compounds carcinogenic, making their half-lives of particular concern. the discussion which follows, the higher molecular weight PAHs have share characteristics grouped together because they influencing their environmental fate and longevity. Because of their large size and hydrophobic properties (e.g. high Kows and Kms), water solubility is low to negligible and a hysteretic effect is exhibited as a result of the high degree of binding to soil These properties are fortuitous in that they render particles. four and five-ringed PAHs immobile, thus greatly limiting any environmental hazard they may pose to the immediate depositional area. Recalcitrant biodegradation is characteristic of these PAHs, as they are not readily bioavailable and their large molecular size may inhibit bacterial assimilation. Ultimately, these compounds are more persistent within soil than the lower molecular weight PAHs.

Air and Surface Water

Half-life estimates for the four and five-ringed PAHs (Tables AII-6 through AII-12) in air ranged from 0.33 to 34.9 hours. These were based on estimated photooxidation rate constants for the reaction with hydroxyl radicals in air (Howard et al. 1991), ozone in a simulated atmosphere (IRIS, 1991) or photolytic rate derived from irradiated degradation in either aqueous or methanolic medium (Howard et al., 1991). Because of the insignificant volatilization of most PAHs from soil (Park et al., 1990) and the short half-life in air, potential atmospheric hazard of diesel fuel leakage from a

UST would be negligible. Photolytic half-life values of the higher molecular weight PAHs in surface waters ranged from 0.33 day for benzo(a)pyrene (Miller et al., 1988) to 200 days at 5-meter depth for fluoranthene (Mackay et al., 1992). Biodegradation rates in water ranged from less than a day for aerobic bacterial culture medium for fluoranthene and pyrene, (Heitkamp and Cerniglia, 1988) to 11 years based on a theoretical judgement derived from an unacclimated anaerobic soil half-life for chrysene (Howard et al., The majority of estimates predicted complete degradation Photolysis and particulate adsorption are within a few days. likely the dominant fate mechanisms in surface waters, with microbial degradation having a minor role in deeper water. Because of low solubility, concentrations of four and five-ringed PAHs in contaminated effluents were difficult receiving water distinguish from baseline and were between 600 to 1000 times greater in the underlying sediments (Herbes and Schwall, 1978). Therefore, it may be concluded that these compounds do not persist in surface water.

Soil

The literature half-life values for the four and five-ringed PAHs were highly variable and ranged from less than one day for pyrene and fluoranthene in surfactant treated acclimated soil columns (Srivastava et al., 1990; Tiehm, 1994) to 14.2 years for benzo(a) anthracene calculated from the mineralization rate constant observed in unacclimated stream sediments in December (Herbes and Schwall, 1978). Overall, these compounds tend to persist

significantly longer than the smaller two and three-ringed PAHs, and this longevity increases with size and ring number.

Half-life values for fluoranthene (Table AII-6) ranged from <1 day (Srivastava et al., 1990) to 7.8 years for unacclimated metal contaminated soils (Wild et al., 1991). The Kidman sandy loam values derived in the study by Park et al. (1990) were of particular interest as reliable half-life predictors. The organic carbon content of 0.5% was similar to that expected for the Kentucky UST subsurface soil depths. Half-life estimates from this triplicate, 196 day, unacclimated soil static flask test were calculated using first order kinetics. This is a conservative approach considering the extensive acclimation periods that exist for larger PAHs. The fluoranthene half-life estimated from this study was 377 days with 95% confidence intervals of 277 to 578 This result fell within the middle of the confidence days. intervals derived from the data base developed by Sherman et al. (1990) for a variety of conditions. Therefore, it was reasonable to assume that, for most UST-associated circumstances, fluoranthene half-life would coincide with the Kidman sandy loam study. likely that only the most extreme and adverse conditions would result in half-lives exceeding the 880-day upper limit noted by Sherman et al. (1990).

Half-life estimates for pyrene (Table AII-7) ranged from less than one day for surfactant (Tiehm, 1994) and oxidant (Srivastava et al., 1990) treated soils to 8.5 years for Luddington soils

contaminated with metals (Wild et al., 1991). Values observed in other studies were scattered throughout this range. The Kidman sandy loam had one of the higher estimates, 260 days, with 95% confidence limits of 193 to 408 days (Park et al., 1990). Two sources had greater estimates. The Luddington study produced anomalous results under adverse conditions (metal toxicity) (Wild et al., 1991), and the upper end of the range noted by Howard et al. (1991) represented unfavorable temperature extremes for bacterial metabolic activity. Therefore, the Kidman sandy loam half-life of 260 days was selected as the value most applicable to the majority of situations.

Half-life estimates for chrysene (Table AII-8), the final four-ringed PAH considered in this study, ranged from approximately four days for a treated, acclimated soil column (Sims and Overcash, 1983) to 8.1 years for metal treated Luddington soils (Wild et al., 1991). Most other observations from the literature fell within the range of 100 to 400 days. The Kidman sandy loam value of 371 days (with a 95% confidence interval of 289 to 531 days) is considered the most appropriate half-life for the majority of environmental circumstances. The upper end of the McLaurin sandy loam 95% confidence intervals from the same study (Park et al., 1990) should include all except the most extraordinary conditions for chrysene degradation in soil.

The literature values for benzo(a)anthracene ranged from 0.6 weeks for a treated acclimated soil column (Sims and Overcash,

1983) to ~8 years estimated from the mineralization rate constant of unacclimated stream sediments in December (Herbes and Schwall, 1978) and the unacclimated metal contaminated Luddington fields (Wild et al., 1991). Most studies in which the ambient environmental conditions were not unnecessarily manipulated resulted in half-lives between 100 and 300 days. The Kidman sandy loam estimate of 261 days with 95% confidence intervals of 210 to 347 days (Park et al., 1990) was one of the highest noted for benzo(a) anthracene. In all except the most unusual circumstances, half-lives for benzo(a) anthracene in soils should be <347 days. Because of the duration of acclimation and the adverse temperatures for microbial metabolic activity, the calculated 8 year half-life from the rate constant of December unacclimated stream sediments (Herbes and Schwall, 1978) is unrealistic for conditions in Kentucky.

Benzo(a)pyrene in contaminated soils (Table AII-10) appeared to be more recalcitrant than the four and five-ringed PAHs previously discussed. Estimates ranged from 2 days (Wild et al., 1991) for a treated acclimated soil column to 39.6 years calculated from the mineralization rate constant for unacclimated December stream sediments (Herbes and Schwall, 1978). The 309 day half-life with 95% confidence limits of 239-462 days for Kidman sandy loam approximated the median value. Because of the number of elevated values, 900 days is considered an appropriate upper limit. Half-lives for benzo(b)fluoranthene and benzo(k)fluoranthene (Tables AII-10 and AII-11) approximate those found for benzo(b)pyrene. A

half-life estimate of 300 days would include approximately half of all circumstances, and 900 days would cover all except the most unusual conditions.

Groundwater

Two sources for groundwater half-lives of the four and fiveringed PAHs were found in the literature. Howard et al. (1991)
provided a theoretical scientific judgement based on a soil dieaway test, while Tabak et al. (1981) examined biodegradation in an
aerobic static flask test inoculated with bacteria and 5-10 mg/L of
compound. Because of the extremely low water solubility and tight
adsorptive binding of the larger molecular weight PAHs, the
groundwater half-lives of these hydrocarbons may be essentially
inconsequential. PAH remediation research has focused recently
upon the use of surfactant to increase bioavailability (Sherman et
al., 1990; Srivastava et al., 1990; Aronstein et al., 1991; Wilson
and Jones, 1993; Kan et al., 1994; Tiehm, 1994).

Ecotoxicology

Toxicity is an important consideration when assessing the environmental and ecological effects of chemicals. The environmental toxicology of many substances has been investigated using toxicity tests which expose a sensitive species to incremental concentrations of a given substance under acute or chronic conditions. An important parameter derived from these tests is the median lethal concentration (LC_{50}), the concentration at which 50% of the experimental population dies. This is used to

compare the toxic effects of different compounds under a given set of conditions.

Naphthalene, acenaphthene, fluoranthene, and PAHs have been designated priority pollutants by the U.S. EPA which has promulgated quality criteria for water and human health protection for these compounds. These values are presented in Table AII-13, and U.S. EPA drinking water standards are provided in Table AII-14. For comparison, this table includes Commonwealth of Kentucky ambient water criteria and drinking water criteria. In addition. the EPA (1984)has designated benzo(a) anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene and chrysene as B2 (probable) human carcinogens. Likewise, the International Agency for Research on Cancer (IARC, 1973; 1983) has designated these compounds as 2A (probable) or 2B (possible) human carcinogens.

The fresh water acute LOEL values for naphthalene, acenaphthene, and fluoranthene are 2.3, 1.7, and 3.96 mg/L, respectively. Fresh water chronic LOEL values for naphthalene and acenaphthene are 620 and 520 μ g/L (U.S. EPA, 1986), respectively (Table AII-13). Although somewhat lower, the acute values above are in the same range (mg/L) as the freshwater acute LOELs for BTEX (Kercher et al., 1995).

Criteria for the protection of human health from water and fish ingestion for acenaphthene, fluoranthene, and PAHs (10^{-6} cancer

risk) are 20, 42, and 0.0028 μ g/L, respectively (Table AII-13). The latter value also is equivalent to the Commonwealth of Kentucky drinking water maximum contaminant level (MCL) for PAHs (KDEP, 1990). For fish consumption only, the values for fluorene and PAHs are 54 and 0.0311 μ g/L, respectively, for both the U.S. EPA and the Commonwealth of Kentucky.

According to the U.S. EPA Drinking Water Standards presented in Table AII-14, the MCL for benzo(a) anthracene is 0.0001 μ g/L and that for benzo(b)fluoranthene, benzo(k)fluoranthene and chrysene is 0.0002 μ g/L. No other MCLs were given. As indicated above, for PAHs the Commonwealth of Kentucky drinking water MCL is 0.0028 μ q/L (Table AII-13). For PAHs in general, the water quality criterion for human health protection at 10^{-6} cancer risk is 0.0031 μ g/L for drinking water; 0.0028 μ g/L for drinking water and aquatic organisms; and 0.031 μ q/L for aquatic organisms. These values carcinogens also were used for the benzo(a) anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, and chrysene.

Animal testing of PAHs has been performed primarily to determine carcinogenicity and other hazards to human health. Aquatic ecotoxicity studies were found in the literature only for naphthalene, acenaphthene, and benzo(a)anthracene (Table AII-15). Acute and chronic LC_{50} values were determined from toxicity tests conducted in freshwater or saltwater. Both the acute and chronic LC_{50} values for the three compounds were in the mg/L range. By

comparison, aquatic LC₅₀ values for highly toxic metals generally are in the μ g/L range. Freshwater acute LC₅₀ values for naphthalene ranged from 2.3 mg/L to 150 mg/L, while for acenaphthene the range was from 0.6 to 1.7 mg/L (72-hour freshwater LC₅₀s). For salt water species, the LC₅₀s ranged from 2.4 to 199 mg/L and 0.5 to 2.2 mg/L for naphthalene and acenaphthene, respectively. The chronic values of 0.62 mg/L for naphthalene (freshwater) and 0.71 mg/L for acenaphthene (saltwater) were approximately an order of magnitude less than acute values determined for these compounds with the same species. The third chronic value, an LC₈₇ of 1 mg/L for benzo(a)anthracene, was comparable to the two LC₅₀ chronic values.

Bioaccumulation

The tendency of a compound to partition from water into the tissue lipids of aquatic animals is termed bioconcentration. Continued bioconcentration of a substance over time can lead to bioaccumulation of the substance within an organism. Neely et al. (1974) demonstrated the relationship between bioconcentration and the n-octanol-water partition coefficient, P (or K_{ow}). The more lipophilic a compound, the greater its tendency to bioaccumulate which was not considered significant when P <1000 (Veith et al., 1980). The ratio between the concentration of a substance in tissue lipids of an organism versus the ambient concentration in the water surrounding the organism is known as the bioconcentration factor (BCF). Veith et al. (1980) expressed the relationship between the BCF and P as the following modification of the original

formula by Neely et al. (1974):

log BCF = 0.76log P - 0.23

BCFs can be used to estimate the bioaccumulation potential of chemicals.

BCFs for the non-carcinogenic PAHs are presented in Table AII-16, carcinogenic PAHs in Table AII-17. Most bioconcentration equilibrium measurements were made under conditions. However, it is possible that biotransformation products of the parent PAH also were measured in some studies using radiolabeled compounds (Spacie et al., 1983; ATSDR, 1994a,b), thus overestimating the BCF. Eisler (1987) reported BCFs for PAHs in crustaceans and fish to range between 100 and 2000. Although most BCF values in Tables AII-16 and AII-17 are <2000, values >2000 were observed in some species, especially for the higher molecular weight PAHs.

In a careful study conducted by the U.S. EPA (1980a), a BCF of 387 was determined for acenaphthene in Lepomis macrochirus. This value is probably representative for the lower molecular weight compounds because PAHs undergo biotransformation in fish (Eisler, 1987) and other estimates may include metabolic degradation products. This BCF value slightly exceeds those for BTEX (Kercher et al., 1995). Freshwater and saltwater BCF values for naphthalene are uniformly low except for those in the algae Selenastrum capricornutum, which range from 6,918.3 to 17,728.8. However, with regard to the four-ringed non-carcinogenic PAHs which have higher

K_{ow}s than naphthalene, several BCFs exceed 2,000. These range from 2,691.2 for pyrene in *Daphnia magna* to 79,432.8 for fluoranthene in *Pontoporeia hoyi*.

The higher molecular weight carcinogenic PAHs with four to five rings have considerably higher K values, ranging from 407,380 for benzo(a) anthracene and chrysene to 1,148,154 for benzo(a) pyrene and benzo(k) fluoranthene (Table AII-1). Many of the BCFs for these compounds in freshwater species exceed 2000 (3,162.3 for benzo(a)anthracene in algae to 141,253.8 for benzo(a)pyrene and benzo(b)fluoranthene in microorganisms). The low BCFs for saltwater species were measured in short-term experiments under non-equilibrium conditions and should be regarded underestimates.

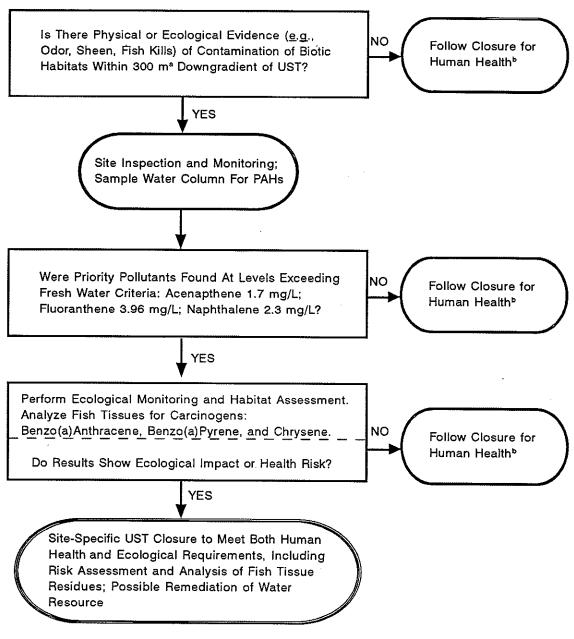
Although exceptions are evident (Tables AII-16 and AII-17), the PAHs tend to accumulate most in organisms associated with lower trophic levels (e.g. bacteria, microorganisms, algae, amphipods, cladocerans). Though bioaccumulation in these organisms indicates potential for biomagnification, it does not occur within food chains at higher trophic levels, according to a study by Eisler (1987). It was suggested that in many species rapid metabolism and biotransformation preclude extensive bioaccumulation. Likewise, reduced metabolism may contribute to bioaccumulation when it does occur in certain species.

Ecological Considerations for UST Remediation

Diesel fuel (herein represented by PAHs) leaking from a UST most commonly enters directly into the soil adjacent to the tank. Further migration from the site into surface waters, surface soil, groundwater or the atmosphere may become complex and involve many factors (McGinley, 1994). Available data suggests that, given the immobility of most PAHs in soil and the relatively small soil surface area involved (Sendlein et al., 1994), contamination of terrestrial ecosystems beyond a UST site would be unlikely. Contamination of GW would be minimal unless leakage occurred directly into the saturated zone or an aquifer. However, the aquatic ecosystems of surface waters and wetlands could be at risk under certain conditions. In the aquatic environment, most PAHs are not highly water soluble or toxic and have short half-lives. Therefore, small releases of PAHS likely would not significantly impact surficial aqueous systems. Only entry of substantial quantities of PAHs as free-standing petroleum product potentially could have significant environmental impact. Such entry of large amounts of PAHs into surface waters and wetland systems could occur if 1) the UST were in close proximity (<300 meters; or <1000 meters if a karst conduit is near) and 2) some avenue for bulk transport existed. Possible avenues of bulk transport could include 1) karst systems or 2) man-made conduits (e.g. storm sewers, drainage ditches).

During remediation of a UST, surface waters within 300 meters downgradient of the site (within 1000 meters downgradient if near a karst conduit) should be evaluated according to the scheme presented in Figure AII-1. Any petroleum spill should be contained and removed as provided under State guidance (NREPC, 1992; 1995). Evidence of oil sheens, odors, biotic impact (e.g. fish kills) or PAH contamination within the freshwater system would trigger monitoring of the water column. If exceedences of acute aquatic criteria for naphthalene, acenaphthene, or fluoranthene occurred (Table AII-13), the site should be identified for continued monitoring at monthly or bimonthly intervals. If the contamination does not meet specified guidelines (Figure AII-1) within six months to one year after the UST remediation has been undertaken, a sitespecific ecological assessment should be considered depending upon the use classification of the resource. This would include habitat assessment and chemical monitoring continued according to criterion specifications (e.g. 96 hours). Also, fish tissues would be analyzed for the carcinogens benzo(a)pyrene, benzo(a)anthracene, and chrysene. If there were ecological impact, or health risk, closure would be site-specific and entail a more comprehensive ecological study with risk assessment and analyses of fish tissue residues. Otherwise, closure for human health would proceed based on distance to receptor (e.g. 0-100, 100-300, >300 meters). closure information is provided in the text of Risk Assessment Plan for Petroleum Underground Storage Tanks (USTs) in Kentucky, Part II: Diesel, Heating Oil, Other Middle Distillates and Waste Oil (Birge et al., 1995).

FIGURE AII-1 DECISION TREE FOR UST CONTAMINATION OF SURFACE WATER SYSTEMS - PAHS



- ^a If UST Near Karst Conduit, Survey Freshwater System up to 1000 m Downgradient.
- ^b Use Matrix Values Based On Distance to Receptors (<u>i.e.</u>, 0-100 m, 100-300 m, >300 m).

Conclusions and Recommendations

- PAHs tend to form two groups, compounds with two or three rings and compounds with four or more rings. PAHs with two or three rings and lower molecular weights have properties intermediate between BTEX compounds and the PAHs with four or more rings.
- conclusion: PAHs with two or three rings have low water solubility, moderate volatility, and moderate to high soil adsorption and lipid solubility. PAHs with four or more rings tend to be essentially insoluble, with low volatility, high lipid solubility and high soil sorption. This combination of properties makes the high molecular weight PAHs less mobile and less bioavailable in the environment than the low molecular weight compounds.
 - Conclusion: The lower molecular weight two and threeringed compounds have relatively short half-lives of days to weeks, whereas the higher molecular weight four or five-ringed compounds have longer half-lives of weeks to years.
- Conclusion: Half-lives of all PAHs in air and surface
 waters generally are short (hours to days) due to abiotic

forces (e.g. adsorption to particulates, photooxidation, photolysis, volatilization).

- Conclusion: Generally, PAH half-lives in soil and groundwater increase as size and ring number increase. Greater adsorption of the compounds to soil particles their bioavailability eliminates effectively Volatilization soil from is microorganisms. inconsequential all PAHs considered except in naphthalene.
- Conclusion: Microfaunal communities must develop metabolic capabilities during an acclimation period. Therefore, PAH half-lives generally are lower in soils and sediments with a prior history of PAH contamination.
- Conclusion: Groundwater contamination potentially could occur by two and three-ringed PAHs leaking from a UST if it were located within proximity of an aquifer or karst system. Despite their long half-lives, PAHs of four or more rings are immobile with essentially no potential for groundwater contamination.
- Conclusion: Based upon the available toxicity values,
 which are in the mg/L range similar to those for BTEX,
 PAHs are slightly to moderately toxic in the aquatic

environment. It is likely that only releases in quantities sufficient to sustain ambient PAH concentrations exceeding the acute freshwater criteria would have significant environmental impact.

- Conclusion: Based upon the available data for the aquatic environment, the higher molecular weight, more lipophilic PAHs may bioconcentrate in some species. However, bioconcentration of PAHs in general is not considered to be important in the environment. Biomagnification within food chains does not occur to any great extent because PAHs are readily metabolized in many species.
- Recommendation: Clean-up and remediation of diesel fuel leaks based on the more conservative human health criteria for PAHs should be protective of freshwater biota as well. Such efforts should minimally meet the acute freshwater criteria, which are respectively: naphthalene, 2.3 mg/L; acenaphthene, 1.7 mg/L; and fluoranthene, 3.96 mg/L.
- Recommendation: Surface water and wetland ecosystems significantly contaminated by diesel fuel likely would represent complex situations which should be evaluated on a site-specific basis.

Table AII-1. Physical-Chemical Constants for Selected PAHs/BTEX

	RFD _{oral} mg/kg/D ^b	$ m H_2O~Sol \ mg/L$	$ m K_{\infty}$ L/kg	H atm-m³/mol	V _p mm Hg	$ m K_{ow}$
Naphthalene	4×10^{-2} (w)	,32	026,	°4.6x10 ⁴	°8.7x10 ⁻²	006'1
Acenaphthene	6×10 ⁻²	3.8	4,571	^d 2.6x10 ⁻³	4.5x10 ⁻³	9,550
Fluorene	4×10 ⁻²	1.90	7,224	6.4x10 ⁻⁵	7.1x10 ⁻⁴	15,136
Anthracene	3x10 ⁻¹	0.07	14,125	8.6x10 ⁻⁵	°7.5×10 ⁻⁶	28,184
Pyrene	3×10 ⁻²	0.132	38,019	°1.2×10 ⁻⁵	2.5x10 ⁻⁶	75,858
Fluoranthene	$4x10^{-2}$	0.26	38,019	6.5x10 ⁻⁶	5x10 ⁻⁶	79,433
Benzo(a)anthracene	;	°1.1×10°²	199,526	1x10 ⁻⁶	$^{\circ}2.1x10^{-7}$	407,380
Benzo(b)fluoranthene	i i	°1.2×10 ⁻³	549,541	1,2x10 ⁻⁵	°1.6×10 ⁻⁷	1,096,478
Benzo(k)fluoranthene	;	8.1x10 ⁻⁴	549,541	3.9x10 ⁻⁵	5x10 ⁻⁷	1,148,154
Benzo(a)pyrene	1	3.8×10 ⁻³	5,495,409	4.9x10 ⁻⁷	5.6x10 ⁻⁹	1,148,154
Chrysene	;	$2x10^{-3}$	199,526	1.1x10 ⁻⁶	6.3x10 ⁻⁹	407,380
O-Xylene	2	6175	648-68	°5x10 ⁻³	9.9°	°1,318
Toluene	$2x10^{-1}$	534.8	°37–160	°5.9x10 ⁻³	.28.2	°537
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(w) = value withdrawn. bu.s. EPA, 1995. Risk-based Concentration Table. Toxicological Profile for PAHs. "ATSDR, 1994b.

"Mackay et al., 1992. Fendinger and Glotfelty, 1989. ATSDR, 1994a. Toxicological Profile for Naphthalene.

Table AII-2. Environmental Half-life Estimates for Naphthalene: Soil

Study	Half life Estimates:	Notes:
Sherman et al. 1990	35 ± 17 days	Mean and standard deviation from data base of half-life literature to 1988.
Wild <i>et al.</i> 1991	< 2.1 years	Sandy loam, 1.8% organic content, pH= 5.8. Mean values from 5 fields; 4 contaminated by 1 metal each.
	0.02 - 46 weeks	Range from 5 studies between 1978-90 and Lee Valley soil. 46 weeks is typographical error in journal article (See Herbes and Schwall 1978).
Heitkamp et al., 1988	< 2 weeks	Sediment-water microcosm inoculated with Mycobacterium.
	~24 days, average of 4 tests	Aqueous Soil- Organic content= 2.9%. Lab test, denitrifying conditions. Barnes-Hamerly soil, unacclimated soil.
Shiaris, 1989	6.5 - 17.5 days	Contaminated estuarine sediments (Range of 3 studies)
	10 - 143 days	Non-contaminated estuarine sediments (2 studies)
	0.2 days	Contaminated stream sediment.
	> 21 days	Non-contaminated stream sediment.
	22.5 - 31 days	Reservoir sediment (2 studies)
Wild and Jones, 1993	28 ± 16 days	Mean from four soil types. Sludge application aerobic microcosm.
	15 days	Spiked soil aerobic microcosm.
Herbes and Schwall, 1978	~5.0 hours	Calculated from rate constant for PAH-contaminated stream sediments in October and November.
	~16 weeks	Calculated from same stream in December.
	~6 months	Calculated from rate constant for uncontaminated stream sediment in December.

Table AII-2. Environmental Half-life Estimates for Naphthalene: Soil (cont.)

Study	Half-life Estimates:	Notes:
Mihelcic and Luthy,	~3 days	Aqueous mixture. Aerobic Microbial.
19668	No degradation after 65 days	Aqueous mixture. Anaerobic Microbial.
	23 - 35 days	Aqueous mixture. Varied denitrifying conditions.
Herbes, 1981	8.9 hours	Calculated from mean rate constant over 2-year period. Stream sediments below coal-coking plant.
Walker et al., 1975	42 days	South Louisiana mixture from estuary sediments.
Al-Bashir et al., 1990	-43 days	Aerobic marine sediment slurry.
	~25 days	50 ppm naphthalene in soil/water slurry - denitrifying conditions.
	33 days	200 ppm naphthalene in soil/water slurry - denitrifying conditions.
	33 days	500 ppm naphthalene in soil/water slurry - deniftrifying conditions.
Park et al., 1990	2.1 days; 1.7 - 2.7 days, 95% C.I.	Kidman sandy loam. Organic content 0.5%, pH= 7.9, unsaturated, 25°C, aerobic. Soil die-away test.
	1.7 - 3.4 days, 95% C.I.	McLaurin sandy loam. 1.1% organic content, pH= 4.8, 25°C, aerobic, unsaturated. Soil die-away test.
Howard et al., 1991	16.6 - 48 days	Estimate based on soil die-away test.

Table AII-2. Environmental Half-life Estimates for Naphthalene: Surface Water

Study	Half-life Estimates:	Notes:
Walker et al., 1975	20.6 days	South Louisiana crude mixture from estuary.
Heitkamp <i>et al.,</i> 1988	2.4 weeks	Sediment from estuary with previous petrochemical contamination.
	3.5 меекв	Sediments from estuary not previously exposed to petrochemicals; with agri-chemicals.
	4.4 weeks	Pristine sediments.
Srivastava <i>et al.,</i> 1990	15 minutes	Liquid culture with PAH-degrading bacteria.
ATSDR, 1994a	7 days	Polluted water, biodegradation rate.
ATSDR, 1994a	~1 days	Estimated based on biodegradation by bacteria and multicellular animals.
Vaishnav and Babeu, 1987	39 days	Filtered harbor and river water with nutrients and acclimated microbes added, static aerobic flask.
	43 – 53 days	Filtered harbor and river water with only acclimated microbes added.
Arvin et al., 1989	<5 days	100% degradation prior to end of aerobic static flask test in mineral basal salt medium with acclimated bacteria added.
Zoeteman et al., 1981	<1 day	Field observation data from Rhine River water.
Mackay et al., 1992	16 hours	Volatilization at 0.5m depth, wind velocity lm/sec.
Howard et al., 1991	12 hours - 20 days	Theoretical estimate based on aqueous die-away test.

Table AII-2. Environmental Half-life Estimates for Naphthalene: Ground Water

Study	Half-life Estimates:	Notes:
Wilson et al., 1985	< 1 week	Below 1 ng/g at time of first sampling interval; contaminated aquifer (creosote).
	4 - 14 weeks	Untreated contaminated pristine aquifer.
Boggs et al., 1993	76 days (99 + 53 days)	Mean from spatial moments and time-series analyses following injection of radiolabelled naphthalene into aquifer.
Thierrin et al., 1993	33 ± 6 дауз	Anaerobic half-life, groundwater tracer test in sulfate reducing Bassendean sands.
	160 ± 20 days	Preliminary data, computer modelled prediction.
Vaishnar and Babeu, 1987	28 days	Filtered groundwater with acclimate bacteria and nutrients added. Static flask, pH= 8.7, aerobic conditions.
Tabak et al., 1981	<1 week	100% degradation after 1 week, aerobic static flask test.
Zoeteman et al., 1981	0.6 year	Estimated from groundwater data beneath waste dump site based on adsorption behavior.
Howard et al., 1991	24 hours - 258 days	Theoretical estimate, based on unacclimated aerobic and anaerobic biodegradation half-lives of sediments.

Environmental Half-life Estimates for Naphthalene: Air

study	Half-life Estimates:	Notes:
Howard <i>et al.</i> , 1991	2.96 - 29.6 hours	Theoretical estimate based on photooxidation rate constant for reaction with hydroxyl radical.
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Table AII-3. Environmental Half-life Estimates for Acenaphthene: Soil

Study	Half-life Estimates:	Notes:
Walker et al., 1975	28 days	South Louisiana crude mixture from estuary.
Sherman et al., 1990	51 ± 19 days	Mean and standard deviation from data base of half-life literature to 1988.
Wild et al., 1991	< 3.2 years	Sandy loam, 1.8% organic content, pH= 5.8. Mean values from 5 fields; 4 contaminated by 1 metal each.
	0.04 - 6 weeks	Range from 5 studies between 1978-90.
		Half-lives were for fluorene and acenaphthene combined.
Mihelcic and Luthy, 1988a	6 days	Aqueous mixture. Aerobic microbial degradation.
	No degradation after 65 days	Aqueous mixture. Anaerobic microbial degradation.
	~30 days	Aqueous mixture. Denitrifying conditions.
Mihelcic and Luthy, 1988b	~54 days	Aqueous soil- Organic content= 2.9%. Lab test, denitrifying conditions; Barnes-Hamerly soil, unacclimated soil.
IRIS, 1994	10 - 60 days	Sandy loam. Aerobic soil column test.
	42.5 - 102.2 days	Oil sludge in Derby soil column. These are same studies that produced Howard et al. half-life values.
Wild and Jones, 1993	65 ± 14.3 days	Mean of four soil types. Sludge application aerobic microcosm.
	28 days	Spiked soil aerobic microcosm.
		Half-lives were for fluorene and acenaphthene combined.
Howard et al., 1991	12.3 - 102 days	Aerobic soil column test.

Table AII-3. Environmental Half-life Estimates for Acenaphthene: Surface Water

Study	Half-life Estimates:	Notes:
Walker et al., 1975	>28 days	South Louisiana crude mixture from estuary sediments.
IRIS, 1994	24.8 days	Water without suspended solids. Biodegradation.
	0.83 - 4.91 days	Water with suspended solids. Biodegradation.
Howard <i>et al.,</i> 1991	3 hours - 12.5 days	Scientific judgement based on estimate rate of photolysis in water.

Table AII-3. Environmental Half-life Estimates for Acenaphthene: Ground Water

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Study	Half-life Estimates:	Notes:
IRIS, 1994	<1 week	Acclimated groundwater aquifer soil, $25^{\circ}\mathrm{C}$. Average rate was 130% degradation/week.
	~8 weeks	Unacclimated groundwater soil, 25°C.
Tabak <i>et al.</i> , 1981	<1 week	95-100% biodegradation after 1 week in aerobic static flask test with groundwater.
Wilson et al., 1985	5.5 - 7.5 weeks	Untreated contaminated aquifer.
	<1 week	Treated acclimated creosote contaminated aquifer. Below 1 ng/g at the time of first sampling interval.
Howard et al., 1991	24.6 - 204 days	Scientífic judgement based on estimated aqueous aerobic biodegradation from soil die-away test.

Environmental Half-life Estimates for Acenaphthene: Air

Study	Half-life Estimates:	Notes:
Howard et al., 1991	0.879 - 8.79 hours	Scientific judgement based on estimated photooxidation rate in air.

Environmental Half-life Estimates for Anthracene: Soil Table AII-4.

Study	Half-life Estimates:	Notes:
Sherman et al., 1990	31 days; 23 - 40 days, 95% C.I.	Mean and confidence intervals from data base.
Tiehm, 1994	3 weeks	Aerobic soil medium, Mycobacterium sp. treatment; 30°C, pH= 7.0, PAHs only source of carbon and energy.
	5 - 12 weeks	Same condition, treated with surfactants at various concentrations (0.5 - 4 mM).
Mackay et al., 1992	17 - 45 days	5 mg/kg and 50 mg/kg treatment.
	3.3 – 175 days	Aerobic soil die-away test.
Park et al., 1990	134 days; 106 - 182 days; 95% C.I.	Kidman sandy loam, 0.5% organic matter, -0.33 bar soil moisture, pH=7.9, 25°C.
	50 days; 42 - 61 days; 95% C.I.	McLaurin sand loam, 1.1% organic matter, -0.33 bar soil moisture, pH= 4.9, 25°C.
Herbes, 1981	7 - 28.5 days	Calculated from mineralization rate of acclimated and unacclimated sediments.
	10 days	Calculated from mean mineralization rate in sediments from 3 site collected year round.
Herbes and Schwall, 1978	2.3 - 4.2 days	Transformation in acclimated stream sediment $(200g/L\ H_2O)$ in October and November.
	8.33 days	Calculated from acclimated stream sediments ($200g/L\ H_2O$) in December.
	83.3 days	Calculated from rate constant anthracene mineralization in pristine stream sediments $(200g/L\ H_2O)$ in December.
Wild and Jones, 1993	141 ± 77.9 days	Mean from four soil types. Sludge application aerobic microcosm.
	48 days	Spiked soil aerobic microcosm.
Howard et al., 1991	50 – 450 days	Aerobic soil die-away test.

Table AII-4. Environmental Half-life Estimates for Anthracene: Surface Water

Study	Half-life Estimates:	Notes:
Mackay et al., 1992	1.4 - 3.5 hours	Degradation under midsummer light conditions in shallow, fast, clear water.
	8.5 - 21.6 hours	Degradation under midsummer light conditions in deep, slow-moving, clear and muddy waters.
	0.75 hours	Photochemical transformation rate in midsummer, midday sunlight at surface.
	4.5 days	Photolysis rate at 5m depth in midsummer sunlight.
Howard <i>et al.,</i> 1991 Mackay <i>et al.,</i> 1992	0.879 - 8.79 hours 0.58 - 1.7 hours	Photolytic rate in water. Photolytic rate in air.

Environmental Half-life Estimates for Anthracene: Ground Water

Study	Half-life Estimates:	Notes:
Tabak <i>et al.,</i> 1981	1 - 2 weeks	Aerobic static flask following inoculated with bacteria; 5 mg/L.
	3 - 4 weeks	Same conditions; 10 mg/L concentration anthracene.
Howard et al., 1991	100 - 900 days	Scientific judgement based on aqueous aerobic biodegradation estimated from soil die-away test.

Environmental Half-life Estimates for Anthracene: Air

Study	Half-life Estimates:	Notes:
Howard et al., 1991	0.879 - 8.79 hours	Based on photolytic half-life in water.
Mackay et al., 1992	0.58 - 1.7 hours	Photolytic half-life in air

Table AII-5. Environmental Half-life Estimates for Fluorene: Soil

Study	Half-life Estimates:	Notes:
Sherman et al., 1990	41 days; 35 - 52 days, 95% C.I.	Compiled data base.
Tiehm, 1994	5 - 7 days	Bacteria without surfactant.
	<3 days	Bacteria with surfactant.
Srivastava et al.,	~4 days	Soil-water column.
0000	<1 day	Soil-water column pretreated with oxidant.
Wild et al., 1991	<2.0 years	Mean half-life from 4 metal contaminated and 1 rural Luddington soils.
	3 days - 6 weeks	Range from 5 studies in literature 1978-1990 and Lee Valley soils.
		Half-lives were for fluorene and acenaphthene combined.
Wild and Jones, 1993	65 ± 14.3 days	Mean from four soil types. Sludge application aerobic microcosm.
	28 days	Spiked soil microcosm.
		Half-lives were for fluorene and acenaphthene combined.
Howard et al., 1991	32 – 60 days	Based on aerobic soil die-away test.
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Table AII-5. Environmental Half-life Estimates for Fluorene: Surface Water

Study	Half-life Estimates:	Notes:
Weissenfels <i>et al.</i> , 1990 36 - 48	36 - 48 hours	Aqueous aerobic mineral salt medium, pH= 7.2, 30°C, inoculated with Pseudomonas vesicularis.
Howard et al., 1991	32 - 60 days	Based upon aerobic soil die-away test.

Environmental Half-life Estimates for Fluorene: Ground Water

Study	Half-life Estimates:	Notes:
Tabak <i>et al.,</i> 1981	<1 week	Calculated from static flask degradation of aquifer material.
Mackay et al., 1992	~1.7 weeks	Calculated from degradation rate in aquifer material by bacteria.
Wilson et al., 1985	<1 week 5 - 8 weeks	Biologically treated contaminated aquifer. Untreated contaminated pristine aquifer.
Howard et al., 1991	64 - 120 days	Scientific judgement based upon estimated unacclimated aerobic soil die-away test.

Environmental Half-life Estimates for Fluorene: Air

Study	Half-life Estimates:	Notes:
Howard et al., 1991	6.81 - 68.1 hours	Scientific judgement based upon estimated photooxidation half-life in air.
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Table AII-6. Environmental Half-life Estimates for Fluoranthene: Soil

Study	Half-life Estimates:	Notes:
Sherman et al., 1990	75 days; 68 - 72 days, 95% C.I.	Mean and confidence intervals derived from data base.
Mackay et al., 1992	34 - 39 days	50 mg/kg and 5 mg/kg treatments.
Park et al., 1990	268 days; 173 - 630 days, 95% C.I.	McLaurin sandy loam.
	377 days; 277 - 578 days, 95% C.I.	Kidman sandy loam.
Tiehm, 1994	39 - 45 hours	Different treatments of surfactant and bacteria. Aerobic soil medium; 30°C, pH= 7.0, PAHs only source of carbon and energy.
	11 days	Same condition without surfactant and bacteria.
Srivastava et al., 1990	<1 day	Soil-water column with oxidant and emulsifier.
	<2 days	Soil-water column with emulsifier pretreatment.
Wild et al., 1991	18 weeks	Average from 5 studies and Lee Valley soils.
	7.8 years	Mean from 4 metal contaminated and 1 rural Luddington soils.
Wild and Jones, 1993	137 ± 35.1 days	Mean from four soil types. Sludge application aerobic microcosm.
	16 days	Spiked soil microcosm.
Howard et al., 1991	140 - 440 days	Based on aerobic soil die-away test.

Table AII-6. Environmental Half-life Estimates for Fluoranthene: Surface Water

Study	Half-life Estimates:	Notes:
Heitkamp and Cerniglia, 1988	<1 day	Mineralization in minimal basal salt medium inoculated with Mycobacterium sp., aerobic conditions.
Weissenfels <i>et al.,</i> 1990	48 – 72 hours	Aqueous aerobic mineral salt medium, pH= 7.2, 30°C, inoculated with Acaligenes denitrificans.
Mackay et al., 1992	21 hours - 200 days	Near surface and 5m depth photolysis rates.
Howard et al., 1991	21 - 63 hours	Based upon photolysis half-life in water.

Environmental Half-life Estimates for Fluoranthene: Ground Water

Study	Half-life Estimates:	Notes:
Tabak <i>et al.,</i> 1981	1 - 2 weeks	Aerobic static flask test inoculated with microbes; 5 mg/L.
	No degradation after 3 weeks	Aerobic static flask test inoculated with microbes; 10 mg/L.
Howard et al., 1991	280 days - 2.41 years	Scientific judgement based upon estimated unacclimated aerobic soil die-away test.

Environmental Half-life Estimates for Fluoranthene: Air

Study	Half-life Estimates:	Notes:
Howard et al., 1991	2.02 - 20.0 hours	Scientific judgement based upon estimated sunlight photolysis half-life in water.
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Table AII-7. Environmental Half-life Estimates for Pyrene: Soil

Study	Half-life Estimates:	Notes:
Sherman et al., 1990	74 days; 63 - 83 days, 95% C.I.	Mean and confidence intervals derived from data base.
Heitkamp and Cerniglia, 1989	35 days	Calculated from mineralization rate during sediment-water microcosm test treated with Mycobacterium sp., 24°C.
Mackay et al., 1992	48 –58 days 500 days	50 mg/kg and 5 mg/kg treatments. Unacclimated soil column.
Park et al., 1990	260 days; 193 - 408 days, 95% C.I. 199 days; 131 - 408 days, 95% C.I.	Kidman sandy loam, 0.5% organic matter, pH= 7.9, -0.33 bar moisture, 25°C. McLaurin sandy loam, 1.1% organic matter, pH= 4.8, -0.33 bar moisture, 25°C.
Tiehm, 1994	~5 weeks <1 day - 8 days	Bacteria without surfactant. Bacteria with surfactant treatment.
Srivastava et al., 1990	<1 day	Soil-water column pretreated with emulsifier. Soil-water column pretreated with emulsifier, oxidant added.
Wild et al., 1991	8.5 years 3 days - >90 weeks	Mean half-life from 4 metal contaminated and 1 rural Luddington soils. Range from 5 studies in literature 1978-90 and Lee Valley soils.
Wild and Jones, 1993	225 ± 92.4 days 51 days	Mean from four soil types. Sludge application aerobic microcosm. Spiked soil aerobic microcosm.
Howard et al., 1991	210 days - 5.2 years	Based on aerobic soil die-away test.

Table AII-7. Environmental Half-life Estimates for Pyrene: Surface Water

Study	Half-life Estimates:	Notes:
Mackay et al., 1992	0.58 hours	Midday, midsummer photochemical transformation rate near surface.
	4.2 days	Photolytic rate at 5m depth.
Heitkamp and Cerniglia, 1988	<1 day	Aquecus aerobic Mycobacterium sp. culture medium; mineralization rate in PAH mixture.
Howard et al., 1991	0.68 - 2.04 hours	Scientific judgement based upon estimated photolysis in water.

Environmental Half-life Estimates for Pyrene: Ground Water

Study	Half-life Estimates:	Notes:
Tabak <i>et al.</i> , 1981	<1 week	Aerobic static flask test inoculated with bacteria; 5 mg/L.
	>4 weeks	Same conditions as listed above. No significant degradation at the end of test; 10 mg/L pyrene.
Howard et al., 1991	1.15 - 10.4 years	Scientific judgement based upon estimated unacclimated aerobic soil die-away test.

Environmental Half-life Estimates for Pyrene: Air

Study	Half-life Estimates:	Notes:
Howard et al., 1991	0.68 - 2.04 hours	scientific judgement based upon estimated photolysis in water.

Table AII-8. Environmental Half-life Estimates for Chrysene: Soil

Study	Half-life Estimates:	Notes:
Walker et al., 1975	>28 days	South Louisiana crude mixture. Sediments from estuary.
Sherman et al., 1990	114 ± 12 days	Mean and standard deviation from data base of half-life literature to 1988.
Srivastava et al., 1990	No degradation after 20 days	Sand-water soil column.
Wild et al., 1991	8.1 years	Sandy loam, 1.8% organic content, pH= 5.8. Mean value from 5 fields, 4 were metal- contaminated.
	0.6 weeks - 3 years	Range from 5 studies from 1987-90 and Lee Valley soils; estimates for benzo(a)anthracene and chrysene combined.
Park et al., 1990	371; 289 - 533, 95% C.I. 387; 257 - 866, 95% C.I.	Kidman sandy loam, 0.5% organic content, pH= 7.9. McLaurin sandy loam, 1.1% organic content, pH= 4.8.
Bossert et al., 1984	150 - 300 days Acclimated - unacclimated	Oily sludge-treated field, pH= 6.6 - 7.5, 1.7% organic content.
Mackay et al., 1992	224 - 328 days	Chrysene concentrations of 50 mg/kg and 5 mg/kg; treated soil.
Wild and Jones, 1993	215 ± 86.3 days	Mean from four soil types. Sludge application aerobic microcosm.
	84 days	Spiked soil aerobic microcosm.
Howard et al., 1991	1 - 2.7 years	Scientific judgement, estimate based on aerobic soil die-away test data.

Table AII-8. Environmental Half-life Estimates for Chrysene: Surface Water

Study	Half-life Estimates:	Notes:
Walker et al., 1975	28 days	South Louisiana crude mixture from estuary.
Srivastava et al., 1990	~5 days	Liquid culture with PAH degrading bacteria.
Mackay et al., 1992	4.4 – 13 hours	Calculated photolytic half-life near surface and 5m deep at midday in midsummer.
Howard et al., 1991	4.4 - 13 hours 1.02 - 2.72 years	Photolytic half-life in water. Theoretical, based on aerobic soil die-away
	4.06 - 11.0 years	test; aerobic. Scientific judgement based upon estimated unacclimated aqueous anaerobic biodegradation half-life (Park et al., 1990 for soil).

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Study	Half-life Estimates:	Notes:
Tabak et al., 1981	14 - 21 days	Static flask test inoculated with microbes.
Howard et al., 1991	2 - 5 years	Theoretical, based on estimated unacclimated aqueous aerobic biodegradation half-life (Park et al., 1990 for soil).

Environmental Half-life Estimates for Chrysene: Air

Study	Half-life Estimates:	Notes:
Howard et al., 1991	0.03 - 0.3 day	Theoretical, based on estimated photooxidation half-life in air.

Table AII-9. Environmental Half-life Estimates for Benzo(a) anthracene: Soil

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Study	Half-life Estimates:	Notes:
Sherman et al., 1990	114 ± 6 days	Mean and standard deviation from data base of half-life literature to 1988.
Herbes and Schwall, 1978	208 days	Calculated using mineralization rate constant from PAH-contaminated previously exposed stream sediments in November.
	14 - 27 days	Transformation half-life under same conditions.
	8 years	Theoretical estimate calculated from mineralization rate constant in previously uncontaminated stream sediments in December.
Herbes, 1981	8.75 days	Calculated using mean rate constant over 2-year period. Stream sediments downstream from coal- coking plant.
Wild et al., 1991	8.1 years	Sandy loam, 1.8% organic content, pH= 5.8. Mean values from 5 fields; 4 were metal- contaminated.
	0.6 weeks - 3 years	Range from 5 studies (1978-90) and Lee Valley soils; estimates for benzo(a)anthracene and chrysene combined.
Park et al., 1990	261 days; 210 - 347 days, C.I.	Soil die-away test, 25°C, unsaturated. Kidman sandy loam, 0.5% organic content, pH= 7.9.
	162 days; 131 - 217 days, C.I.	McLaurin sandy loam, 1.1% organic content, pH= 4.8.
Bossert et al., 1984	89 - 270 days, range acclimated - unacclimated	Oily sludge-treated field monitored for 3.5 years, 1.7% organic content, pH= 6.6 - 7.5.
Mackay et al., 1992	130 - 240 days	50 and 5 mg/kg treated soil.
Wild and Jones, 1993	215 ± 86.3 days	Mean from four soil types. Sludge application aerobic microcosm.
	84 days	Spiked soil aerobic microcosm.
		Half-lives were for chrysene and benzo(a)anthracene combined.
Howard et al., 1991	102 – 680 days	Scientific judgement based on estimate from aerobic soil die-away test.

Table AII-9. Environmental Half-life Estimates for Benzo(a)anthracene: Surface Water

Study	Half-life Estimates:	Notes:
IRIS, 1994	5 hours	Photolysis in water.
	2.9 hours	Summer.
	7.8 hours	Winter.
	0.6 hours	Mid-summer.
ATSDR, 1994b IRIS, 1994	90 hours	Estimate based on volatilization rate in water.
ATSDR, 1979b	10 - 50 hours	Estimate based on rate of photolysis
	38 hours	THE WASTER
	13 hours	Estimate Dased On Oxidation rate in Water.
	22 hours	Computer model for stream.
	8 hours	Computer model for eutrophic pond or lake.
		Computer model for oligotrophic lake.
Howard <i>et al.,</i> 1991	1 – 3 hours	Scientific judgement based upon estimated photolysis rate constant.

Table AII-9. Environmental Half-life Estimates for Benzo(a)anthracene: Ground Water

Study	Half-life Estimates:	Notes:
Howard et al., 1991	204 days - 3.5 years	Scientific judgement based upon estimated aqueous soil die-away.
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Environmental Half-life Estimates for Benzo(a)anthracene: Air

Study	Half-life Estimates:	Notes:
Howard et al., 1991	1 - 3 hours	Estimate based upon rate constant for photolysis.

Table AII-10. Environmental Half-life Estimates for Benzo(a)pyrene: Soil

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stuay	nali-lile Estimates:	Nocar
Sherman et al., 1990	57.5 ± 12.5 days	Mean and standard deviation from data base of half-life literature values to 1988.
IRIS, 1994	54.16 days	Stream sediment 0.5 km downstream from coke effluent.
,	> 833 days	Stream sediment 0.3 km below petroleum storage.
	> 833 days	Uncontaminated stream sediment.
Wild et al., 1991	8.2 years	Sandy loam 1.8% organic content, pH= 5.8. Mean values from 5 fields; 4 were metal-contaminated.
	2 days – 6 years	Range from 5 studies between 1978-90 and Lee Valley soil.
Herbes and Schwall, 1978	~2.3 years	Calculated using rate constant from PAH-contaminated sediments in December.
	~39.6 years	Calculated using rate constant from previously uncontaminated stream sediments in winter.
Herbes, 1981	84.9 days	Calculated using mean rate constant over 2-year period. Stream sediments downstream from coal-coking plant.
Shiaris, 1989	27 - >1400 days	Previously contaminated and uncontaminated estuarine sediment.
	> 625 days	Previously contaminated and uncontaminated stream sediments.
Miller et al., 1988	.105 days	Estimate based on 21-day test; un-photolyzed sample.
	42 days	Estimate based on 21-day test; pre-photolyzed and 0.1M H ₂ O ₂ .
Park <i>et al.,</i> 1990	309 days; 239 - 462 days, 95% C.I.	Aerobic soil die-away test, 25°c, unsaturated. Kidman sandy loam, 0.5% organic carbon, pH= 7.9.
	229 days; 178 - 315 days, 95% C.I.	McLaurin sandy loam, 1.1% organic carbon, pH= 4.8.
Wild and Jones, 1993	211 ± 68.7 days	mean from four soil types. Sludge application aerobic microcosm.
	112 days	Spiked soil aerobic microcosm.
Howard et al., 1991	1 - 2.5 years	Estimate based on aerobic die-away test.

Table AII-10. Environmental Half-life Estimates for Benzo(a)pyrene: Surface Water

Study	Half-life Estimates:	Notes:
17007		
ATSDK, 1994b	1 - 2 hours	Estimate based on rate of photolysis in water.
	96 hours	Estimate based on rate of oxidation in water.
	22 hours	Estimate based on volatilization in water.
Miller et al., 1988	0.33 - 1.5 hours	300 nm light: based on photolytic half-life in methanol with and without H ₂ O ₂ .
	4 - 6 hours	sunlight: without $ ext{H}_2 ext{O}_2$.
Heitkamp and Cerniglia, 1989	~1 year	Sediment mixture from pristine reservoir ecosystem with Mycobacterium added.
Srivastava <i>et al.,</i> 1990	~5 days	Liquid culture with PAH-degrading bacteria.
Mackay et al., 1992	2 hours	254 nm light; photolytic half-life in methanol solution.
	1.1 hours	Estimated photolytic half-life near surface in mid- December.
	0.54 - 76.8 hours	Estimated photolytic half-life at surface and 5m depth at midday in mid-summer.
Howard et al., 1991	0.37 - 1.1 hours	Scientific judgement based on photolysis rate in 20% aqueous acetonitrile.
		The second secon

Table AII-10. Environmental Half-life Estimates for Benzo(a)pyrene: Ground Water

Study	Half-life Estimates:	Notes:
Howard et al., 1991	114 days - 2.9 years	Scientific judgement based on aerobic soil die-away test.

Environmental Half-life Estimates for Benzo(a)pyrene: Air

Study	Half-life Estimates:	Notes:
Miller et al., 1988	0.33 - 4 hours	Based on photolytic half-life in methanol with H ₂ O ₂ exposed to 300 nm light or sunlight.
Howard et al., 1991	0.37 - 1.1 hours	Scientific judgement based on photolysis rate in 20% aqueous acetonitrile.

Table AII-11. Environmental Half-life Estimates for Benzo(b)fluoranthene: Soil

Study	Half-life Estimates:	Notes:
Sherman et al., 1990	140 ± 10 days	Data base, mean and standard deviation.
Wild <i>et al.,</i> 1991	9 years	Mean from 4 soils (sandy loam, pH=5.8, 1.8% organic content) each contaminated with 1 metal and a rural soil.
	42 weeks	Value from study (1987-90) and Lee Valley soil.
Park <i>et al.,</i> 1990	294 days; 231 - 385 days, 95% C.I.	Aerobic soil die-away test. Kidman sandy loam, 0.5% organic content, pH= 7.9, 25°C.
	211 days; 169 - 277 days, 95% C.I.	McLaurin sandy loam, 1:1% organic content, pH= 4.8, 25°C.
Bossert et al., 1984	~340 days	Oily sludge-treated field, 1.7% organic content, pH= 6.6 - 7.5.
Wild and Jones, 1993	202 ± 90.8 days	Mean from four soil types. Sludge application aerobic microcosm.
	334 days	Spiked soil aerobic microcosm.
Howard et al., 1991	360 days - 1.67 years	Aerobic die-away test.

Table AII-11. Environmental Half-life Estimates for Benzo(b)fluoranthene: Surface Water

study	Half-life Estimates:	Notes:
Howard et al., 1991	8.7 hours - 30 days	Scientific judgement based on estimated aqueous photolysis in haptene irradiated light > 290 nm.

Environmental Half-life Estimates for Benzo(b)fluoranthene: Ground Water

Study	Half-life Estimates:	Notes:
Howard et al., 1991	1.97 - 3.34 years	Scientific judgement based on estimated aqueous aerobic biodegradation estimation - no data.

Environmental Half-life Estimates for Benzo(b)fluoranthene: Air

Study	Half-life Estimates:	Notes:
IRIS, 1994	1.9 - 4.2 hours	Irradiated in presence of ozone.
Howard et al., 1991	1.43 - 14.3 hours	Scientific judgement based on estimated rate constant for reaction with hydroxyl radical.

Table AII-12. Environmental Half-life Estimates for Benzo(k)fluoranthene: Soil

	Half-life Estimates:	Notes:
Sherman et al., 1990 13	123 ± 11.5 days	Mean and standard deviation from data base of half-life literature to 1988.
Wild et al., 1991 8	8.7 years	Mean value from 5 different soils; 4 contaminated with a single metal each, and a rural soil.
Wild and Jones, 1993 3	301 ± 105.2 days	Mean from four soil types. Sludge application aerobic microcosm.
Ω,	55 days	Spiked soil aerobic microcosm.
Howard et al., 1991 2	2.49 - 5.86 years	Aerobic die-away test data.

Table AII-12. Environmental Half-life Estimates for Benzo(k)fluoranthene: Surface Water

study	Half-life Estimates:	Notes:
Howard et al., 1991	3.8 hours - 21 days	Scientific judgement based on photolysis in haptene and adjusted by ratio of photolysis in water vs. haptene for benzo(a)anthracene.

Environmental Half-life Estimates for Benzo(k)fluoranthene: Ground Water

Study	Half-life Estimates:	Notes:
Howard et al., 1991	4.99 - 11.7 years	Scientific judgement based on estimated unacclimated aqueous aerobic biodegradation.

Environmental Half-life Estimates for Benzo(k)fluoranthene: Air

study	Half-life Estimates:	Notes:
IRIS, 1994	14.1 hours	Sunlight, without ozone. Laboratory simulated atmosphere.
	3.9 hours	Sunlight, with ozone. Laboratory simulated atmosphere.
	34.9 hours	Dark, no ozone. Laboratory simulated atmosphere.
	111 minutes	Irradiated. Laboratory simulated atmosphere.
Howard et al., 1991	1.1 - 11 hours	Scientific judgement based on photooxidation rate constant for reaction with hydroxyl radical.

Table AII-13. U.S. EPA^a and Commonwealth of Kentucky^b Quality Criteria for Water (μg/L)

	Priority Pollutant	Carcinogen	FW Acute LOEL μg/L	FW Chronic LOEL	Water and Fish Ingestion (10° Cancer Risk)	Fish Consumption (10 ⁻⁶ Cancer Risk) μg/L	umption er Risk) L	Drinking Water MCL μg/L	MCL
1000				µg/L	μ8/Γ	EPA	KY		KY
Naphthalene	Yes	No	2,300	620	4 4	er el	1		1
Acenaphthene	Yes	No	1,700	520	20	-		•	:
Fluoranthene	Yes	No	3,960		42	54	54	1	î t
PAHs	Yes	Yes	l	ı	0.0028	0.0311	0.0311	(WHO European) 0.2	0.0028

U.S. EPA, 1986. Quality Criteria for Water.
 VEDEP, 1990. Kentucky Water Quality Standards.
 WHO, 1977. International Standards for Drinking Water.

Table AII-14. U.S. EPA Drinking Water Standards, Criteria and Human Health Advisories (µg/L)

	Quantification	MCL	MCLG		Water Qua	lity Criteria, Hı	Water Quality Criteria, Human Health Protection	tection		Human Health Advisories	Advisories
	Limits			Drinking Water	Water	Drinking Aquatic (Drinking Water and Aquatic Organisms	Aquatic Organisms	rganisms	70kg Adult	Jult
				Threshold Toxicity Protection	10* Cancer Risk	Threshold Toxicity Protection	10* Cancer Risk	Threshold Toxicity Protection	10 ⁴ Cancer Risk	Rfd (mg/kg/day)	Lifetime (mg/L)
Naphthalene	•	The state of the s		## ##	1	1	-	6	1	0.004b	0.02 ^b
Acenaphthene	10*		:	204	**	-	-	L	1	0.6هٔ	;
PAHs	* *	-	-	-	0.0031	1	0.0028	ŀ	0.031	ŀ	:
Anthracene	10.		-	-	1	3	-	-	•	0.3 ^b	
Pyrene	10*	1	1	*	-		:	-	t i	0.03 ^b	1
Fluorene	10.	-		1	ł				L I	0.04 ^b	ł
Fluoranthene	101	-	-	188*	1	42ª	-	54*	:	1 2	1
Benzo(a)anthracene	10"	0.0001	zero ^b	L.	0.0031	-	0.0028	£ \$	0.031	ŀ	ŀ
Benzo(a)pyrene	10.	!	•	•	0.0031	•	0.0028	i e	0.031	1	!
Benzo(b)fluoranthene	10.	0.0002 ^b	zero ^b	1	0.0031	-	0.0028	ŧ ,	0.031	1	ł
Benzo(k)fluoranthene	10*	0:0002 ^b	zero	1	0.0031	-	0.0028	;	0.031	£ ;	
Chrysene	10.	0.0002 ^b	zero ^b	-	0.0031		0.0028		0.031	•	I.

*U.S. EPA., 1989. Determining Soil Response Action Levels Based on Potential Contaminant Migration to Groundwater: A Compendium of Examples. bU.S. EPA., 1992. Drinking Water Regulations and Health Advisories.

Table AII-15. PAH Toxicity Values ($\mu g/L$)

Acena	apthene	Napthalene
	Fresh Water Acute Value	
Fathead Minnow Pimephales promelas	Channel Catfish Ictalurus punctatus	Fathead Minnow Pimephales promelas
72-HR LC ₅₀ 1,700° 96-HR LC ₅₀ 1,600°	96-HR LC ₅₀ 1,720°	6,600 ^b
Bluegill Sunfish Lepomis macrochirus	Water Flea Daphnia magna	Rainbow Trout Onchorhynchus mykiss
96-HR LC ₅₀ 1,700 ^h	41,200 ^h	2,300 ^b
Rainbow Trout Onchorhynchus mykiss	Snail Aplexa hynorum	Mosquitofish Gambusia affinis
24-HR LC ₅₀ 1,570° 48-HR LC ₅₀ 1,130° 72-HR LC ₅₀ 800° 96-HR LC ₅₀ 670°	96-HR LC _∞ 2,040 ^c	150,000 ⁱ
Brown Trout Salmo trutta	Alga Selenastrum capricornutum	Water Flea Daphnia magna
24-HR LC ₅₀ 840° 48-HR LC ₅₀ 650° 72-HR LC ₅₀ 600° 96-HR LC ₅₀ 580°	530 ^h	8,750²
	Salt Water Acute Value	
Sheepshead Minnow Cyprinodon variegatus		Pacific Oyster Crassostrea gigas
96-HR LC ₅₀ 2,230 ^h		199,000 ^d
Alga Skeletonema costatum		Polychaete Worm Neanthes arenaceodentata
500 ^h		3,800°
Mysid Shrimp Mysidopsis bahia		Grass Shrimp Palaemonetes pugio
96-HR LC₅0 970 ^h		2,350 ^f

Table AII-15. PAH Toxicity Values (µg/L) (continued)

Acenapthene	Napthalene	Benzo(a)Anthracene
Salt Water Chronic Value	Fresh W	ater Chronic Value
Sheepshead Minnow Cyprinodon varigatus	Fathead Minnow Pimephales promelas	Bluegill Lepomis macrochirus
710 ^b	620 ^b	6-month LC ₈₇ 1,000*

^aBrown et al., 1975.

^bDeGraeve et al., in: U.S. EPA, 1980c.

'Holcombe et al., 1983.

^dLe Gore, 1974.

Rossi and Neff, 1978.

fTatem, 1975.

^gU.S. EPA, 1978.

^hU.S. EPA, 1980a.

Wallen et al., 1957.

Table AII-16. BCF Values, Non-carcinogenic PAHs

Naphthalene	Anthracene	Pyrene
	Freshwater Species	
Rainbow Trout Oncorhynchus mykiss	Rainbow Trout Oncorhynchus mykiss	Goldfish Crassius auratus
40 - 300² (4 weeks)	9,120.1°	457.1∞
Bluegill Sunfish Lepomis macrochirus	Bluegill Sunfish Lepomis macrochirus	Water Flea Daphnia magna
316.2°°; 302°°	676.1hh; 891.3hh; 1,202.3hh	2,691.2 ^{tb}
Fathead Minnow Pimephales promelas	Fathead Minnow Pimephales promelas	Water Flea Daphnia pulex
426.6 ^m	478.6 ⁱⁱ	2,691.2 ^{x,ii}
Fish 426.6 ^y ; 36.2 ^h	Fish 7,762.4 ¹¹	Scud Pontoporeia hoyi 44,668.3 ²
Water Flea Daphnia pulex	Goldfish Crassius auratus	Alga Selenustrum capricornutum
131.8 ^ü ; 117.5 ^t	162.2∞	36,307.8°; 16,595.9°; 56,234.1°
Algae Selenastrum capricornutum	Water Flea Daphnia pulex	Microorganisms 12,022.6 ^w ; 23,988.3 ^{kk}
12,589.3°; 6,918.3°; 17,728.8°	758.6°; 712°; 912°; 1,202.3°	
Algae Chlorella fusca	Water Flea Daphnia magna	
128.8 ⁱ	977.2 ^{bb}	
Algae 125.9 ^h	Scud Pontoporeia hoyi 16,595.9 ^s	
Microorganisms	Algae	
416.9*	7,762.5 ^{i,k} ; 6,760.8 ^h	
	Microorganisms	
	4,677.4*	

Table AII-16. BCF Values, Non-carcinogenic PAHs (continued)

Naphthalene	Anthracene	Pyrene
10.5 ^{mm} (weighted) Theoretical 60 - 1,000° Theoretical 426.6 ^{mn} Theoretical 60 - 1,000° Theoretical 60 - 1,000° 269.2 ⁱ 93.3 st 1,000 ^h (activated sludge)	1,202.3 ⁱⁱ (kinetic estimation) 3,548 ^s (calculated) 1,047 ^y 6,760.8 ^h 3,715.4 ^{ff} (calculated-x) 912 ^r (calculated)	3,311.3 ^{ii,m} (calculated) (kinetic estimation) 1,949.8 ^g (calculated) 3,630.8 ^g (calculated-K _{ow}) 2,691.5 ^m (calculated) 2,691.2 ^{ff} (calculated) (quoted exponential) 3,090.3 ^g (calculated-K _{ow})
	Saltwater Species	
Coho Salmon Oncorhynchus kisutch 12 ^{co} (5 weeks); 40 ^{dd} (6 weeks)	Sand Dab Citharichthys stigmacus 77' (1 hour)	Mussel 4,466.8 ¹
Crustacean Calanus helgolandicus 60°; 50° (1 day)	Starry Flounder Platyichthys stellatus 270 ^{dd} (2 weeks)	Clam 6,456.5 ¹
Mussel Mytilus edulis 44 ^u (4 hours); 60 - 1,000 ^j ; 30.9 ⁿ	Worm Polychaeta sp. 6.6°	Shrimp 223.9 ¹ ; 501.2 ¹
Sand Goby Gillichthys mirabilis 63' (1 hour)	Polychaete Worm Capitella capitata 23.6°	Worm Polychaeta sp. 707.9 ¹ ; 1.179°
Sculpin Oligocottus maculosus 32t (3 hours)		Polychaete Worm Capitella capitata 13.305°

Table AII-16. BCF Values, Non-carcinogenic PAHs (continued)

Fluorene	Fluoranthene	Acenaphthalene	Acenaphthene
1,288.3 ^w (calculated-K _{ow}) 2,454.7 ^{ff} (calculated-x) 1,288.3 ^r (calculated) 416.9 ^a (calculated-K _{ow})	1,513.6º	301 ⁿ 380.2 ^r	1,202.3 ^m 389 ^w 389.1 ^{ff,gg} 1,995.3 ^{ff} 380.2 ^f 281.8 ^f
-	Freshwater	Species	
Water Flea Daphnia magna	Water Flea Daphnia magna	Copepod Eurytemora affinis	Bluegill Sunfish Lepomis macrochirus
501.2 ^{bb}	1,737.856	5,000° (9 days); 350°	389 ^{b,f,nn}
Microorganisms 4,677.4 ^w	Worm Polychaeta sp. 45.72° Polychaete Worm Capitella capitata	Microorganisms 1,000 ^w	
	11.995°		
	Scud Pontoporeia hoyi 79,432.8 ²		
	Microorganisms 12,022.6°		

*Banerjee, J. and Baughman, 1991.

^bBarrow et al., 1980.

Bayona et al., 1991.

^dBysshe, 1982.

Casserly et al., 1983.

Davis and Dobbs, 1984.

Eadie et al., 1982.

Freitag et al., 1985.

iGeyer et al., 1984.

Geyer et al., 1982.

Geyer et al., 1981.

Geyer et at., 1901.

Gobas et al., 1987.

"Govers et al., 1984.

"Hansen et al., 1978 in: Howard et al., 1989.

°Harris et al., 1977a.

PHarris et al., 1977b.

Herbes and Risi, 1978.

Isnard and Lambert, 1988.

Kenaga, 1980b.

Lee et al., 1972a.

"Lee et al., 1972b.

Linder et al., 1985.

"Mabey et al., 1982.

*Mackay and Hughes, 1984.

Mackay, 1982.

^zMelancon and Lech, 1978.

²²McCarthy and Jimenez, 1985.

bbNewsted and Giesy, 1987.

[∞]Ogata et al., 1984.

^{dd}Roubal et al., 1978.

[∞]Roubal et al., 1977.

"Sabljic, 1987.

88 Schüürmann and Klein, 1988.

hhSpacie et al., 1983.

"Southworth et al., 1978.

iiSouthworth, 1977.

kSteen and Karickhoff, 1981.

11US EPA, 1980d.

mmU.S. EPA, 1980c.

™Veith *et al.*, 1979.

Table AII-17. BCF Values, Carcinogenic PAHs

Benzo(k)fluoranthene	Benzo(b)fluoranthene	Chrysene
28,200 ^a calculated-K _{ow} 11,100 ^a weighted average	28,200° calculated-K _{ow} 11,100° weighted average	11,700 ^a calculated-K _{ow} 4,620 ^a weighted average
	Freshwater Species	
Water Flea Daphnia magna	Water Flea Daphnia magna	Water Flea Daphnia magna
13,182.6 ^k	10,000 ^k	6,095.4 ^k
Microorganisms	Microorganisms	Microoganisms
141,253.8 ⁱ	141,253.8 ⁱ	52,480.7 ⁱ
		Scud Pontoporeia hoyi
		21,877.6; 20,417.4
	Saltwater Species	
Diatoms	Diatoms	Diatoms
0.02 ^m	0.01 ^m	0.03 ^m
Worm Polychaeta sp.	Worm <i>Polychaeta sp.</i>	Clam Rangia cuneata
14.1 ¹	9.1 ¹	8.2°
Polychaete Worm Capitella capitata	Polychaete Worm Capitella capitata	Worm Polychaeta sp.
1.81	1.7 ¹	14.8 ¹
		Polychaete Worm Capitella capitata
		6.21

Table AII-17. BCF Values, Carcinogenic PAHs (continued)

, Benzo(a)pyro	ene .	Benzo(a)anthracene
	Freshwater Species	
Bluegill Sunfish Lepomis macrochirus 12.6°; 2,630.3°; 223.9°	Scud Amphipoda sp. 48,977.9 [∞]	Fathead minnow Pimephales promelas 10,000**
4,897.8 ^u ; 28,183.8 ^u ; 4,897.8 ^u ; 489.8 ^u ; Scud Pontoporeia hoyi 54,954.1 ⁱ ; 8,912,509.4 ⁱ ; 35,936.6 ⁱ ; 40,738 ^x	Stylodrilus heringianus 7,413.1 ²	Fish 346.7*
Mosquitofish Gambusia affinis 930 ^b (3 days)	Snail <i>Physa sp.</i> 82,231 ^b (3 days)	Water Flea Daphnia pulex 10,000h.cc.dd
Fish 478.6*	Worms 3,235.9 ^x	Algae 3,162.3**
Water Flea Daphnia pulex 134,248 ^b (3 days)	Mayfly Hexagenia limbata 5,888.4 ²	Microorganisms 52,480.7 ⁱ
Water Flea Daphnia magna 2,818.4 ^a ; 7,943.3 ^a ; 12,882.5 ^b	Blue-green Alga Oedogonium cardiacum 5,258 ^b (3 days)	Bacteria 36,307.8 ^{bb} ; 100,000 ^{bb}
Mosquito Culex pipiens quinquefasceatus 11,536 ^b (3 days)	Algae 3,311.3*	
Mysid Crustacean Mysis relicta 7,413.1 ² ; 8,511.4 ^{cc}	Microorganisms 141,253.8 ⁱ	
	Saltwater Species	
Clam Rangia cuneata 8.66°; 236 ^f	Mudsucker Gillichthys mirabilis 0.0488 (Edible Tissue)	Diatoms 0.02 ^m
Eastern Oyster Crassostrea virginica 3000° (8 days); 242 ^d	Diatoms 0.01 ^m	
Sand Dab Citharichthys stigmacus 0.208	Worm Polychaete sp. 13.81	
Tidepool Sculpin Oligocottus maculosus	Polychaete Worm Capitella capitata	
0.138	0.71	

Table AII-17. BCF Values, Carcinogenic PAHs (continued)

Benz	zo(a)pyrene	Benzo(a)anthracene	
28,200° calculated-K _{ow} ; 11,100° weighted average	446,683.6 ^q (calculated); 489.8 ^r (calculated); 5,011.9 ^p ; 63,095.7 ^p (calculated);	11,700° calculated-K _{ow} ; 4,620° weighted average; 4,677.4° (calculated); 36,307.8° (calculated)	
	10,000™ (activated sludge)	19,498.4° (calculated); 25,704° (calculated) 24,547.1° (activated sludge)	

*US EPA, 1980d.

^bLu et al., 1977.

Lee et al., 1978.

^dCouch, 1980.

Neff et al., 1976a.

Neff et al., 1976b.

^gLee *et al.*, 1972a.

^hSouthworth et al., 1978.

ⁱMabey *et al.*, 1982.

^jEadie *et al.*, 1982.

^kNewsted and Giesy, 1987.

¹Bayona et al., 1991.

^mStronkhorst et al., 1994.

ⁿSmith et al., 1978.

°Mackay, 1982.

^pSabljic, 1987.

^qKenaga and Goring, 1980.

'Gobas et al., 1987.

*Leversee et al., 1981.

¹McCarthy, 1983.

"Spacie et al., 1983.

^vMcCarthy and Jimenez, 1985.

*Freitag et al., 1985.

*Frank et al., 1986.

^yLandrum et al., 1985.

Landrum and Poore, 1988.

^{aa}Veith et al., 1979.

bbBaughman and Paris, 1981.

^{cc}Mackay and Hughes, 1984.

^{dd}Hawker and Connell, 1986.

[∞]Evans and Landrum, 1989.

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