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Table 3-1
Summary of Subsurface Soil Analytical Results (ug/kg)
Grand Street and Fortmann Way Property
Alameda, California

Sampling Location	Sampling Date	CHEMICAL					
		Benzene	Toluene	Ethylbenzene	Xylenes (total)	TPHd	Benzo(a)pyrene [1]
TP3A-2	Oct-94	2.5 U	2.5 U	2.5 U	2.5 U	1,400,000	9.80E-02
MW-5-2.5	Oct-94	2.5 U	2.5 U	2.5 U	2.5 U	23,000	1.61E-03
MW-5.5	Oct-94	2.5 U	2.5 U	2.5 U	2.5 U	27,000	1.89E-03
MW-5A-6	Oct-94	2.5 U	2.5 U	2.5 U	2.5 U	1,000 U	7.00E-05 U
MS-6-2.5	Oct-94	2.5 U	2.5 U	2.5 U	2.5 U	28,000	1.96E-03
MW-7.2	Oct-94	2.5 U	2.5 U	2.5 U	15	240,000	1.68E-02
MW-8-3.5	Oct-94	5 U	5.7	10	84	97,000	6.79E-03

Notes:
U = Chemical not detected. Value shown represents the sample quantitation limit.
TPHd = Total Petroleum Hydrocarbons as diesel
[1] Samples were not analyzed for benzo(a)pyrene. TPHd was used to estimate a surrogate concentration for benzo(a)pyrene. Benzo(a)pyrene concentrations were calculated by taking 0.07 mg/kg of TPHd concentrations in soil (Guerin et al., 1984).
Guerin, M.R., et al., 1984. "Comparative Toxicological and Chemical Properties of Fuels Developed from Coal, Shale, or Petroleum." Oak Ridge National Laboratory

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Table 3-2
Summary of Groundwater Analytical Results (ug/L)
BTEX and TPHd
Grand Street and Fortmann Way Property
Alameda, California

Sampling Location	Sampling Date	CHEMICAL				
		Benzene	Toluene	Ethylbenzene	Xylenes (total)	TPHd
MW-1	Nov-94	0.5	1.1	0.65	1.4	400
	Feb-95	0.5 U	0.5 U	0.5 U	0.5 U	1,300
	May-95	–	–	–	–	–
	Aug-95	0.5 U	0.5 U	0.5 U	0.5 U	–
	Nov-95	0.5 U	0.5 U	0.5 U	0.5 U	1,100
	Mar-96	0.5 U	0.5 U	0.5 U	0.5 U	330
MW-2	Nov-94	510	670	65	320	–
	Feb-95	360	230	20	100	–
	May-95	550	350	28	120	–
	Aug-95	290	120	11	37	–
	Dec-95	190	35	6.4	16	–
	Mar-96	–	–	–	–	1,100
MW-4	Nov-94	–	–	–	–	–
	Feb-95	0.5 U	–	–	–	–
	May-95	0.5 U	0.5 U	0.5 U	0.5 U	–
	Aug-95	0.5 U	0.5 U	0.5 U	0.5 U	–
	Dec-95	0.5 U	0.5 U	0.5 U	0.5 U	–
MW-4	Nov-94	0.5 U	0.5 U	0.5 U	0.5 U	240
	Feb-95	0.5 U	0.5 U	0.5 U	0.5 U	660
	May-95	0.5 U	0.5 U	0.5 U	0.5 U	50 U
	Aug-95	0.5 U	0.5 U	0.5 U	0.5 U	410
	Nov-95	0.5 U	0.5 U	0.5 U	0.5 U	460
	Mar-96	0.5 U	0.5 U	0.5 U	0.5 U	–
MW-5	Nov-94	0.5 U	0.5 U	0.5 U	0.5 U	560
	Feb-95	0.5 U	0.5 U	0.5 U	0.5 U	460
	May-95	0.5 U	0.5 U	0.5 U	0.5 U	50 U
	Aug-95	0.5 U	0.5 U	0.5 U	0.5 U	910
	Nov-95	0.5 U	0.5 U	0.5 U	0.5 U	260
	Mar-96	0.5 U	0.5 U	0.5 U	0.5 U	–
MW-6	Nov-94	0.5 U	0.5 U	0.5 U	0.5 U	500
	Feb-95	0.5 U	0.5 U	0.5 U	0.5 U	570
	May-95	0.5 U	0.5 U	0.5 U	0.5 U	50 U
	Aug-95	0.5 U	0.5 U	0.5 U	0.5 U	790
	Nov-95	0.5 U	0.5 U	0.5 U	0.5 U	330
	Mar-96	0.5 U	0.5 U	0.5 U	0.5 U	–
MW-6a	Nov-94	0.5 U	0.5 U	0.5 U	0.5 U	–
	Feb-95	0.5 U	0.5 U	0.5 U	2.5	–
	May-95	0.5 U	0.5 U	0.5 U	0.5 U	–
	Aug-95	0.5 U	0.5 U	0.5 U	0.5 U	–
	Dec-95	0.5 U	0.5 U	0.5 U	0.5 U	–

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Table 3-2
Summary of Groundwater Analytical Results (ug/L)
BTEX and TPHd
Grand Street and Fortmann Way Property
Alameda, California

ampling ocation	Sampling Date	CHEMICAL				
		Benzene	Toluene	Ethylbenzene	Xylenes (total)	TPHd
IW-7	Nov-94	0.5 U	0.5 U	0.5 U	0.5 U	970
	Feb-95	0.5 U	0.5 U	0.5 U	0.5 U	1,300
	May-95	0.5 U	0.5 U	0.5 U	0.5 U	50 U
	Aug-95	0.5 U	0.5 U	0.5 U	0.5 U	2,200
	Nov-95	0.5 U	0.5 U	0.5 U	0.5 U	700
	Mar-96	0.5 U	0.5 U	0.5 U	0.5 U	--
IW-8	Nov-94	0.5 U	0.5 U	0.5 U	0.5 U	1,000
	Feb-95	0.5 U	0.5 U	0.5 U	0.5 U	700
	May-95	0.5 U	0.5 U	0.5 U	0.5 U	50 U
	Aug-95	0.5 U	0.5 U	0.5 U	0.5 U	1,500
	Nov-95	0.5 U	0.5 U	0.5 U	0.5 U	570
	Mar-96	0.5 U	0.5 U	0.5 U	0.5 U	--

lotes:
l = Chemical not detected. Value shown represents the sample quantitation limit.
-- Not sampled.

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Table 3-3
Summary of Groundwater Analytical Results (ug/L)
Polycyclic Aromatic Hydrocarbons (PAHs)
March 1996 Data
Grand Street and Fortmann Way Property
Alameda, California

CHEMICAL	MW-1	MW-2	MW-4	MW-5	MW-6	MW-7	MW-8
Acenaphthene	10 U	2 U	10 U	10 U	10 U	10 U	10 U
Acenaphthylene	10 U	2 U	10 U	10 U	10 U	10 U	10 U
Anthracene	10 U	0.5 U	10 U	10 U	10 U	10 U	10 U
Benzo(a)anthracene	10 U	0.1 U	10 U	10 U	10 U	10 U	10 U
Benzo(a)pyrene	10 U	0.05 U	10 U	10 U	10 U	10 U	10 U
Benzo(b)fluoranthene	10 U	0.05 U	10 U	10 U	10 U	10 U	10 U
Benzo(g,h,i)perylene	10 U	0.1 U	10 U	10 U	10 U	10 U	10 U
Benzo(k)fluoranthene	10 U	0.05 U	10 U	10 U	10 U	10 U	10 U
Chrysene	10 U	0.1 U	10 U	10 U	10 U	10 U	10 U
Dibenzo(a,h)anthracene	10 U	0.1 U	10 U	10 U	10 U	10 U	10 U
Fluoranthene	10 U	0.1 U	10 U	10 U	10 U	10 U	10 U
Fluorene	10 U	0.9	10 U	10 U	10 U	10 U	10 U
Indeno(1,2,3)pyrene	10 U	0.1 U	10 U	10 U	10 U	10 U	10 U
Naphthalene	10 U	9.3	10 U	10 U	10 U	10 U	10 U
Phenanthrene	10 U	0.5 U	10 U	10 U	10 U	10 U	10 U
Pyrene	10 U	0.1 U	10 U	10 U	10 U	10 U	10 U

Notes:
U: Chemical not detected. Value shown represents the sample quantitation limit.
-- Not sampled.

Comparison of Maximum Detected Site Subsurface Soil and Groundwater Concentrations Against ASTM RBCA Tier 1 RBSLs
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	SUBSURFACE SOIL (µg/kg) [a] Maximum Detected Concentration	ASTM RBCA Tier 1 RBSL [c][d]	Maximum Detect Exceeds RBSL?	Chemical of Potential Concern (COPC)?	GROUNDWATER (µg/L) [b] Maximum Detected Concentration	ASTM RBCA Tier 1 RBSL [c][d]	Maximum Detect Exceeds RBSL?	Chemical of Potential Concern (COPC)?
Indoor Inhalation of Vapor								
Benzene	nd	1.09E+01	no	no	5.50E+02	7.39E+01	YES	YES
Ethylbenzene	1.00E+01	1.10E+06	no	no	6.50E+01	>S	no	no
Toluene	5.70E+00	5.45E+04	no	no	6.70E+02	8.50E+04	no	no
Xylenes	8.40E+01	RES	no	no	3.20E+02	>S	no	no
Naphthalenes	NA	1.07E+05	no	no	9.30E+00	1.23E+04	no	no
Fluorene	NA	NA	NA	no	9.00E-01	NA	NA	YES
Benzo(a)pyrene	NA	RES	no	no	nd	>S	no	no
Outdoor Inhalation of Vapor								
Benzene	nd	4.57E+02	no	no	5.50E+02	1.84E+04	no	no
Ethylbenzene	1.00E+01	RES	no	no	6.50E+01	>S	no	no
Toluene	5.70E+00	RES	no	no	6.70E+02	>S	no	no
Xylenes	8.40E+01	RES	no	no	3.20E+02	>S	no	no
Naphthalenes	NA	RES	no	no	9.30E+00	>S	no	no
Fluorene	NA	NA	NA	no	9.00E-01	NA	NA	YES
Benzo(a)pyrene	NA	RES	no	no	nd	>S	no	no
Ingestion [e]								
Benzene	nd	1.00E+04	no	no	5.50E+02	9.87E+00	YES	YES
Ethylbenzene	1.00E+01	1.15E+07	no	no	6.50E+01	1.02E+04	no	no
Toluene	5.70E+00	1.87E+07	no	no	6.70E+02	2.04E+04	no	no
Xylenes	8.40E+01	2.08E+08	no	no	3.20E+02	>S	no	no
Naphthalenes	NA	1.90E+06	no	no	9.30E+00	4.09E+02	no	no
Fluorene	NA	NA	NA	no	9.00E-01	NA	NA	YES
Benzo(a)pyrene	NA [f]	3.04E+02	NA	YES	nd	1.17E-02	no	no

Notes:
nd = not detected
NA = not available
[a] Subsurface soil concentrations shown represent data from the October 1994 sampling round.
[b] Groundwater concentrations shown represent data from November 1994 to March 1996.
[c] Tier 1 risk-based screening levels (RBSLs) shown are for a commercial/industrial land use scenario. The RBSL for carcinogens (i.e., benzene and benzo(a)pyrene) is based on an excess cancer risk of 1E-06. The RBSL for noncarcinogens (i.e., ethylbenzene, toluene, xylenes, and naphthalenes) is based on a hazard index of 1.0.
[d] American Society for Testing and Materials (ASTM). 1995. Standard Guide for Risk-Based Corrective Action (RBCA) Applied at Petroleum Release Sites. E 1739-95. November.
[e] Soil ingestion RBSLs shown also consider dermal contact and inhalation of vapors and particulates.
[f] ASTM recommends benzo(a)pyrene as an indicator compound for diesel, however benzo(a)pyrene was not analyzed. Due to the uncertainty involved with estimating benzo(a)pyrene concentrations from diesel, the screening process is not applied and benzo(a)pyrene is retained as a COPC.

RES = Selected risk level is not exceeded for pure compound present at any concentration (ASTM, 1995).
>S = Selected risk level is not exceeded for all possible dissolved levels (less than or equal to pure component solubility) (ASTM).

Table 3-5
Statistical Analysis of Subsurface Soil Data for COPCs
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Units	Number Detected [a]	Number of Samples [a]	Detection Frequency	Minimum Estimated [a]	Maximum Estimated [a]	Arithmetic Mean [a,b]	Normal 95 UCL [a,c]
Benzo(a)pyrene	mg/kg	6	7	86%	1.61E-06	9.80E-05	1.82E-05	4.44E-05

Notes:
[a] = not analysed, concentration shown represents a surrogate concentration based on Guerin et al., 1984, which estimates a benzeo(a)pyrene concentration to be approximately 0.07 mg/kg of diesel.

[b] = Statistics calculated assuming one-half the sample quantitation limit for nondetected data.

[c] = 95% Upper Confidence Limit (UCL) on the arithmetic mean assuming a normal distribution.

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Table 3-6
Statistical Analysis of Groundwater Data for COPCs
(Site-Wide)
Grand Street and Fortmann Way Property
Alameda, California

Chemical	Units	Number Detected	Number of Samples	Detection Frequency	Minimum Detected	Maximum Detected	Arithmetic Mean [a]	Normal 95 UCL [b]
Benzene	ug/L	6	45	13%	5.00E-01	5.50E+02	4.25E+01	7.51E+01
Fluorene	ug/L	1	7	14%	9.00E-01	9.00E-01	4.41E+00	

Notes:

[a] = Statistics calculated assuming one-half the sample quantitation limit for nondetected data.

[b] = 95% Upper Confidence Limit (UCL) on the arithmetic mean assuming a normal distribution.

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Table 4-1
Statistical Analysis of Groundwater COPC Data for Wells MW-2 and MW-4
(Grand Street Office Building)
Grand Street and Fortmann Way Property
Alameda, California

Chemical	Data group	Units	Number Detected	Number of Samples	Detection Frequency	Minimum Detected	Maximum Detected	Arithmetic Mean [a]	Normal 95 UCL [b]
Benzene	Bldg	ug/L	5	11	45%	1.90E+02	5.50E+02	1.73E+02	2.93E+02
Fluorene	Bldg	ug/L	1	2	50%	9.00E-01	9.00E-01	2.95E+00	

Notes:

[a] = Statistics calculated assuming one-half the sample quantitation limit for nondetected data.

[b] = 95% Upper Confidence Limit (UCL) on the arithmetic mean assuming a normal distribution.

Table 4-2
Exposure Point Concentrations for Groundwater COPCs
(Site-Wide)
Grand Street and Fortmann Way Property
Alameda, California

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Chemical Name	Direct Groundwater Contact (mg/L)	VFwesp (mg/m^3-air)/(mg/L-H_2O)	Enclosed Air Concentration (mg/m^3) [1]	VFwamb (mg/m^3-air)/(mg/L-H_2O)	Ambient Air Concentration (mg/m^3) [2]
Benzene	7.51E-02	9.02E-04	6.77E-05	2.76E-05	2.07E-06
Fluorene	9.00E-04	1.05E-05	9.44E-09	2.26E-06	2.03E-09

Notes:

[1] Enclosed air concentration calculated by multiplying groundwater concentration (mg/L) by appropriate ASTM volatilization factor (VF_{wesp}) [(mg/m^3-air)/(mg/L-H_2O)].

[2] Ambient air concentration calculated by multiplying groundwater concentration (mg/L) by appropriate ASTM volatilization factor (VF_{wamb}) [(mg/m^3-air)/(mg/L-H_2O)].

Table 4-3
Exposure Point Concentrations for Groundwater COPCs
(Office Building Scenario)
Grand Street and Fortmann Way Property
Alameda, California

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Chemical Name	Direct Groundwater Contact (mg/L)	VFwesp (mg/m^3-air)/(mg/L-H_2O)	Enclosed Air Concentration (mg/m^3) [1]	VFwamb (mg/m^3-air)/(mg/L-H_2O)	Ambient Air Concentration (mg/m^3) [2]
Benzene	2.93E-01	9.02E-04	2.64E-04	2.76E-05	8.08E-06
Fluorene	9.00E-04	1.05E-05	9.44E-09	2.26E-06	2.03E-09

Notes:

[1] Enclosed air concentration calculated by multiplying groundwater concentration (mg/L) by appropriate ASTM volatilization factor (VF_{wesp}) [(mg/m^3-air)/(mg/L-H_2O)].

[2] Ambient air concentration calculated by multiplying groundwater concentration (mg/L) by appropriate ASTM volatilization factor (VF_{wamb}) [(mg/m^3-air)/(mg/L-H_2O)].

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Table 4-4
Exposure Point Concentrations for Soil COPCs
Grand Street and Fortmann Way Property
Alameda, California

Chemical Name	Direct Soil Contact (mg/kg)	Particulate Emission Factor (m^3/kg)	Airborne Soil Particulates (mg/m^3) [1]
Benzo(a)pyrene	4.44E-05	4.63E+09	9.59E-15

Notes:
[1] Airborne soil particulate concentration calculated by dividing the soil concentration with the Particulate Emission Factor (PEF) of 4.63 E + 09 m^3/kg.

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Table 4-5
Chemical Intake Exposure Assumptions -- Incidental Soil Ingestion
On-Site Construction Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = CS x IR x CF x EF x ED x FI / [BW x AT]

Intake Parameter			On-Site Construction Worker Value
CS	=	Chemical concentration in soil (mg/kg)	See Table 4-4
IR	=	Soil ingestion rate (mg/day)	50
CF	=	Conversion factor (kg/mg)	1E-06
EF	=	Exposure frequency (days/year)	60
ED	=	Exposure duration (years)	1
FI	=	Fraction from contaminated source (unitless)	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

Notes:
All of the soil contacted is assumed to be site-related.

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Table 4-7
Chemical Intake Exposure Assumptions -- Inhalation of Airborne Particulates
On-Site Construction Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = [CA x IR x ET x EF x ED] /[BW x AT]

Intake Parameter			On-Site Construction Worker Value
CA	=	Chemical concentration in air (mg/m^3)	See Table 4-4
IR	=	Inhalation rate, outdoor (m^3/hr)	1.35
ET	=	Exposure time (hr/day)	8
EF	=	Exposure frequency (days/year)	60
ED	=	Exposure duration (years)	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

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Table 4-6
Chemical Intake Exposure Assumptions – Dermal Contact with Soil
On-Site Construction Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = [CS x CF x SA x AF x ABS x EF x ED x FI] /[BW x AT]

Intake Parameter			On-Site Construction Worker Value
CS	=	Chemical concentration in surface soil (mg/kg)	See Table 4-4
CF	=	Conversion factor (kg/mg)	1E-06
SA	=	Skin Surface Area (cm^2/day)	2,000
AF	=	Soil/skin adherence factor (mg/cm^2)	0.5
ABS	=	Absorption factor-organics (unitless)	0.01
EF	=	Exposure frequency (days/year)	60
ED	=	Exposure duration (years)	1
FI	=	Fraction from contaminated source (unitless)	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

Notes:
All of the soil contacted is assumed to be site-related.

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Table 4-8
Air Concentrations Calculated from Soil Particulate Emissions
Grand Street and Fortmann Way Property
Alameda, California

Particulate Emissions Model (USEPA, 1991)

The particulate emission factor (PEF) relates the chemical concentration in soil with the concentration of respirable particles (PM_{10}) in the air due to fugitive dust emissions from surface soil. This model is a conservative estimate for particulate emissions from surface soils and is taken from USEPA, 1991. This relationship is derived by Cowherd (1985) for a rapid assessment procedure applicable to a typical hazardous waste site where the surface soil provides a relatively continuous and constant potential of emission over an extended period of time (*e.g.*, years).

The particulate emissions are assumed due to wind erosion and, therefore, depend on the erodibility of the surface material. The equation is representative of a surface with unlimited erosion potential, which is characterized by bare surfaces of finely divided material such as sandy agricultural soil with a large number (unlimited reservoir) of erodible particles. Such surfaces erode at low wind speeds, and particulate emission rates are relatively time independent at a given wind speed.

$$PEF = [(LS \times V \times DH \times CF_{one})/A] \times [CF_{two} / (RF \times (1-G) \times (U_m/U_t)^3 \times F(x))]$$

Parameter		Value	Units	Reference
PEF	= Particulate Emission Factor	4.63E+09	m^3/kg	
LS	= Width of contaminated area	45	m	USEPA, 1991
V	= Wind speed in mixing zone	2.25	m/s	USEPA, 1991
DH	= Diffusion height	2	m	USEPA, 1991
A	= Area of contamination	2,025	m^2	USEPA, 1991
RF	= Respirable fraction	0.036	g/m^2-hr	USEPA, 1991
G	= Fraction of vegetative cover	0	[unitless]	USEPA, 1991
Um	= Mean annual wind speed	4.5	m/s	USEPA, 1991
Ut	= Equivalent threshold value of wind speed at 10 m	12.8	m/s	USEPA, 1991
F(x)	= Function dependent on U_m/U_t	0.0497	[unitless]	Cowherd, 1985
CF_{one}	= Conversion Factor 1	3,600	s/hr	--
CF_{two}	= Conversion Factor 2	1,000	g/kg	--

Air Concentration (C_A) = C/ PEF

Chemical	UCL95 Soil Concentration (C) [mg/kg]	Particulate Emission Factor (PEF) [m^3/kg]	Air Concentration (C_A) (C/PEF) [mg/m^3]
Benzo(a)pyrene	4.44E-05	4.63E+09	9.59E-15

Notes:

Cowherd, C., Muleski, G., Engelhart, P., and D. Gillette. 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination. EPA Office of Health and Environmental Assessment. EPA/600/8-85/002.

U.S. Environmental Protection Agency. 1991. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Publication 9285.7-01B. December.

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Dermal Permeability Constants for Groundwater COPCs
Grand Street and Fortmann Way Property
Alameda, California

Chemical	Dermal permeability constant (cm/hr) [1]
Benzene	2.10E-02
Fluorene [2]	3.60E-01

Notes:
[1] U.S. Environmental Protection Agency (USEPA). 1992. Table 3-1, Dermal Exposure Assessment: Principles and Applications, Interim Report. Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-91/011B. January.

[2] The dermal permeability constant for fluorene is not available. The value shown represents the dermal permeability constant for fluoranthene.

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Table 4-11
Chemical Intake Exposure Assumptions -- Inhalation of Indoor Air VOCs Emanating from Groundwater
On-Site Commercial Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = [C_A x IR x ET x EF x ED] /[BW x AT]

Intake Parameter			On-Site Commercial Worker Value
C_A	=	Chemical concentration in air (mg/m^3)	See Tables 4-2 and 4-3
IR	=	Inhalation rate (m^3/hr)	0.83
ET	=	Exposure time (hr/day)	8
EF	=	Exposure frequency (days/year)	250
ED	=	Exposure duration (years)	25
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	9,125
		Carcinogens	25,550

Table 4-10
Chemical Intake Exposure Assumptions -- Dermal Contact with Groundwater
On-Site Construction Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Intake (mg/kg-day) = [Cgw x SA x PC x CF x ET x EF x ED x FC] /[BW x AT]

Intake Parameter			On-Site Construction Worker Value
Cgw	=	Chemical concentration in groundwater (mg/L)	See Tables 4-2 and 4-3
SA	=	Skin surface area (cm^2)	2,000
PC	=	Dermal permeability constant (cm/hr) [1]	
		Benzene	2.10E-02
		Fluorene [2]	3.60E-01
CF	=	Conversion factor (L/cm^3)	1E-03
ET	=	Exposure time (hr/event)	2
EF	=	Exposure frequency (events/year)	60
ED	=	Exposure duration (years)	1
FC	=	Fraction of time contacting exposure area	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

Notes:
[1] U.S. Environmental Protection Agency (USEPA). 1992. Table 5-7, Dermal Exposure Assessment: Principles and Applications, Interim Report. Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-91/011B. January.

[2] The dermal permeability constant for fluorene is not available. The value shown represents the dermal permeability constant for fluoranthene.

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Table 4-12
Chemical Intake Exposure Assumptions -- Inhalation of Ambient Air VOCs Emanating from Groundwater
On-Site Construction Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = [C_A x IR x ET x EF x ED] /[BW x AT]

Intake Parameter			On-Site Construction Worker
			Value
C_A	=	Chemical concentration in air (mg/m^3)	See Tables 4-2 and 4-3
IR	=	Inhalation rate (m^3/hr)	1.35
ET	=	Exposure time (hr/day)	8
EF	=	Exposure frequency (days/year)	60
ED	=	Exposure duration (years)	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

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Table 5-1
Toxicity Values
Grand Street and Fortmann Way Property
Alameda, California

Chemical Name	Carcinogenic Weight-of-Evidence	Oral/Dermal Slope Factor (SF) (mg/kg-day)$^{-1}$		Inhalation Slope Factor (SF) (mg/kg-day)$^{-1}$		Oral/Dermal Reference Dose (RfD) (mg/kg-day)		Inhalation Reference Dose (RfD) (mg/kg-day)	
		Value	Source	Value	Source	Value	Source	Value	Source
Benzene	A	1.00E-01	CalEPA,1995	1.00E-01	CalEPA, 1995	--			
Benzo(a)pyrene	B2	1.20E+01	CalEPA, 1995	3.90E+00	CalEPA, 1995	--		--	
Fluorene	D	--		--		4.00E-02	USEPA, 1995b	4.00E-02	USEPA, 1995b

Notes:
-- No toxicity value available. Chemical either does not exhibit toxicity via this route or sufficient evidence is not available to derive a toxicity value.

California Environmental Protection Agency (CalEPA). 1995. California Cancer Potency Factors: Update. Office of Environmental Health Hazard Assessment. April 10

U.S. Environmental Protection Agency (USEPA). 1995a. Risk-Based Concentration Table. USEPA Region III. October 20

U.S. Environmental Protection Agency (USEPA). 1995b. Integrated Risk Information System. On-line data base. Office of Research and Development. Cincinnati, Ohio.

U.S. Environmental Protection Agency (USEPA). 1995c. Preliminary Remediation Goals. USEPA Region IX. February 1.

Shaded values represent provisional toxicity values. Provisional toxicity values have not received consensus judgment by USEPA's Reference Dose Work Groups and/or Carcinogenic Risk Assessment Verification Endeavor Work Group. The values are used in this analysis to provide more conservative risk estimates.

Table 5-3
Toxicological Profile for Benzo(a)Pyrene
Grand Street and Fortmann Way Property
Alameda, California

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Benzo(a)Pyrene	
Chemical Properties	
CAS #	50-32-8
Chemical Formula	$C_{20}H_{12}$
Chemical Characteristic	Polycyclic aromatic hydrocarbon (PAH)
Synonyms	BaP; benzo(d,e,f)chrysene; 3,4-benzopyrene; 6,7-benzopyrene; BP; and 3,4-BP
Weight of Evidence (WOE)	EPA=B2 (probable human carcinogen)
Chemical Use, Fate and Transport	
What is chemical used for?	No known uses for Benzo(a)pyrene, except regarding research purposes.
Where does chemical occur?	PAHs are a group of chemicals formed during incomplete combustion of hydrocarbons. They are formed naturally and anthropogenically. They occur throughout the environment in soil, sediment, air and water.
What type of chemical fate and transport to human exposure point?	Benzo(a)pyrene tends to strongly sorb to soil and sediment, where they remain fixed. In addition, volatilization is not common due to low Henry's constant.
Chemical Disposition	
Absorption	Ingestion, inhalation and dermal contact
Distribution	Distributed to: lungs, liver, kidney, gastrointestinal tract, carcass, blood and brain
Metabolism	Metabolism occurs in all tissues to produce a metabolyte which is more hydrophilic and excretable
Excretion	Respired by lungs and excreted in urine and feces
Chemical Toxicity	
Slope Factor (SF) (mg/kg-day)$^{-1}$	Oral: 1.2 E +1 (CalEPA, 1995) ; Dermal: 1.2 E +1 (CalEPA, 1995) ; Inhalation: 3.9 E +0 (CalEPA, 1995)
Reference Dose (RfD) (mg/kg-day)	Oral: -- ; Dermal: -- ; Inhalation: --
Unit Risk Value (ug/m^3)$^{-1}$	Oral: -- ; Dermal: -- ; Inhalation: 1.1 E -3 (CalEPA, 1995)
Long-Term Exposure	
Animals	Pregnancy/neonate data: reproductive difficulty in mice studies . Genotoxicity data: positive. Sufficient carcinogenicity data (increased incidences of tumors) exists via ingestion, inhalation, and dermal contact animal studies.
Humans	Although human carinogenicity data is inadequate, lung cancer has been shown to be induced in humans by various PAH mixtures known to contain BaP including cigarette smoke, roofing tar and coke oven emissions.

Notes:

CalEPA, 1995 = California Environmental Protection Agency (CalEPA). 1995. California Cancer Potency Factors: Update. Office of Environmental Health Hazard Assessment. April 10.

Table 5-2
Toxicological Profile for Benzene
Grand Street and Fortmann Way Property
Alameda, California

DRAFT

Benzene	
Chemical Properties	
CAS #	71-43-2
Chemical Formula	C_6H_6
Chemical Characteristic	Aromatic hydrocarbon
Synonyms	benzol, coal naphtha, phenyl hydride, and pyrobenzol
Weight of Evidence (WOE)	IARC=Group I (carcinogenic to humans), NTP=Clear evidence, EPA=Group A (human carcinogen)
Chemical Use, Fate and Transport	
What is chemical used for?	In past, widely used as a solvent, but due to known adverse health effects, uses are now minimal. Mostly used as starting material for various organic coumpound synthesis and minor uses as substance in gasoline (0.8 - 2.0 %).
Where does chemical occur?	Mobile in soil/gw systems with sandy/low organic content soils. Volatilization important in surface soil or soil-air compartments. Hydrolysis and biodegradation not expected in natural soils, but acclimated microbial populations can biodegrade benzene.
What type of chemical fate and transport to human exposure point?	Primary pathway from a soil-water system is migration to gw drinking supplies (historically common). Inhalation from volatilization from surface soils possibly important.
Chemical Disposition	
Absorption	Inhalation, ingestion, dermal contact (lesser absorption)
Distribution	Ingestion: to bile, blood, brain, fat (abdominal), kidney, liver and mammary glands. Dermal: to kidney, liver and skin
Metabolism	Mainly by liver's cytochrome P-450 system
Excretion	Exhalation and urinary excretion
Chemical Toxicity	
Slope Factor (SF) (mg/kg-day)$^{-1}$	Oral: 1.0 E-1 (CalEPA, 1995); Dermal: 1.0 E-1 (CalEPA, 1995); Inhalation: 1.0 E-1 (CalEPA, 1995)
Reference Dose (RfD) (mg/kg-day)	Oral: -- ; Dermal: -- ; Inhalation: 1.71 E -3 (USEPA, 1995a)
Unit Risk Value (ug/m^3)$^{-1}$	Oral: -- ; Dermal: -- ; Inhalation: 2.9 E -5 (CalEPA, 1995)
Signs and Symptoms from Human Exposure	Inhalation and ingestion primarily affects the CNS with following symptoms: headache, dizziness, drowsiness, and nausea progressing to convulsions, respiratory paralysis and death due to high vapor concentrartions. Eye and skin irritant.
Long-Term Exposure	Pancytopenia, leukemia. Pregnancy/neonate data: embryotoxicity and fetotoxicity at maternally toxic doses. Genotoxicity data: mixed results.

Notes:

CalEPA, 1995 = California Environmental Protection Agency (CalEPA). 1995. California Cancer Potency Factors: Update. Office of Environmental Health Hazard Assessment. April 10.

USEPA, 1995a = U.S. Environmental Protection Agency (USEPA). 1995. Risk-Based Concentration Table. USEPA Region III. October 20.

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Table 5-4
Toxicological Profile for Fluorene
Grand Street and Fortmann Way Property
Alameda, California

Fluorene	
Chemical Properties	
CAS #	86-73-7
Chemical Formula	$C_{13}H_{10}$
Chemical Characteristic	Polycyclic aromatic hydrocarbon (PAH)
Synonyms	ortho-biphenylene methane; diphenylenemethane; 2,2-methylene biphenyl; and 2,3-benzidene
Weight of Evidence (WOE)	EPA=Group D (not classifiable as to human carcinogenicity)
Chemical Use, Fate and Transport	
What is chemical used for?	Fluorene is used as a chemical intermediate in chemical processes and in polyradical formation.
Where does chemical occur?	PAHs are a group of chemicals formed during incomplete combustion of hydrocarbons. They are formed naturally and anthropogenically. They occur throughout the environment in soil, sediment, air and water.
What type of chemical fate and transport to human exposure point?	Some PAHs tends to strongly sorb to soil and sediment, where they remain fixed.
Chemical Behavior	
Absorption	Ingestion, inhalation and dermal contact
Distribution	Distributed to: lungs, liver, kidney, gastrointestinal tract, carcass, blood and brain
Metabolism	Metabolism occurs in all tissues to produce a metabolyte which is more hydrophilic and excretable
Excretion	Respired by lungs and excreted in urine and feces
Chemical Toxicity	
Slope Factor (SF) (mg/kg-day)$^{-1}$	Oral: – ; Dermal: – ; Inhalation: –
Reference Dose (RfD) (mg/kg-day)	Oral: 4.00E-2 (USEPA, 1995b); Dermal: 4.00E-2 (USEPA, 1995b); Inhalation: 4.00E-2 (USEPA, 1995c)
Uncertainty Factor (UF)	3000 (oral RfD)
Short Term Exposure	
Animals	Chronic studies indicate hypoactivity, a decreased red blood cell count, and increased liver and spleen weights are all dose-related.

Notes:

CalEPA, 1995 = California Environmental Protection Agency (CalEPA). 1995. California Cancer Potency Factors: Update. Office of Environmental Health Hazard Assessment. April 10.

USEPA, 1995a = U.S. Environmental Protection Agency (USEPA). 1995. Risk-Based Concentration Table. USEPA Region III. October 20.

USEPA, 1995b = U.S. Environmental Protection Agency (USEPA). 1995. Integrated Risk Information System. On-line data base. Office of Research and Development. Cincinnati, Ohio.

USEPA, 1995c = U.S. Environmental Protection Agency (USEPA). 1995. Preliminary Remediation Goals. USEPA Region IX. February 1.

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Table 6-1
Excess Cancer Risk Summary
Site-Wide Scenario
Grand Street and Fortmann Way Property
Alameda, California

Exposure Pathway	EXCESS CANCER RISK	
	Construction Worker	Commercial Worker
Incidental Ingestion of Soil	8.94E-13	–
Dermal Contact with Soil	1.79E-13	–
Inhalation of Airborne Particulates	1.35E-17	–
Dermal Contact with Groundwater	2.12E-08	–
Inhalation of Indoor Air VOCs Emanating from Groundwater	–	1.57E-07
Inhalation of Ambient Air VOCs Emanating from Groundwater	7.50E-11	–
TOTAL EXCESS CANCER RISK	**2E-08**	**2E-07**

Table 6-3
Non-Cancer Risk Summary
Site-Wide Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Exposure Pathway	NON-CANCER RISK	
	Construction Worker	Commercial Worker
Incidental Ingestion of Soil	--	--
Dermal Contact with Soil	--	--
Inhalation of Airborne Particulates	--	--
Dermal Contact with Groundwater	7.61E-05	--
Inhalation of Indoor Air VOCs Emanating from Groundwater	--	2.57E-03
Inhalation of Ambient Air VOCs Emanating from Groundwater	3.07E-05	--
TOTAL NON-CANCER RISK	**1E-04**	**3E-03**

Table 6-2
Excess Cancer Risk Summary
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

DRAFT

Exposure Pathway	EXCESS CANCER RISK	
	Construction Worker	Commercial Worker
Incidental Ingestion of Soil	8.94E-13	--
Dermal Contact with Soil	1.79E-13	--
Inhalation of Airborne Particulates	1.35E-17	--
Dermal Contact with Groundwater	8.26E-08	--
Inhalation of Indoor Air VOCs Emanating from Groundwater	--	6.13E-07
Inhalation of Ambient Air VOCs Emanating from Groundwater	2.93E-10	--
TOTAL EXCESS CANCER RISK	**8E-08**	**6E-07**

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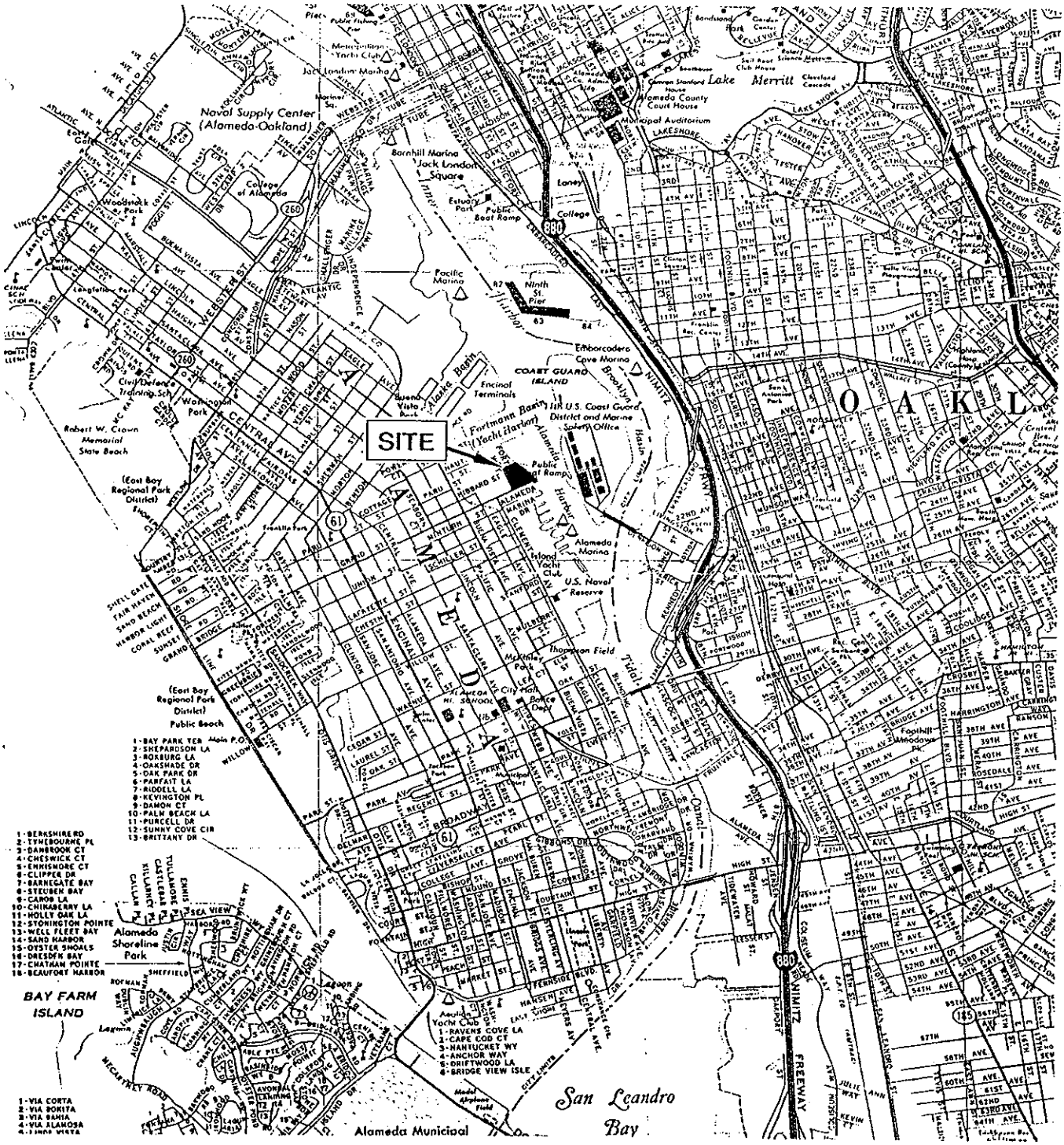
Table 6-4
Non-Cancer Risk Summary
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

Exposure Pathway	NON-CANCER RISK	
	Construction Worker	Commercial Worker
Incidental Ingestion of Soil	--	--
Dermal Contact with Soil	--	--
Inhalation of Airborne Particulates	--	--
Dermal Contact with Groundwater	7.61E-05	--
Inhalation of Indoor Air VOCs Emanating from Groundwater	--	1.00E-02
Inhalation of Ambient Air VOCs Emanating from Groundwater	1.20E-04	--
TOTAL NON-CANCER RISK	**2E-04**	**1E-02**



SOURCE: BASE MAP FROM H.M. GOUSHA, 1988, OAKLAND AND EAST BAY CITIES.

NORTH

0 1

SCALE MILE

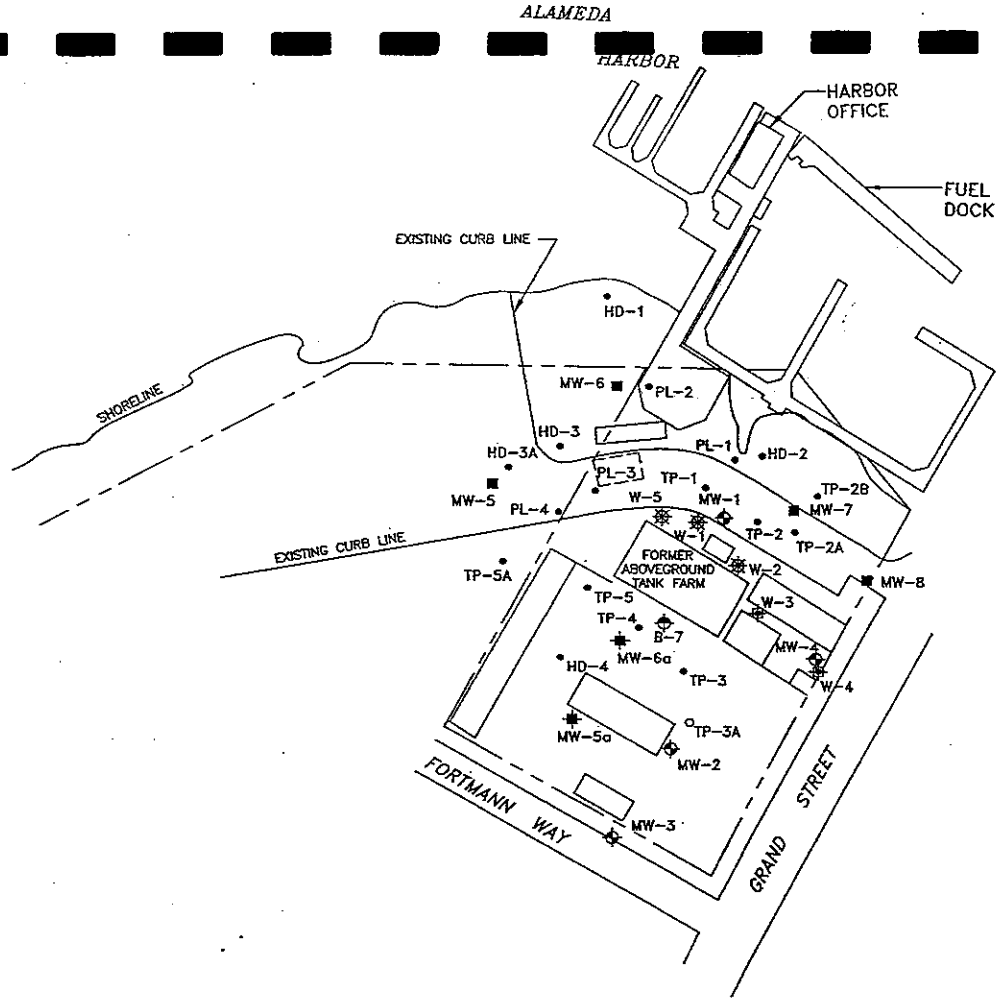
DRAWN	CCR
APPR	JGR
DATE	23JAN95
JOB NO.	

SECOR
INTERNATIONAL INCORPORATED

FIGURE 1-1
GRAND STREET AND FORTMANN WAY PROPERTY
ALAMEDA, CALIFORNIA

SITE LOCATION MAP

198501.061052 I:\ARCD\81TE-P



LEGEND

MW-5a ✱	MONITORING WELL (ACC, 10/94)
MW-8 ■	MONITORING WELL (SECOR, 10/94)
TP-3A ○	BORING (SECOR, 10/94)
PL-2 •	BORING (SECOR, 10/93)
MW-1 ⊕	MONITORING WELL (ZACCOR, 5/92)
B-7 ⊕	MONITORING WELL (HARDING-LAWSON, 6/87)
W-3 ✱	ABANDONED MONITORING WELL (CROWLEY ENVIRONMENTAL SERVICES, 4/87)
W-4 ⊕	MONITORING WELL (CROWLEY, 4/87)
— — — —	PROPERTY LINE

N

0 100 200
SCALE FEET

SOURCE: BASED ON SURVEY BY RON ARCHER, CIVIL ENGINEER INC., NOVEMBER 1994.

SECOR INTERNATIONAL INCORPORATED

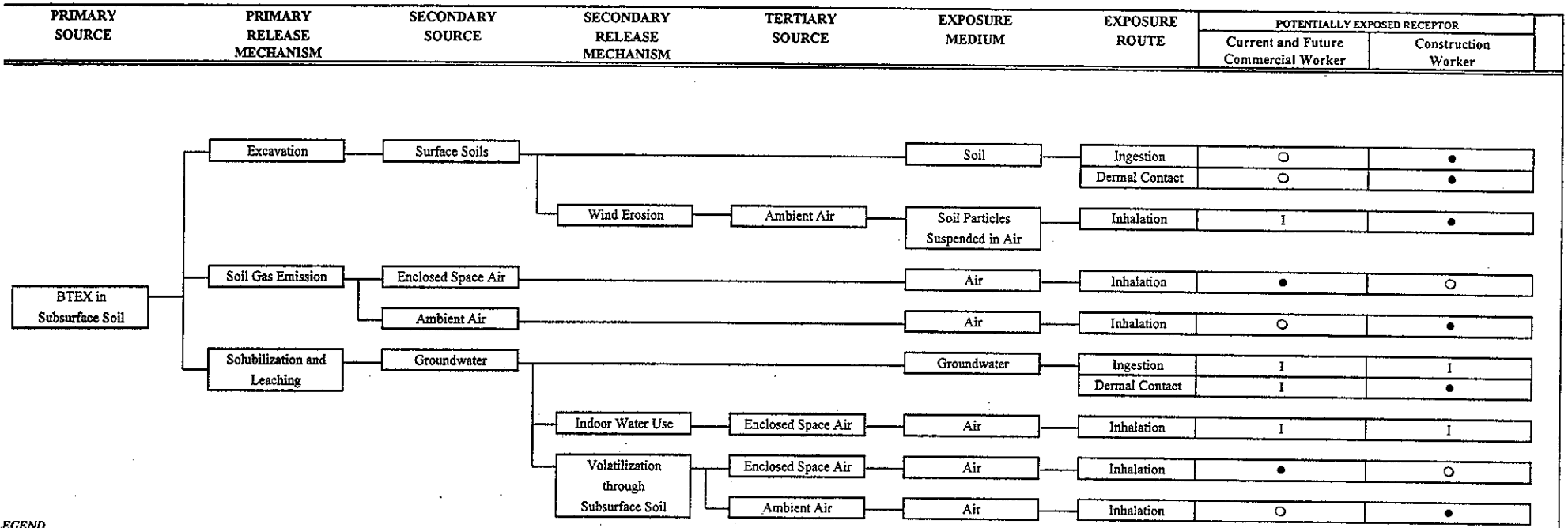
DRAWN	KN
APPR.	JGR
DATE	03JUL96
JOB NO.	50085-001-01

FIGURE 2-1
GRAND STREET AND FORTMANN WAY PROPERTY
ALAMEDA, CALIFORNIA

SITE PLAN

19950I.101781 I:\JOBS\MAR\NA181\TEP1.1

DRAFT



Grand Street and Fortmann Way Property
Alameda, California
SECOR International Incorporated

CONCEPTUAL SITE MODEL
Commerical Land Use with Municipal Water Supply

Figure 4-1

Appendix A
Volatilization Factor Calculations for an Occupational Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Table of Contents

Notes:
Volatilization Factor (VF) calculations are based on ASTM E 1739-95 Risk-Based Corrective Action Applied at Petroleum Release Sites. November, 1995.

Table 1a
Chemical-Specific Properties
Volatilization Factor Calculation for an Occupational Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	D_{air} (cm^2/s)	Source	D_{wat} (cm^2/s)	Source	H (cm^3-H_2O/cm^3-air)	Source	k_{oc} (g-H_2O/g-C)	Source	S (mg/L-H_2O)	Source	k_s (g-H_2O/g-soil)	Source
Benzene	8.70E-02	[a]	9.80E-06	[a]	2.20E-01	[a]	5.70E+01	[a]	1.78E+03	[a]	5.70E-01	[d]
Fluorene	3.63E-02	[a]	8.36E-06	[b]	3.00E-03	[a]	7.93E+03	[a]	1.86E+00	[a]	7.93E+01	[d]

Notes:
[a] U.S. Environmental Protection Agency. 1994. Technical Background Document for Soil Screening Guidance. Review draft. Office of Solid Waste and Emergency Response, Washington, D.C. EPA540/R-94/106. November.

[b] Dwat was not available for fluorene. A value of 8.36 E-06 was assumed based upon another chemical (2,4,6-Trichlorophenol) with a Dair value which is similar to fluorene.

[d] $k_s = k_{oc} x f_{oc}$. Value for f_{oc} is presented in Table 2.
D_{air} = Diffusion coefficient in air
D_{wat} = Diffusion coefficient in water
H = Henry's law constant
k_{oc} = Carbon-water sorption coefficient
S= Pure component solubility in water
Unknown values are shaded.

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Table A-2
Nonchemical-Specific Properties
Volatilization Factor Calculations for an Occupational Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Parameter	Definition	Units	Results	Source
d	Lower depth of surficial soil zone	cm	100	ASTM, 1995
ER	Enclosed-space air exchange rate	1/s	0.00167	Burton, 1990
f_{oc}	Fraction of organic carbon in soil	g-C/ g-soil	0.01	ASTM, 1995
h_{cap}	Thickness of capillary fringe	cm	5	ASTM, 1995
h_v	Thickness of vadose zone	cm	100	Site-Specific
I	Infiltration rate of water through soil	cm/year	30	ASTM, 1995
k_s	Soil-water sorption coefficient ($f_{oc} \times k_{oc}$)	g-H_2O/g-soil	see table 1	ASTM, 1995
L_B	Enclosed-space volume/infiltration area ratio	cm	300	ASTM, 1995
L_{crack}	Enclosed-space foundation or wall thickness	cm	15	ASTM, 1995
L_{GW}	Depth to groundwater ($h_{cap} + h_v$)	cm	105	ASTM, 1995
L_S	Depth to subsurface soil sources	cm	100	ASTM, 1995
P_e	Particulate emission rate	g/cm^2-s	6.9E-14	ASTM, 1995
U_{air}	Wind speed above ground surface in ambient mixing zone	cm/s	225	ASTM, 1995
U_{gw}	Ground water Darcy velocity	cm/year	2.50E+03	ASTM, 1995
W	Width of source area parallel to wind, or groundwater flow direction	cm	1500	ASTM, 1995
δ_{air}	Ambient air mixing zone height	cm	200	ASTM, 1995
δ_{gw}	Ground water mixing zone thickness	cm	200	ASTM, 1995
η	Areal fraction of cracks in foundation/walls	cm^2-cracks /cm^2-total area	0.01	ASTM, 1995
Θ_{acap}	Volumetric air content in capillary fringe soils	cm^3-air/cm^3-soil	0.038	ASTM, 1995
Θ_{acrack}	Volumetric air content in foundation/wall cracks	cm^3-air/cm^3-total volume	0.26	ASTM, 1995
Θ_{as}	Volumetric air content in vadose zone soils	cm^3-air/cm^3-soil	0.26	ASTM, 1995
Θ_T	Total soil porosity	cm^3/cm^3-soil	0.38	ASTM, 1995
Θ_{wcap}	Volumetric water content in capillary fringe soils	cm^3-$H_2$0/cm^3-soil	0.342	ASTM, 1995
Θ_{wcrack}	Volumetric water content in foundation/wall cracks	cm^3-H_2O/cm^3-total volume	0.12	ASTM, 1995
Θ_{ws}	Volumetric water content in vadose zone soils	cm^3-H_2O/cm^3-soil	0.12	ASTM, 1995
ρ_s	Soil bulk density	g-soil/cm^3-soil	1.7	ASTM, 1995
T	Averaging time for vapor flux	s	7.88E+08	ASTM, 1995

Notes:
American Society for Testing and Materials (ASTM). 1995. Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. E 1739-95. November.

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Effective Diffusion Coefficient in Soil Based on Vapor-Phase Concentration ($Deff_S$)
Grand Street and Fortmann Way Property
Alameda, California

$$Deff_S\ [cm^2/s] = [D_{air} \times (\Theta_{as}^{3.33}/\Theta_T^{2})] + [(D_{wat}/H) \times (\Theta_{ws}^{3.33}/\Theta_T^{2})]$$

Chemical	D_{air} (cm^2/s)	Θ_{as} (cm^3-air/ cm^3-soil)	Θ_T (cm^3 / cm^3-soil)	D_{wat} (cm^2/s)	H (cm^3-H_2O/ cm^3-air)	Θ_{ws} (cm^3-H_2O/ cm^3-soil)	$Deff_S$ (cm^2/s)
Benzene	0.087	0.26	0.38	9.80E-06	0.22	0.12	6.79E-03
Fluorene	0.0363	0.26	0.38	8.36E-06	0.003	0.12	2.85E-03

Table A-3
Effective Diffusion Coefficient through Capillary Fringe ($Deff_{cap}$)
Grand Street and Fortmann Way Property
Alameda, California

DRAFT

$$Deff_{cap}\ [cm^2/s] = [D_{air} \times (\Theta_{acap}^{3.33}/\Theta_T^{2})] + [(D_{wat}/H) \times (\Theta_{wcap}^{3.33}/\Theta_T^{2})]$$

Chemical	D_{air} (cm^2/s)	Θ_{acap} (cm^3-air / cm^3 soil)	Θ_T (cm^3 / cm^3-soil)	D_{wat} (cm^2/s)	H (cm^3-H2O / cm^3-air)	Θ_{wcap} (cm^3H2O / cm^3-soil)	$Deff_{cap}$ (cm^2/s)
Benzene	0.087	0.038	0.38	9.80E-06	0.22	0.342	1.99E-05
Fluorene	0.0363	0.038	0.38	8.36E-06	0.003	0.342	5.46E-04

Table A-4
Effective Diffusion Coefficient through Foundation ($Deff_{crack}$)
Grand Street and Fortmann Way Property
Alameda, California

DRAFT

$$Deff_{crack}\ [cm^2/s] = [D_{air} \times (\Theta_{acrack}^{3.33}/\Theta_T^{2})] + [(D_{wat}/H) \times (\Theta_{wcrack}^{3.33}/\Theta_T^{2})]$$

Chemical	D_{air} (cm^2/s)	Θ_{acrack} (cm^3-air/ cm^3-total volume)	Θ_T (cm^3 / cm^3-soil)	D_{wat} (cm^2/s)	H (cm^3-H_2O/ cm^3-air)	Θ_{wcrack} (cm^3-H_2O/ cm^3-total	$Deff_{crack}$ (cm^2/s)
Benzene	0.087	0.26	0.38	9.80E-06	0.22	0.12	6.79E-03
Fluorene	0.0363	0.26	0.38	8.36E-06	0.003	0.12	2.85E-03

Effective Diffusion Coefficient between Groundwater and Soil Surface ($Deff_{ws}$)
Grand Street and Fortmann Way Property
Alameda, California

DRAFT

$$Deff_{ws}\ [cm^2/s] = (h_{cap} + h_v)\ x\ [(h_{cap}/Deff_{cap}) + (h_v/Deff_S)]^{-1}$$

Chemical	h_{cap} (cm)	h_v (cm)	$Deff_{cap}$ (cm2/s)	$Deff_S$ (cm2/s)	$Deff_{ws}$ [cm2/s]
Benzene	5	100	1.99E-05	6.79E-03	3.95E-04
Fluorene	5	100	5.46E-04	2.85E-03	2.37E-03

Volatilization Factor: Groundwater to Enclosed-Space Vapors (VF_{wesp})
Grand Street and Fortmann Way Property
Alameda, California

DRAFT

$$VF_{wesp}\ [(mg/m^3\ air)/(mg/L\ H_2O)] = [H((Deff_{ws}/L_{GW})/(ER\ x\ L_B))/(1 + ((Deff_{ws}/L_{GW})/(ER\ x\ L_B)) + ((Deff_{WS}/L_{GW})/(Deff_{crack}/L_{crack})n))]\ x\ 10^3\ L/m^3$$

Chemical	H (cm^3-H2O / cm^3-air)	$Deff_{ws}$ (cm^2/s)	L_{GW} (cm)	$Deff_{crack}$ (cm^2/s)	ER (L/s)	L_B (cm)	η (cm^2-cracks / cm^2 total area)	L_{crack} (cm)	VF_{wesp} (mg/m^3 air) / (mg/L H_2O)
Benzene	0.22	3.95E-04	105	6.79E-03	0.00167	300	1.00E-02	1.50E+01	9.02E-04
Fluorene	0.003	2.37E-03	105	2.85E-03	0.00167	300	1.00E-02	1.50E+01	1.05E-05

Table A-9
Groundwater-Ambient Air Concentration Calculation
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Groundwater Concentration	Volatilization Factor	Ambient Air Concentration (Site-Wide)
	(mg/L)	VF_{wamb} [(mg/m^3-air)/(mg/L H_2O)]	(mg/m^3)
Benzene	7.51E-02	2.76E-05	2.07E-06
Fluorene	9.00E-04	2.26E-06	2.03E-09

Table A-8
Volatilization Factor: Groundwater to Ambient Air (Vapors) (VF_{wamb})
Grand Street and Fortmann Way Property
Alameda, California

DRAFT

$$VF_{wamb}\ [(mg/m^3\ air)/(mg/L\ H_2O)] = H/[(1+(U_{air} \times \delta_{air} \times L_{GW}))/(W \times Deff_{ws})] \times 10^3\ L/m^3$$

Chemical	H (cm^3-H_2O / cm^3-air)	U_{air} (cm/s)	δ_{air} (cm)	L_{GW} (cm)	W (cm)	$Deff_{ws}$ (cm^2/s)	VFwamb (mg/m^3 air)/(mg/L H_2O)
Benzene	0.22	225	200	105	1500	3.95E-04	2.76E-05
Fluorene	0.003	225	200	105	1500	2.37E-03	2.26E-06

Groundwater-Enclosed Space Air Concentration Calculation
Grand Street and Fortmann Way Property
Alameda, California

DRAFT

Chemical	Groundwater Concentration	Volatilization Factor	Enclosed-Space Air Concentration (Site-Wide)
	(mg/L)	VF_{wesp} [(mg/m^3-air)/(mg/L H_2O)]	(mg/m^3)
Benzene	7.51E-02	9.02E-04	6.77E-05
Fluorene	9.00E-04	1.05E-05	9.44E-09

Groundwater-Ambient Air Concentration Calculation
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Groundwater Concentration	Volatilization Factor	Ambient Air Concentration (Office Building)
	(mg/L)	VF_{wamb} [(mg/m^3-air)/(mg/L H_2O)]	(mg/m^3)
Benzene	2.93E-01	2.76E-05	8.08E-06
Fluorene	9.00E-04	2.26E-06	2.03E-09

Table C-12

Groundwater-Enclosed Space Air Concentration Calculation
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Groundwater Concentration	Volatilization Factor	Enclosed-Space Air Concentration (Office Building)
	(mg/L)	VF_{wesp} [(mg/m^3-air)/(mg/L H_2O)]	(mg/m^3)
Benzene	2.93E-01	9.02E-04	2.64E-04
Fluorene	9.00E-04	1.05E-05	9.44E-09

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Appendix B
Table of Contents
Risk Calculations
Site-Wide Occupational Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Summary of Potentially Complete Exposure Pathways
Grand Street and Fortmann Way Property
Alameda, California

Exposure Pathway/Route [1]	RECEPTOR: On-Site Construction Worker	RECEPTOR: On-Site Commercial Worker
SOIL PATHWAYS		
COC: Benzo(a)pyrene		
Incidental Soil Ingestion	x	
Dermal Contact with Soil	x	
Inhalation of Airborne Soil Particulates	x	
GROUNDWATER PATHWAYS		
COCs: Benzene and Fluorene		
Dermal Contact with Groundwater	x	
Inhalation of VOCs Emanating from Groundwater to Indoor Air		x
Inhalation of VOCs Emanating from Groundwater to Ambient Air	x	

Notes:
[1] See the Conceptual Site Model for additional information regarding exposure pathways.
x = Pathway is quantitatively evaluated for this receptor.

Summary of Exposure Assumptions
Occupational Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

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EXPOSURE PARAMETER	On-Site Commercial Worker		On-Site Construction Worker	
	Value	Source	Value	Source
Contact Rate Assumptions				
Inhalation rate (indoors) (m^3/hr)	0.83	ASTM, 1995	--	
Inhalation rate (outdoors) (m^3/hr)	--		1.35	USEPA, 1989a [1]
Soil ingestion rate (mg/day)	--		50	ASTM, 1995
Skin surface area (cm^2/day)	--		2,000	USEPA, 1989a [2]
Soil-to-skin adherence factor (mg/cm^2)	--		0.5	ASTM, 1995
Absorption factor-organics (unitless)	--		0.01	USEPA, 1992
General Assumptions				
Exposure time (hr/day)	8	Professional Judgment	8	Professional Judgment
Exposure time to groundwater (hr/day)	--		2	Professional Judgment
Exposure frequency (days/year)	250	ASTM, 1995	60	Professional Judgment
Exposure duration (years)	25	ASTM, 1995	1	Professional Judgment
Conversion factor (kg/mg)	--		1E-06	
Conversion factor (L/cm^3)	--		1E-03	
Fraction of time contacting exposure area (unitless)	1		1	
Body weight (kg)	70	ASTM, 1995	70	ASTM, 1995
Averaging time (days)				
Noncarcinogens	9,125	Professional Judgment	365	Professional Judgment
Carcinogens	25,550	USEPA, 1989b	25,550	USEPA, 1989b

Notes:
-- Not applicable.

American Society for Testing and Materials (ASTM). 1995. Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. ASTM Designation: E 1739-95. November.

U.S. Environmental Protection Agency (USEPA). 1989a. Exposure Factors Handbook. Office of Health and Environmental Assessment. Washington, D.C. EPA/600/8-89/043. July.

U.S. Environmental Protection Agency (USEPA). 1989b. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final. Office of Emergency and Remedial Response, Washington, D.C. EPA-540/1-89/002. December.

U.S. Environmental Protection Agency (USEPA). 1992. New Interim Region IV Guidance. Region IV, Atlanta, GA. February.

[1] Inhalation rate assumes a moderate activity level 50 percent of the time (2.1 m^3/hr) and a light activity level the remaining 50 percent of the time (0.6 m^3/hr).
[2] Skin surface area assumes exposure to hands and face.

Table 3
Chemical Intake Exposure Assumptions -- Incidental Soil Ingestion
On-Site Construction Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Intake (mg/kg-day) = [CS x IR x CF x EF x ED x FI] / [BW x AT]

Intake Parameter		Construction Worker Value
CS	= Chemical concentration in soil (mg/kg)	See Table 11
IR	= Soil ingestion rate (mg/day)	50
CF	= Conversion factor (kg/mg)	1E-06
EF	= Exposure frequency (days/year)	60
ED	= Exposure duration (years)	1
FI	= Fraction from contaminated source (unitless)	1
BW	= Body weight (kg)	70
AT	= Averaging time (days)	
	Noncarcinogens	365
	Carcinogens	25,550

Notes:
All of the soil contacted is assumed to be site-related.

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Table 4
Chemical Intake Exposure Assumptions -- Dermal Contact with Soil
On-Site Construction Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = [CS x CF x SA x AF x ABS x EF x ED x FI] /[BW x AT]

Intake Parameter			Construction Worker Value
CS	=	Chemical concentration in surface soil (mg/kg)	See Table 11
CF	=	Conversion factor (kg/mg)	1E-06
SA	=	Skin Surface Area (cm^2/day)	2,000
AF	=	Soil/skin adherence factor (mg/cm^2)	0.5
ABS	=	Absorption factor-organics (unitless)	0.01
EF	=	Exposure frequency (days/year)	60
ED	=	Exposure duration (years)	1
FI	=	Fraction from contaminated source (unitless)	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

Notes:
All of the soil contacted is assumed to be site-related.

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Table 5
Chemical Intake Exposure Assumptions -- Inhalation of Airborne Particulates
On-Site Construction Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = [CA x IR x ET x EF x ED] /[BW x AT]

Intake Parameter			Construction Worker Value
CA	=	Chemical concentration in air (mg/m^3)	See Table 11
IR	=	Inhalation rate, outdoor (m^3/hr)	1.35
ET	=	Exposure time (hr/day)	8
EF	=	Exposure frequency (days/year)	60
ED	=	Exposure duration (years)	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

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Table 6
Air Concentrations Calculated from Soil Particulate Emissions
Grand Street and Fortmann Way Property
Alameda, California

Particulate Emissions Model (USEPA, 1991)

The particulate emission factor (PEF) relates the chemical concentration in soil with the concentration of respirable particles (PM_{10}) in the air due to fugitive dust emissions from surface soil. This model is a conservative estimate for particulate emissions from surface soils and is taken from USEPA, 1991. This relationship is derived by Cowherd (1985) for a rapid assessment procedure applicable to a typical hazardous waste site where the surface soil provides a relatively continuous and constant potential of emission over an extended period of time (e.g., years).

The particulate emissions are assumed due to wind erosion and, therefore, depend on the erodibility of the surface material. The equation is representative of a surface with unlimited erosion potential, which is characterized by bare surfaces of finely divided material such as sandy agricultural soil with a large number (unlimited reservoir) of erodible particles. Such surfaces erode at low wind speeds, and particulate emission rates are relatively time independent at a given wind speed.

$$PEF = [(LS \times V \times DH \times CF_{one})/A] \times [CF_{two} / (RF \times (1-G) \times (U_m/U_t)^3 \times F(x))]$$

Parameter		Value	Units	Reference
PEF	= Particulate Emission Factor	4.63E+09	m^3/kg	
LS	= Width of contaminated area	45	m	USEPA, 1991
V	= Wind speed in mixing zone	2.25	m/s	USEPA, 1991
DH	= Diffusion height	2	m	USEPA, 1991
A	= Area of contamination	2,025	m^2	USEPA, 1991
RF	= Respirable fraction	0.036	g/m^2-hr	USEPA, 1991
G	= Fraction of vegetative cover	0	[unitless]	USEPA, 1991
Um	= Mean annual wind speed	4.5	m/s	USEPA, 1991
Ut	= Equivalent threshold value of wind speed at 10 m	12.8	m/s	USEPA, 1991
F(x)	= Function dependent on U_m/U_t	0.0497	[unitless]	Cowherd, 1985
CF_{one}	= Conversion Factor 1	3,600	s/hr	--
CF_{two}	= Conversion Factor 2	1,000	g/kg	--

Air Concentration (C_A) = C/ PEF

Chemical	UCL95 Soil Concentration (C) [mg/kg]	Particulate Emission Factor (PEF) [m^3/kg]	Air Concentration (C_A) (C/PEF) [mg/m^3]
Benzo(a)pyrene	4.44E-05	4.63E+09	9.59E-15

Notes:

Cowherd, C., Muleski, G., Engelhart, P., and D. Gillete. 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination. EPA Office of Health and Environmental Assessment. EPA/600/8-85/002.

U.S. Environmental Protection Agency. 1991. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Publication 9285.7-01B. December.

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Table 7
Chemical Intake Exposure Assumptions – Dermal Contact with Groundwater
On-Site Construction Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

$$Intake\ (mg/kg\text{-}day) = [Cgw \times SA \times PC \times CF \times ET \times EF \times ED \times FC] / [BW \times AT]$$

Intake Parameter		Construction Worker Value
Cgw	= Chemical concentration in groundwater (mg/L)	See Table 12
SA	= Skin surface area (cm^2)	2,000
PC	= Dermal permeability constant (cm/hr) [1]	
	Benzene	2.10E-02
	Fluorene [2]	3.60E-01
CF	= Conversion factor (L/cm^3)	1E-03
ET	= Exposure time (hr/event)	2
EF	= Exposure frequency (events/year)	60
ED	= Exposure duration (years)	1
FC	= Fraction of time contacting exposure area	1
BW	= Body weight (kg)	70
AT	= Averaging time (days)	
	Noncarcinogens	365
	Carcinogens	25,550

Notes:
[1] U.S. Environmental Protection Agency (USEPA). 1992. Table 5-7, Dermal Exposure Assessment: Principles and Applications, Interim Report. Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-91/011B. January.

[2] The dermal permeability constant for fluorene is not available. The value shown represents the dermal permeability constant for fluoranthene.

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Table 8
Chemical Intake Exposure Assumptions -- Inhalation of Indoor Air VOCs Emanating from Groundwater
On-Site Commercial Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = [C_A x IR x ET x EF x ED] /[BW x AT]

Intake Parameter			Commercial Worker Value
C_A	=	Chemical concentration in air (mg/m^3)	See Table 12
IR	=	Inhalation rate (m^3/hr)	0.83
ET	=	Exposure time (hr/day)	8
EF	=	Exposure frequency (days/year)	250
ED	=	Exposure duration (years)	25
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	9,125
		Carcinogens	25,550

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Table 9
Chemical Intake Exposure Assumptions -- Inhalation of Ambient Air VOCs Emanating from Groundwater
On-Site Construction Worker Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = [C_A x IR x ET x EF x ED] /[BW x AT]

Intake Parameter			Construction Worker Value
C_A	=	Chemical concentration in air (mg/m^3)	See Table 12
IR	=	Inhalation rate (m^3/hr)	1.35
ET	=	Exposure time (hr/day)	8
EF	=	Exposure frequency (days/year)	60
ED	=	Exposure duration (years)	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

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Table 10
Toxicity Values
Grand Street and Fortmann Way Property
Alameda, California

Chemical Name	Carcinogenic Weight-of-Evidence	Oral/Dermal Slope Factor (SF) $(mg/kg\text{-}day)^{-1}$		Inhalation Slope Factor (SF) $(mg/kg\text{-}day)^{-1}$		Oral/Dermal Reference Dose (RfD) (mg/kg-day)		Inhalation Reference Dose (RfD) (mg/kg-day)	
		Value	Source	Value	Source	Value	Source	Value	Source
Benzene	A	1.00E-01	CalEPA,1995	1.00E-01	CalEPA, 1995	--		[redacted]	[redacted]
Benzo(a)pyrene	B2	1.20E+01	CalEPA, 1995	3.90E+00	CalEPA, 1995	--		--	
Fluorene	D	--		--		4.00E-02	USEPA, 1995b	[redacted]	[redacted]

Notes:

-- No toxicity value available. Chemical either does not exhibit toxicity via this route or sufficient evidence is not available to derive a toxicity value.

California Environmental Protection Agency (CalEPA). 1995. California Cancer Potency Factors: Update. Office of Environmental Health Hazard Assessment. April 10

U.S. Environmental Protection Agency (USEPA). 1995a. Risk-Based Concentration Table. USEPA Region III. October 20

U.S. Environmental Protection Agency (USEPA). 1995b. Integrated Risk Information System. On-line data base. Office of Research and Development. Cincinnati, Ohio.

U.S. Environmental Protection Agency (USEPA). 1995c. Preliminary Remediation Goals. USEPA Region IX. February 1.

Shaded values represent provisional toxicity values. Provisional toxicity values have not received consensus judgment by USEPA's Reference Dose Work Groups and/or Carcinogenic Risk Assessment Verification Endeavor Work Group. The values are used in this analysis to provide more conservative risk estimates.

Table 11
Exposure Point Concentrations for Soil COCs
Grand Street and Fortmann Way Property
Alameda, California

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Chemical Name	Direct Soil Contact (mg/kg)	Particulate Emission Factor (m^3/kg)	Airborne Soil Particulates (mg/m^3) [1]
Benzo(a)pyrene	4.44E-05	4.63E+09	9.59E-15

Notes:

[1] Airborne soil particulate concentration calculated by dividing the soil concentration with the Particulate Emission Factor (PEF) of 4.63 E + 09 m^3/kg.

Table 12
Exposure Point Concentrations for Groundwater COCs
Grand Street and Fortmann Way Property
Alameda, California

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Chemical Name	Direct Groundwater Contact (mg/L)	VFwesp (mg/m^3-air)/(mg/L-H_2O)	Enclosed Air Concentration (mg/m^3) [1]	VFwamb (mg/m^3-air)/(mg/L-H_2O)	Ambient Air Concentration (mg/m^3) [2]
Benzene	7.51E-02	9.02E-04	6.77E-05	2.76E-05	2.07E-06
Fluorene	9.00E-04	1.05E-05	9.44E-09	2.26E-06	2.03E-09

Notes:

[1] Enclosed air concentration calculated by multiplying groundwater concentration (mg/L) by appropriate ASTM volatilization factor (VF_{wesp}) [(mg/m^3-air)/(mg/L-H_2O)].

[2] Ambient air concentration calculated by multiplying groundwater concentration (mg/L) by appropriate ASTM volatilization factor (VF_{wamb}) [(mg/m^3-air)/(mg/L-H_2O)].

Table 13
Risk Calculations
On-Site Construction Worker, Incidental Soil Ingestion
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Exposure Assumptions									DOSE		TOXICITY VALUE Oral		Cancer Risk	Hazard Quotient
	C_S (mg/kg)	IR (mg/day)	CF (kg/mg)	EF (day/yr)	ED (yr)	FI (-)	BW (kg)	AT-C (day)	AT-NC (day)	Cancer (mg/kg-day)	Non-Cancer (mg/kg-day)	SF $(mg/kg\text{-}day)^{-1}$	RfD (mg/kg-day)		
Benzo(a)Pyrene	4.44E-05	50	1E-06	60	1	1	70	25,550	365	7.45E-14	5.21E-12	1.20E+01	--	8.94E-13	--
												Total		8.94E-13	--

Notes:

C_S	= *Exposure Point Concentration,Soil*
IR	= *Soil Ingestion Rate*
CF	= *Conversion Factor*
EF	= *Exposure Frequency*
ED	= *Exposure Duration*
FI	= *Fraction Ingested from contaminated source*
BW	= *Body Weight*
AT-C	= *Averaging Time, carcinogens*
AT-NC	= *Averaging Time, noncarcinogens*
DOSE (cancer)	= *[CS x IgR x CF x EF x ED x FI] / [BW x AT-C]*
DOSE (non-cancer)	= *[CS x IgR x CF x EF x ED x FI] / [BW x AT-NC]*
SF	= *Slope Factor*
RfD	= *Reference Dose*
Cancer Risk	= *DOSE x SF*
Hazard Quotient	= *DOSE / RfD*
--	*Not Available*

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Chemical	Exposure Assumptions											DOSE		TOXICITY VALUE			
														Dermal			
	C_S	CF	SA	AF	ABS	EF	ED	FI	BW	AT-C	AT-NC	Cancer	Non-Cancer	SF	RfD	Cancer	Hazard
	(mg/kg)	(kg/mg)	(cm^2/day)	(mg/cm^2)	(-)	(day/yr)	(yr)	(-)	(kg)	(day)	(day)	(mg/kg-day)	(mg/kg-day)	$(mg/kg\text{-}day)^{-1}$	(mg/kg-day)	Risk	Quotient
Benzo(b)Pyrene	4.44E-05	1E-6	2,000	0.5	0.01	60	1	1	70	25,550	365	1.49E-14	1.04E-12	1.20E+01	--	1.79E-13	--

Notes:

C_S	= *Exposure Point Concentration, Soil*
CF	= *Conversion Factor*
SA	= *Skin Surface Area*
AF	= *Soil/Skin Adherence Factor*
ABS	= *Absorption factor*
EF	= *Exposure Frequency*
ED	= *Exposure Duration*
FI	= *Fraction from Contaminated Source*
BW	= *Body Weight*
AT-C	= *Averaging Time, carcinogens*
AT-NC	= *Averaging Time, noncarcinogens*
DOSE (cancer)	= *[CS x CF x SA x AF x ABS x EF x ED] / [BW x AT-C]*
DOSE (non-cancer)	= *[CS x CF x SA x AF x ABS x EF x ED] / [BW x AT-NC]*
SF	= *Slope Factor*
RfD	= *Reference Dose*
Cancer Risk	= *DOSE x SF*
Hazard Quotient	= *DOSE / RfD*
--	*Not Available*

Total	1.79E-13	--

Risk Calculations
On-Site Construction Worker, Inhalation of Airborne Particulates
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Exposure Assumptions								DOSE		TOXICITY VALUE			
											Inhalation			
	C_A	IR	ET	EF	ED	BW	AT-C	AT-NC	Cancer	Non-Cancer	SF	RfD	Cancer	Hazard
	(mg/m^3)	(m^3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(day)	(day)	(mg/kg-day)	(mg/kg-day)	$(ng/kg\text{-}day)^{-1}$	(mg/kg-day)	Risk	Quotient
Benzo(a)Pyrene	9.59E-15	1.35	8	60	1	70	25,550	365	3.47E-18	2.43E-16	3.90E+00	--	1.35E-17	--

Notes:

C_A	= *Exposure Point Concentration, Airborne Particulates*
IR	= *Inhalation Rate*
ET	= *Exposure Time*
EF	= *Exposure Frequency*
ED	= *Exposure Duration*
BW	= *Body Weight*
AT-C	= *Averaging Time, carcinogens*
AT-NC	= *Averaging Time, noncarcinogens*
DOSE (cancer)	= *[C_A x IR x EF x ED] / [BW x AT-C]*
DOSE (non-cancer)	= *[C_A x IR x EF x ED] / [BW x AT-NC]*
SF	= *Slope Factor*
RfD	= *Reference Dose*
Cancer Risk	= *DOSE x SF*
Hazard Quotient	= *DOSE / RfD*
--	*Not Available*

Total	1.35E-17	--

Table 17

Risk Calculations
On-Site Indoor Commercial Worker, Inhalation of Indoor Air VOCs Emanating from Groundwater
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Exposure Assumptions								DOSE		TOXICITY VALUE		Cancer Risk	Hazard Quotient
											Inhalation			
	C_A (mg/m³)	IR (m³/hr)	ET (hr/day)	EF (day/yr)	ED (yr)	BW (kg)	AT-C (day)	AT-NC (day)	Cancer (mg/kg-day)	Non-Cancer (mg/kg-day)	SF (mg/kg-day)⁻¹	RfD (mg/kg-day)		
Benzene	6.77E-05	0.83	8	250	25	70	25,550	9,125	1.57E-06	4.40E-06	1.00E-01	1.71E-03	1.57E-07	2.57E-03
Fluorene	9.44E-09	0.83	8	250	25	70	25,550	9,125	2.19E-10	6.14E-10	--	4.00E-02	--	1.53E-08
												Total	1.57E-07	2.57E-03

Notes:

C_A	= *Exposure Point Concentration, Enclosed-Space Air*
IR	= *Inhalation Rate*
ET	= *Exposure Time*
EF	= *Exposure Frequency*
ED	= *Exposure Duration*
BW	= *Body Weight*
AT-C	= *Averaging Time, carcinogens*
AT-NC	= *Averaging Time, noncarcinogens*
DOSE (cancer)	= *[C_A x IR x ET x EF x ED] / [BW x AT-C]*
DOSE (non-cancer)	= *[C_A x IR x ET x EF x ED] / [BW x AT-NC]*
SF	= *Slope Factor*
RfD	= *Reference Dose*
Cancer Risk	= *DOSE x SF*
Hazard Quotient	= *DOSE / RfD*
--	*Not Available*

Table 16

Risk Calculations
On-Site Construction Worker, Dermal Contact with Groundwater
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Exposure Assumptions											DOSE		TOXICITY VALUE		Cancer Risk	Hazard Quotient
														Dermal			
	C_{GW} (mg/L)	SA (cm²/day)	PC (cm/hr)	CF (L/cm³)	ET (hr/day)	EF (day/yr)	ED (yr)	FC (--)	BW (kg)	AT-C (day)	AT-NC (day)	Cancer (mg/kg-day)	Non-Cancer (mg/kg-day)	SF (mg/kg-day)⁻¹	RfD (mg/kg-day)		
Benzene	7.51E-02	2,000	2.10E-02	1E-03	2	60	1	1	70	25,550	365	2.12E-07	1.48E-05	1.00E-01	--	2.12E-08	--
Fluorene	9.00E-04	2,000	3.60E-01	1E-03	2	60	1	1	70	25,550	365	4.35E-08	3.04E-06	--	4.00E-02	--	7.61E-05
															Total	2.12E-08	7.61E-05

Notes:

C_{GW}	= *Exposure Point Concentration, Groundwater*
SA	= *Skin Surface Area*
PC	= *Dermal Permeability Constant*
CF	= *Conversion Factor*
ET	= *Exposure Time*
EF	= *Exposure Frequency*
ED	= *Exposure Duration*
FC	= *Fraction of Time Contacting Exposure Area*
BW	= *Body Weight*
AT-C	= *Averaging Time, carcinogens*
AT-NC	= *Averaging Time, noncarcinogens*
DOSE (cancer)	= *[C_{GW} x SA x PC x CF x ET x EF x ED x FC] / [BW x AT-C]*
DOSE (non-cancer)	= *[C_{GW} x SA x PC x CF x ET x EF x ED x FC] / [BW x AT-NC]*
SF	= *Slope Factor*
RfD	= *Reference Dose*
Cancer Risk	= *DOSE x SF*
Hazard Quotient	= *DOSE / RfD*
--	*Not Available*

Risk Calculations

On-Site Construction Worker, Inhalation of Ambient Air VOCs Emanating from Groundwater
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Exposure Assumptions								DOSE		TOXICITY VALUE		Cancer Risk	Hazard Quotient
											Inhalation			
	C_A (mg/m^3)	IR (m^3/hr)	ET (hr/day)	EF (day/yr)	ED (yr)	BW (kg)	AT-C (day)	AT-NC (day)	Cancer (mg/kg-day)	Non-Cancer (mg/kg-day)	SF (mg/kg-day)$^{-1}$	RfD (mg/kg-day)		
Benzene	2.07E-06	1.35	8	60	1	70	25,550	365	7.50E-10	5.25E-08	1.00E-01	1.71E-03	7.50E-11	3.07E-05
Fluorene	2.03E-09	1.35	8	60	1	70	25,550	365	7.37E-13	5.16E-11	--	4.00E-02	--	1.29E-09
												Total	7.50E-11	3.07E-05

Notes:

C_A	= *Exposure Point Concentration, Ambient Air*
IR	= *Inhalation Rate*
ET	= *Exposure Time*
EF	= *Exposure Frequency*
ED	= *Exposure Duration*
BW	= *Body Weight*
AT-C	= *Averaging Time, carcinogens*
AT-NC	= *Averaging Time, noncarcinogens*
DOSE (cancer)	= *[C_A x IR x ET x EF x ED] / [BW x AT-C]*
DOSE (non-cancer)	= *[C_A x IR x ET x EF x ED] / [BW x AT-NC]*
SF	= *Slope Factor*
RfD	= *Reference Dose*
Cancer Risk	= *DOSE x SF*
Hazard Quotient	= *DOSE / RfD*
--	*Not Available*

Table 19
Excess Cancer Risk Summary
Occupational Exposure
Grand Street and Fortmann Way Property
Alameda, California

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Exposure Pathway	EXCESS CANCER RISK	
	Construction Worker	Commercial Worker
Incidental Ingestion of Soil	8.94E-13	--
Dermal Contact with Soil	1.79E-13	--
Inhalation of Airborne Particulates	1.35E-17	--
Dermal Contact with Groundwater	2.12E-08	--
Inhalation of Indoor Air VOCs Emanating from Groundwater	--	1.57E-07
Inhalation of Ambient Air VOCs Emanating from Groundwater	7.50E-11	--
TOTAL EXCESS CANCER RISK	**2E-08**	**2E-07**

Table 20
Non-Cancer Risk Summary
Occupational Exposure
Grand Street and Fortmann Way Property
Alameda, California

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Exposure Pathway	NON-CANCER RISK	
	Construction Worker	Commercial Worker
Incidental Ingestion of Soil	--	--
Dermal Contact with Soil	--	--
Inhalation of Airborne Particulates	--	--
Dermal Contact with Groundwater	7.61E-05	--
Inhalation of Indoor Air VOCs Emanating from Groundwater	--	2.57E-03
Inhalation of Ambient Air VOCs Emanating from Groundwater	3.07E-05	--
TOTAL NON-CANCER RISK	1E-04	3E-03

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Appendix C
Table of Contents
Risk Calculations
Occupational Office Building Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Summary of Potentially Complete Exposure Pathways
Office Building Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Exposure Pathway/Route [1]	RECEPTOR: On-Site Construction Worker	RECEPTOR: On-Site Commercial Worker
SOIL PATHWAYS		
COC: Benzo(a)pyrene		
Incidental Soil Ingestion	x	
Dermal Contact with Soil	x	
Inhalation of Airborne Soil Particulates	x	
GROUNDWATER PATHWAYS		
COCs: Benzene and Fluorene		
Dermal Contact with Groundwater	x	
Inhalation of VOCs Emanating from Groundwater to Indoor Air		x
Inhalation of VOCs Emanating from Groundwater to Ambient Air	x	

Notes:
[1] See the Conceptual Site Model for additional information regarding exposure pathways.
x = Pathway is quantitatively evaluated for this receptor.

Summary of Exposure Assumptions
Occupational Office Building Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

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EXPOSURE PARAMETER	On-Site Commercial Worker		On-Site Construction Worker	
	Value	Source	Value	Source
Contact Rate Assumptions				
Inhalation rate (indoors) (m^3/hr)	0.83	ASTM, 1995	--	
Inhalation rate (outdoors) (m^3/hr)	--		1.35	USEPA, 1989a [1]
Soil ingestion rate (mg/day)	--		50	ASTM, 1995
Skin surface area (cm^2/day)	--		2,000	USEPA, 1989 [2]
Soil-to-skin adherence factor (mg/cm^2)	--		0.5	ASTM, 1995
Absorption factor-organics (unitless)	--		0.01	USEPA, 1992
General Assumptions				
Exposure time (hr/day)	8	Professional Judgment	8	Professional Judgment
Exposure time to groundwater (hr/day)	--		2	Professional Judgment
Exposure frequency (days/year)	250	ASTM, 1995	60	Professional Judgment
Exposure duration (years)	25	ASTM, 1995	1	Professional Judgment
Conversion factor (kg/mg)	--		1E-06	
Conversion factor (L/cm^3)	--		1E-03	
Fraction of time contacting exposure area (unitless)	1		1	
Body weight (kg)	70	ASTM, 1995	70	ASTM, 1995
Averaging time (days)				
Noncarcinogens	9,125	Professional Judgment	365	Professional Judgment
Carcinogens	25,550	USEPA, 1989b	25,550	USEPA, 1989b

Notes:
-- Not applicable.

American Society for Testing and Materials (ASTM). 1995. Emergency Standard Guide for Risk-Based Corrective Action Applied at Petroleum Release Sites. ASTM Designation: E 1739-95. November.

U.S. Environmental Protection Agency (USEPA). 1989a. Exposure Factors Handbook. Office of Health and Environmental Assessment. Washington, D.C. EPA/600/8-89/043. July.

U.S. Environmental Protection Agency (USEPA). 1989b. Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A), Interim Final. Office of Emergency and Remedial Response, Washington, D.C. EPA-540/1-89/002. December.

U.S. Environmental Protection Agency (USEPA). 1992. New Interim Region IV Guidance. Region IV. Atlanta, GA. February.

[1] Inhalation rate assumes a moderate activity level 50 percent of the time (2.1 m^3/hr) and a light activity level for the remaining 50 percent of the time (0.6 m^3/hr).
[2] Skin surface area assumes exposure to hands and face.

Table 3
Chemical Intake Exposure Assumptions – Incidental Soil Ingestion
On-Site Construction Worker
Office Building Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Intake (mg/kg-day) = [CS x IR x CF x EF x ED x FI] / [BW x AT]

Intake Parameter		Construction Worker Value
CS	= Chemical concentration in soil (mg/kg)	See Table 11
IR	= Soil ingestion rate (mg/day)	50
CF	= Conversion factor (kg/mg)	1E-06
EF	= Exposure frequency (days/year)	60
ED	= Exposure duration (years)	1
FI	= Fraction from contaminated source (unitless)	1
BW	= Body weight (kg)	70
AT	= Averaging time (days)	
	Noncarcinogens	365
	Carcinogens	25,550

Notes:
All of the soil contacted is assumed to be site-related.

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Table 4
Chemical Intake Exposure Assumptions -- Dermal Contact with Soil
On-Site Construction Worker
Office Building Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = [CS x CF x SA x AF x ABS x EF x ED x FI] /[BW x AT]

Intake Parameter			Construction Worker Value
CS	=	Chemical concentration in surface soil (mg/kg)	See Table 11
CF	=	Conversion factor (kg/mg)	1E-06
SA	=	Skin Surface Area (cm^2/day)	2,000
AF	=	Soil/skin adherence factor (mg/cm^2)	0.5
ABS	=	Absorption factor-organics (unitless)	0.01
EF	=	Exposure frequency (days/year)	60
ED	=	Exposure duration (years)	1
FI	=	Fraction from contaminated source (unitless)	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

Notes:
All of the soil contacted is assumed to be site-related.

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Table 5
Chemical Intake Exposure Assumptions -- Inhalation of Airborne Particulates
On-Site Construction Worker
Office Building Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = [CA x IR x ET x EF x ED] /[BW x AT]

Intake Parameter			Construction Worker Value
CA	=	Chemical concentration in air (mg/m^3)	See Table 11
IR	=	Inhalation rate, outdoor (m^3/hr)	1.35
ET	=	Exposure time (hr/day)	8
EF	=	Exposure frequency (days/year)	60
ED	=	Exposure duration (years)	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

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Table 6
Air Concentrations Calculated from Soil Particulate Emissions
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

Particulate Emissions Model (USEPA, 1991)

The particulate emission factor (PEF) relates the chemical concentration in soil with the concentration of respirable particles (PM_{10}) in the air due to fugitive dust emissions from surface soil. This model is a conservative estimate for particulate emissions from surface soils and is taken from USEPA, 1991. This relationship is derived by Cowherd (1985) for a rapid assessment procedure applicable to a typical hazardous waste site where the surface soil provides a relatively continuous and constant potential of emission over an extended period of time (*e.g.*, years).

The particulate emissions are assumed due to wind erosion and, therefore, depend on the erodibility of the surface material. The equation is representative of a surface with unlimited erosion potential, which is characterized by bare surfaces of finely divided material such as sandy agricultural soil with a large number (unlimited reservoir) of erodible particles. Such surfaces erode at low wind speeds, and particulate emission rates are relatively time independent at a given wind speed.

$$PEF = [(LS \times V \times DH \times CF_{one})/A] \times [CF_{two} / (RF \times (1-G) \times (U_m/U_t)^3 \times F(x))]$$

Parameter		Value	Units	Reference
PEF	= Particulate Emission Factor	4.63E+09	m^3/kg	
LS	= Width of contaminated area	45	m	USEPA, 1991
V	= Wind speed in mixing zone	2.25	m/s	USEPA, 1991
DH	= Diffusion height	2	m	USEPA, 1991
A	= Area of contamination	2,025	m^2	USEPA, 1991
RF	= Respirable fraction	0.036	g/m^2-hr	USEPA, 1991
G	= Fraction of vegetative cover	0	[unitless]	USEPA, 1991
Um	= Mean annual wind speed	4.5	m/s	USEPA, 1991
Ut	= Equivalent threshold value of wind speed at 10 m	12.8	m/s	USEPA, 1991
F(x)	= Function dependent on U_m/U_t	0.0497	[unitless]	Cowherd, 1985
CF_{one}	= Conversion Factor 1	3,600	s/hr	--
CF_{two}	= Conversion Factor 2	1,000	g/kg	--

Air Concentration (C_A) = C/ PEF

Chemical	UCL95 Soil Concentration (C) [mg/kg]	Particulate Emission Factor (PEF) [m^3/kg]	Air Concentration (C_A) (C/PEF) [mg/m^3]
Benzo(a)pyrene	4.44E-05	4.63E+09	9.59E-15

Notes:

Cowherd, C., Muleski, G., Engelhart, P., and D. Gillette. 1985. Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination. EPA Office of Health and Environmental Assessment. EPA/600/8-85/002.

U.S. Environmental Protection Agency. 1991. Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). Publication 9285.7-01B. December.

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Table 7
Chemical Intake Exposure Assumptions -- Dermal Contact with Groundwater
On-Site Construction Worker
Office Building Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

$$Intake\ (mg/kg\text{-}day) = [Cgw \times SA \times PC \times CF \times ET \times EF \times ED \times FC] / [BW \times AT]$$

Intake Parameter			Construction Worker Value
Cgw	=	Chemical concentration in groundwater (mg/L)	See Table 12
SA	=	Skin surface area (cm^2)	2,000
PC	=	Dermal permeability constant (cm/hr) [1]	
		Benzene	2.10E-02
		Fluorene [2]	3.60E-01
CF	=	Conversion factor (L/cm^3)	1E-03
ET	=	Exposure time (hr/event)	2
EF	=	Exposure frequency (events/year)	60
ED	=	Exposure duration (years)	1
FC	=	Fraction of time contacting exposure area	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

Notes:
[1] U.S. Environmental Protection Agency (USEPA). 1992. Table 5-7, Dermal Exposure Assessment: Principles and Applications, Interim Report. Office of Health and Environmental Assessment, Washington, D.C. EPA/600/8-91/011B. January.

[2] The dermal permeability constant for fluorene is not available. The value shown represents the dermal permeability constant for fluoranthene.

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Table 8
Chemical Intake Exposure Assumptions -- Inhalation of Indoor Air VOCs Emanating from Groundwater
On-Site Commercial Worker
Office Building Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = $[C_A \times IR \times ET \times EF \times ED] / [BW \times AT]$

Intake Parameter			Commercial Worker Value
C_A	=	Chemical concentration in air (mg/m^3)	See Table 12
IR	=	Inhalation rate (m^3/hr)	0.83
ET	=	Exposure time (hr/day)	8
EF	=	Exposure frequency (days/year)	250
ED	=	Exposure duration (years)	25
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	9,125
		Carcinogens	25,550

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Table 9
Chemical Intake Exposure Assumptions -- Inhalation of Ambient Air VOCs Emanating from Groundwater
On-Site Construction Worker
Office Building Exposure Scenario
Grand Street and Fortmann Way Property
Alameda, California

Intake (mg/kg-day) = $[C_A \times IR \times ET \times EF \times ED] / [BW \times AT]$

Intake Parameter			Construction Worker Value
C_A	=	Chemical concentration in air (mg/m^3)	See Table 12
IR	=	Inhalation rate (m^3/hr)	1.35
ET	=	Exposure time (hr/day)	8
EF	=	Exposure frequency (days/year)	60
ED	=	Exposure duration (years)	1
BW	=	Body weight (kg)	70
AT	=	Averaging time (days)	
		Noncarcinogens	365
		Carcinogens	25,550

Table 10
Toxicity Values
Grand Street and Fortmann Way Property
Office Building Scenario
Alameda, California

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Chemical Name	Carcinogenic Weight-of-Evidence	Oral/Dermal Slope Factor (SF) (mg/kg-day)$^{-1}$		Inhalation Slope Factor (SF) (mg/kg-day)$^{-1}$		Oral/Dermal Reference Dose (RfD) (mg/kg-day)		Inhalation Reference Dose (RfD) (mg/kg-day)	
		Value	Source	Value	Source	Value	Source	Value	Source
Benzene	A	1.00E-01	CalEPA,1995	1.00E-01	CalEPA, 1995	--		[redacted]	[redacted]
Benzo(a)pyrene	B2	1.20E+01	CalEPA, 1995	3.90E+00	CalEPA, 1995	--		--	
Fluorene	D	--		--		4.00E-02	USEPA, 1995b	[redacted]	[redacted]

Notes:

-- No toxicity value available. Chemical either does not exhibit toxicity via this route or sufficient evidence is not available to derive a toxicity value.

California Environmental Protection Agency (CalEPA). 1995. California Cancer Potency Factors: Update. Office of Environmental Health Hazard Assessment. April 10

U.S. Environmental Protection Agency (USEPA). 1995a. Risk-Based Concentration Table. USEPA Region III. October 20

U.S. Environmental Protection Agency (USEPA). 1995b. Integrated Risk Information System. On-line data base. Office of Research and Development. Cincinnati, Ohio.

U.S. Environmental Protection Agency (USEPA). 1995c. Preliminary Remediation Goals. USEPA Region IX. February 1.

Shaded values represent provisional toxicity values. Provisional toxicity values have not received consensus judgment by USEPA's Reference Dose Work Groups and/or Carcinogenic Risk Assessment Verification Endeavor Work Group. The values are used in this analysis to provide more conservative risk estimates.

Table 11
Exposure Point Concentrations for Soil COCs
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Chemical Name	Direct Soil Contact (mg/kg)	Particulate Emission Factor (m^3/kg)	Airborne Soil Particulates (mg/m^3) [1]
Benzo(a)pyrene	4.44E-05	4.63E+09	9.59E-15

Notes:

[1] Airborne soil particulate concentration calculated by dividing the soil concentration with the Particulate Emission Factor (PEF) of 4.63 E + 09 m^3/kg.

Table 13
Risk Calculations
On-Site Construction Worker, Incidental Soil Ingestion
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Exposure Assumptions									DOSE		TOXICITY VALUE		Cancer Risk	Hazard Quotient
												Oral			
	C_S (mg/kg)	IR (mg/day)	CF (kg/mg)	EF (day/yr)	ED (yr)	FI (-)	BW (kg)	AT-C (day)	AT-NC (day)	Cancer (mg/kg-day)	Non-Cancer (mg/kg-day)	SF (mg/kg-day)$^{-1}$	RfD (mg/kg-day)		
Benzo(a)Pyrene	4.44E-05	50	1E-06	60	1	1	70	25,550	365	7.45E-14	5.21E-12	1.20E+01	--	8.94E-13	--
													Total	8.94E-13	--

Notes:

C_s	= *Exposure Point Concentration,Soil*
IR	= *Soil Ingestion Rate*
CF	= *Conversion Factor*
EF	= *Exposure Frequency*
ED	= *Exposure Duration*
FI	= *Fraction Ingested from contaminated source*
BW	= *Body Weight*
AT-C	= *Averaging Time, carcinogens*
AT-NC	= *Averaging Time, noncarcinogens*
DOSE (cancer)	= *[CS x IgR x CF x EF x ED x FI] / [BW x AT-C]*
DOSE (non-cancer)	= *[CS x IgR x CF x EF x ED x FI] / [BW x AT-NC]*
SF	= *Slope Factor*
RfD	= *Reference Dose*
Cancer Risk	= *DOSE x SF*
Hazard Quotient	= *DOSE / RfD*
--	*Not Available*

Table 12
Exposure Point Concentrations for Groundwater COCs
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Chemical Name	Direct Groundwater Contact (mg/L)	VFwesp (mg/m^3-air)/(mg/L-H_2O)	Enclosed Air Concentration (mg/m^3) [1]	VFwamb (mg/m^3-air)/(mg/L-H_2O)	Ambient Air Concentration (mg/m^3) [2]
Benzene	2.93E-01	9.02E-04	2.64E-04	2.76E-05	8.08E-06
Fluorene	9.00E-04	1.05E-05	9.44E-09	2.26E-06	2.03E-09

Notes:

[1] Enclosed air concentration calculated by multiplying groundwater concentration (mg/L) by appropriate ASTM volatilization factor (VF_{wesp}) [(mg/m^3-air)/(mg/L-H_2O)].

[2] Ambient air concentration calculated by multiplying groundwater concentration (mg/L) by appropriate ASTM volatilization factor (VF_{wamb}) [(mg/m^3-air)/(mg/L-H_2O)].

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Chemical	Exposure Assumptions											DOSE		TOXICITY VALUE		Cancer Risk	Hazard Quotient
														Dermal			
	C_S	CF	SA	AF	ABS	EF	ED	FI	BW	AT-C	AT-NC	Cancer	Non-Cancer	SF	RfD		
	(mg/kg)	(kg/mg)	(cm^2/day)	(mg/cm^2)	(-)	(day/yr)	(yr)	(-)	(kg)	(day)	(day)	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)$^{-1}$	(mg/kg-day)		
Benzo(a)Pyrene	4.44E-05	1E-6	2,000	0.5	0.01	60	1	1	70	25,550	365	1.49E-14	1.04E-12	1.20E+01	--	1.79E-13	--

Total 1.79E-13 --

Notes:

C_S	= *Exposure Point Concentration, Soil*
CF	= *Conversion Factor*
SA	= *Skin Surface Area*
AF	= *Soil/Skin Adherence Factor*
ABS	= *Absorption factor*
EF	= *Exposure Frequency*
ED	= *Exposure Duration*
FI	= *Fraction from Contaminated Source*
BW	= *Body Weight*
AT-C	= *Averaging Time, carcinogens*
AT-NC	= *Averaging Time, noncarcinogens*
DOSE (cancer)	= *[CS x CF x SA x AF x ABS x EF x ED] / [BW x AT-C]*
DOSE (non-cancer)	= *[CS x CF x SA x AF x ABS x EF x ED] / [BW x AT-NC]*
SF	= *Slope Factor*
RfD	= *Reference Dose*
Cancer Risk	= *DOSE x SF*
Hazard Quotient	= *DOSE / RfD*
--	*Not Available*

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Chemical	Exposure Assumptions								DOSE		TOXICITY VALUE		Cancer Risk	Hazard Quotient
											Inhalation			
	C_A	IR	ET	EF	ED	BW	AT-C	AT-NC	Cancer	Non-Cancer	SF	RfD		
	(mg/m^3)	(m^3/hr)	(hr/day)	(day/yr)	(yr)	(kg)	(day)	(day)	(mg/kg-day)	(mg/kg-day)	(mg/kg-day)$^{-1}$	(mg/kg-day)		
Benzo(a)Pyrene	9.59E-15	1.35	8	60	1	70	25,550	365	3.47E-18	2.43E-16	3.90E+00	--	1.35E-17	--

Total 1.35E-17 --

Notes:

C_A	= *Exposure Point Concentration, Airborne Particulates*
IR	= *Inhalation Rate*
ET	= *Exposure Time*
EF	= *Exposure Frequency*
ED	= *Exposure Duration*
BW	= *Body Weight*
AT-C	= *Averaging Time, carcinogens*
AT-NC	= *Averaging Time, noncarcinogens*
DOSE (cancer)	= *[C_A x IR x EF x ED] / [BW x AT-C]*
DOSE (non-cancer)	= *[C_A x IR x EF x ED] / [BW x AT-NC]*
SF	= *Slope Factor*
RfD	= *Reference Dose*
Cancer Risk	= *DOSE x SF*
Hazard Quotient	= *DOSE / RfD*
--	*Not Available*

Table
Risk Calculations
On-Site Indoor Commercial Worker, Inhalation of Indoor Air VOCs Emanating from Groundwater
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

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Chemical	Exposure Assumptions								DOSE		TOXICITY VALUE		Cancer Risk	Hazard Quotient
											Inhalation			
	C_A (mg/m³)	IR (m³/hr)	ET (hr/day)	EF (day/yr)	ED (yr)	BW (kg)	AT-C (day)	AT-NC (day)	Cancer (mg/kg-day)	Non-Cancer (mg/kg-day)	SF (mg/kg-day)⁻¹	RfD (mg/kg-day)		
Benzene	2.64E-04	0.83	8	250	25	70	25,550	9,125	6.13E-06	1.72E-05	1.00E-01	1.71E-03	6.13E-07	1.00E-02
Fluorene	9.44E-09	0.83	8	250	25	70	25,550	9,125	2.19E-10	6.14E-10	--	4.00E-02	--	1.53E-08
												Total	6.13E-07	1.00E-02

Notes:

C_A = *Exposure Point Concentration, Enclosed-Space Air*
IR = *Inhalation Rate*
ET = *Exposure Time*
EF = *Exposure Frequency*
ED = *Exposure Duration*
BW = *Body Weight*
AT-C = *Averaging Time, carcinogens*
AT-NC = *Averaging Time, noncarcinogens*
DOSE (cancer) = $[C_A \times IR \times ET \times EF \times ED] / [BW \times AT\text{-}C]$
DOSE (non-cancer) = $[C_A \times IR \times ET \times EF \times ED] / [BW \times AT\text{-}NC]$
SF = *Slope Factor*
RfD = *Reference Dose*
Cancer Risk = *DOSE x SF*
Hazard Quotient = *DOSE / RfD*
-- *Not Available*

Table
Risk Calculations
On-Site Construction Worker, Dermal Contact with Groundwater
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

DRAFT

Chemical	Exposure Assumptions											DOSE		TOXICITY VALUE		Cancer Risk	Hazard Quotient
														Dermal			
	C_{GW} (mg/L)	SA (cm²/day)	PC (cm/hr)	CF (L/cm³)	ET (hr/day)	EF (day/yr)	ED (yr)	FC (-)	BW (kg)	AT-C (day)	AT-NC (day)	Cancer (mg/kg-day)	Non-Cancer (mg/kg-day)	SF (mg/kg-day)⁻¹	RfD (mg/kg-day)		
Benzene	2.93E-01	2,000	2.10E-02	1E-03	2	60	1	1	70	25,550	365	8.26E-07	5.78E-05	1.00E-01	--	8.26E-08	--
Fluorene	9.00E-04	2,000	3.60E-01	1E-03	2	60	1	1	70	25,550	365	4.35E-08	3.04E-06	--	4.00E-02	--	7.61E-05
															Total	8.26E-08	7.61E-05

Notes:

C_{GW} = *Exposure Point Concentration, Groundwater*
SA = *Skin Surface Area*
PC = *Dermal Permeability Constant*
CF = *Conversion Factor*
ET = *Exposure Time*
EF = *Exposure Frequency*
ED = *Exposure Duration*
FC = *Fraction of Time Contacting Exposure Area*
BW = *Body Weight*
AT-C = *Averaging Time, carcinogens*
AT-NC = *Averaging Time, noncarcinogens*
DOSE (cancer) = $[CGW \times SA \times PC \times CF \times ET \times EF \times ED \times FC] / [BW \times AT\text{-}C]$
DOSE (non-cancer) = $[CGW \times SA \times PC \times CF \times ET \times EF \times ED \times FC] / [BW \times AT\text{-}NC]$
SF = *Slope Factor*
RfD = *Reference Dose*
Cancer Risk = *DOSE x SF*
Hazard Quotient = *DOSE / RfD*
-- *Not Available*

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Risk Calculations
On-Site Construction Worker, Inhalation of Ambient Air VOCs Emanating from Groundwater
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

	Exposure Assumptions								DOSE		TOXICITY VALUE			
											Inhalation			
Chemical	C_A (mg/m³)	IR (m³/hr)	ET (hr/day)	EF (day/yr)	ED (yr)	BW (kg)	AT-C (day)	AT-NC (day)	Cancer (mg/kg-day)	Non-Cancer (mg/kg-day)	SF (mg/kg-day)⁻¹	RfD (mg/kg-day)	Cancer Risk	Hazard Quotient
Benzene	8.08E-06	1.35	8	60	1	70	25,550	365	2.93E-09	2.05E-07	1.00E-01	1.71E-03	2.93E-10	1.20E-04
Fluorene	2.03E-09	1.35	8	60	1	70	25,550	365	7.37E-13	5.16E-11	--	4.00E-02	--	1.29E-09
												Total	2.93E-10	1.20E-04

Notes:

C_A	= *Exposure Point Concentration, Ambient Air*
IR	= *Inhalation Rate*
ET	= *Exposure Time*
EF	= *Exposure Frequency*
ED	= *Exposure Duration*
BW	= *Body Weight*
AT-C	= *Averaging Time, carcinogens*
AT-NC	= *Averaging Time, noncarcinogens*
DOSE (cancer)	= *[C_A x IR x ET x EF x ED] / [BW x AT-C]*
DOSE (non-cancer)	= *[C_A x IR x ET x EF x ED] / [BW x AT-NC]*
SF	= *Slope Factor*
RfD	= *Reference Dose*
Cancer Risk	= *DOSE x SF*
Hazard Quotient	= *DOSE / RfD*
--	*Not Available*

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Table 19
Excess Cancer Risk Summary
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

Exposure Pathway	EXCESS CANCER RISK	
	Construction Worker	Commercial Worker
Incidental Ingestion of Soil	8.94E-13	--
Dermal Contact with Soil	1.79E-13	--
Inhalation of Airborne Particulates	1.35E-17	--
Dermal Contact with Groundwater	8.26E-08	--
Inhalation of Indoor Air VOCs Emanating from Groundwater	--	6.13E-07
Inhalation of Ambient Air VOCs Emanating from Groundwater	2.93E-10	--
TOTAL EXCESS CANCER RISK	8E-08	6E-07

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Table 20
Non-Cancer Risk Summary
Office Building Scenario
Grand Street and Fortmann Way Property
Alameda, California

Exposure Pathway	NON-CANCER RISK	
	Construction Worker	Commercial Worker
Incidental Ingestion of Soil	--	--
Dermal Contact with Soil	--	--
Inhalation of Airborne Particulates	--	--
Dermal Contact with Groundwater	7.61E-05	--
Inhalation of Indoor Air VOCs Emanating from Groundwater	--	1.00E-02
Inhalation of Ambient Air VOCs Emanating from Groundwater	1.20E-04	--
TOTAL NON-CANCER RISK	**2E-04**	**1E-02**