

Appendix C

RiskE Calculation Spreadsheets

Appendix C1

RSBC 0m

Toxicity and Dermal Absorption Parameters

Chemical	Non-Threshold Slope Factor				Threshold ADI, TDI or Reference Dose				Background Intake				
	Oral (mg/kg/day) ¹		Inhalation (mg/kg/day) ¹		Dermal (mg/kg/day) ¹		Oral (mg/kg/day)			Inhalation (mg/kg/day)		Dermal (mg/kg/day)	
1,2-dichloroethane	1.20E-02	NHMRC	9.80E-03	NHMRC	1.20E-02	R					0.00E+00	R	0%
cis-1,2-dichloroethene							1.00E-02	HEAST	1.00E-02	R	1.00E-02	R	0%
hexachlorobenzene							1.60E-04	WHO	1.6E-04	R	1.60E-04	R	0%
1,2-hexachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
hexachlorobutadiene							2.00E-04	NHMRC	2.0E-04	R	2.00E-04	R	0%
methylene chloride							1.20E-03	NHMRC	2.9E-01	ATSDR	1.20E-03	R	20%
octachlorostyrene							3.10E-04	Health Canada	3.10E-04	R	3.10E-04	R	0%
pentachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
tetrachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
tetrachloroethene							1.40E-02	WHO	5.71E-02	WHO	1.40E-02	R	34%
1,1,2-trichloroethane							4.00E-03	USEPA	4.00E-03	R	4.00E-03	R	0%
trichloroethene			1.51E-03	WHO			1.46E-03	WHO	1.46E-03	R	1.46E-03	R	0%
1,1,1,2 tetrachloroethane							3.00E-02	USEPA	3.00E-02	WHO	3.00E-02		0%
1,2-dibromo-3-chloropropane	3.50E-01	WHO	2.40E-03	USEPA	3.50E-01	R							0%

Calculation of Vapour Concentrations from Groundwater Source Guidance from ASTM (1996)

Constituent	Concentration in soil (mg/kg)	NonThreshold Risk (unitless)	Threshold Hazard (unitless)	Target NonThreshold Risk (unitless)	Target Threshold Hazard (unitless)
1,2-dichloroethane	3.2	1.0E-06	--	1E-06	
cis-1,2-dichloroethene	6.5	--	0.10		0.10
hexachlorobenzene	55	--	0.00		0.10
1,2-hexachlorobutadiene	4.5	--	0.10		0.10
hexachlorobutadiene	4.5	--	0.10		0.10
methylene chloride	130	--	0.10		0.10
octachlorostyrene	110	--	0.00		0.10
pentachlorobutadiene	4.2	--	0.10		0.10
tetrachlorobutadiene	4.2	--	0.10		0.10
tetrachloroethene	16	--	0.10		0.10
1,1,2-trichloroethane	15	--	0.10		0.10
trichloroethene	1	9.6E-08	0.10		
1,1,1,2 tetrachloroethane	100	--	0.10		
1,2-dibromo-3-chloropropane	9.5	7.2E-09	--	1E-06	

Calculation of Vapour Concentrations from Groundwater Source Guidance from ASTM (1996)

Constituent	Concentration in soil (mg/kg)	NonThreshold Risk (unitless)	Threshold Hazard (unitless)	Target NonThreshold Risk (unitless)	Target Threshold Hazard (unitless)
1,2-dichloroethane	52	1.0E-06		1E-06	
cis-1,2-dichloroethene	110		0.10		0.10
hexachlorobenzene	55		0.10		0.10
1,2-hexachlorobutadiene	38		0.10		0.10
hexachlorobutadiene	38		0.10		0.10
methylene chloride	280		0.10		0.10
octachlorostyrene	110		0.10		0.10
pentachlorobutadiene	35		0.10		0.10
tetrachlorobutadiene	35		0.10		0.10
tetrachloroethene	1500		0.10		0.10
1,1,2-trichloroethane	210		0.10		0.10
trichloroethene	17	9.3E-08	0.10		0.10
1,1,1,2 tetrachloroethane	7500		0.10		0.10
1,2-dibromo-3-chloropropane	21	8.9E-07		1E-06	0.10

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Vapour Migration Indoors				
Site Specific Physical Input Parameters	Units	Abbrev.	Value	Comments
Depth of Top of Contaminated Soil (BGS)	[m]	d	0.01	Calculated from layers
Thickness of Surface Contamination	[m]	surfd	6	Estimated for soil types
Soil Temperature	[C]	T	17	site-specific assumption
<u>Vadose Zone Characteristics of Top Layer</u>				
Depth of Layer 1	[m]	vd1	0.01	<u>Sandy Gravel</u> Assumed depth of fill under foundation
Moisture Content	[g/g]	mocon	0.1	Assumption for sandy gravel
Organic Carbon Fraction	-	foc	0.01	Assumption for sandy gravel
Soil Bulk Density	[g/cm ³]	rhob	1.6	Assumption for sandy gravel
Density of Solids	[g/cm ³]	sd	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta	0.40	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon	0.160	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon	0.236	theta-wacon
<u>Vadose Zone Characteristics at and above Source</u>				
Depth of Layer 2	[m]	vd2	0	<u>Ash Sand (Impacted Layer)</u> Assumed soil type of remediated soils
Moisture Content	[g/g]	mocon2	0.1	Assumption for Sandy Clay
Organic Carbon Fraction	-	foc2	0.003	Assumption for Sandy Clay
Soil Bulk Density	[g/cm ³]	rhob2	1.8	Assumption for Sandy Clay
Density of Solids	[g/cm ³]	sd2	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta2	0.32	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon2	0.180	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon2	0.141	theta-wacon
Receptor Specific Input Parameters	Units	Abbrev.	Value	Comments
<u>Building Characteristics</u>				
Area of Emission - Building Area	[m ²]	emarea	100.0	assumed area of the room
Foundation/wall thickness	[m]	fthick	0.15	Default Value
Height of Room	[m]	boxh	3	Typical height for commercial premises
Hourly Volume Exchange of Fresh Air	[exch/hr]	exchanges	2	Minimum for commercial bldgs AS1668.2
Fraction of Cracks in Walls and foundation	-	cracks	0.001	Value for sound concrete with no vapour barrier
Volumetric Water Content in foundation/wall cracks	[cm ³ /cm ³]	fwacon	0.12	Default Value
Volumetric Air Content in foundation/wall cracks	[cm ³ /cm ³]	facon	0.260	Default Value

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Chemical Specific Parameters	Water Solubility (mg/L)	MW (g/mol)	Koc (cm ³ /g)	Air Diffusion Coefficient (cm ² /s)	Water Diffusion Coefficient (cm ² /s)	Vapour Pressure (mmHg)	Henry's Law Constant (unitless)
1,2-dichloroethane	8690	98.96	17.4	0.104	9.9E-06	79.1	0.0401
cis-1,2-dichloroethene	3500	96.95	35.5	0.0736	1.1E-05	180	0.167
hexachlorobenzene	0.006	284.79	4.5	0.0542	5.9E-06	0.000011	0.0695
1,2-hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachloroethane	50	236.74	1820	0.0025	6.8E-06	0.4	0.114
methylene chloride	13200	84.93	11.7	0.101	1.2E-05	349	0.0898
octachlorostyrene	0.00174	379.68	200000	0.048	4.1E-06	1.30E-05	0.0053
pentachlorobutadiene	2	226.32	5181	0.0622	5.6E-06	0.15	0.421
tetrachlorobutadiene	2	191.87	5181	0.0617	5.5E-06	0.15	0.421
tetrachloroethene	200	165.83	155	0.072	8.2E-06	18.5	0.754
1,1,2-trichloroethane	1100	133.41	67.7	0.078	8.8E-06	22.49	0.0374
trichloroethene	1100	131.4	166	0.079	9.1E-06	74	0.422
1,1,1,2 tetrachloroethane	1070	167.85	96.63	0.0423	9.1E-06	12	0.0989
1,2-dibromo-3-chloropropane	1230	236.33	130	0.0212	7.0E-06	0.58	0.006

Vapour Transport Calculations	Deff Layer 1 (cm ² /s)	Deff Layer 2 (cm ² /s)	Deff Foundations and Cracks (cm ² /s)	Total Effective Diffusion (Subsurface soil to surface) (cm ² /s)
1,2-dichloroethane	5.40E-3	1.47E-3	7.43E-3	5.40E-3
cis-1,2-dichloroethene	3.82E-3	1.04E-3	5.26E-3	3.82E-3
hexachlorobenzene	2.81E-3	7.67E-4	3.87E-3	2.81E-3
1,2-hexachlorobutadiene	2.91E-3	7.91E-4	4.01E-3	2.91E-3
hexachlorobutadiene	2.91E-3	7.91E-4	4.01E-3	2.91E-3
methylene chloride	5.24E-3	1.43E-3	7.22E-3	5.24E-3
octachlorostyrene	2.49E-3	6.97E-4	3.41E-3	2.49E-3
pentachlorobutadiene	3.23E-3	8.77E-4	4.44E-3	3.23E-3
tetrachlorobutadiene	3.20E-3	8.70E-4	4.41E-3	3.20E-3
tetrachloroethene	3.74E-3	1.02E-3	5.14E-3	3.74E-3
1,1,2-trichloroethane	4.05E-3	1.11E-3	5.57E-3	4.05E-3
trichloroethene	4.10E-3	1.11E-3	5.65E-3	4.10E-3
1,1,1,2 tetrachloroethane	2.20E-3	5.99E-4	3.02E-3	2.20E-3
1,2-dibromo-3-chloropropane	1.12E-3	3.36E-4	1.52E-3	1.12E-3

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Subsurface Soils Phase Partitioning Results	Soil Concentration (mg/kg)	Vapour Phase Concentration (g/cm ³)	Saturated Soil Concentration (mg/kg)	Saturated Vapour Concentration (g/cm ³)	Free Phase Mole Fraction (mol/mol)	Concentration above Free Phase (g/cm ³)	Calculation Vapour Phase used in Calculation (g/cm ³)
1,2-dichloroethane	3.2	8.3E-07	1.3E+03	4.3E-04	0	0.0E+00	8.3E-07
cis-1,2-dichloroethene	6.5	4.9E-06	7.7E+02	9.6E-04	0	0.0E+00	4.9E-06
hexachlorobenzene	55	3.2E-05	7.1E-04	1.7E-10	0	0.0E+00	1.7E-10
1,2-hexachlorobutadiene	4.5	1.2E-07	3.1E+01	2.2E-06	0	0.0E+00	1.2E-07
hexachlorobutadiene	4.5	1.2E-07	3.1E+01	2.2E-06	0	0.0E+00	1.2E-07
methylene chloride	130	8.2E-05	1.9E+03	1.6E-03	0	0.0E+00	8.2E-05
octachlorostyrene	110	9.7E-10	1.0E+00	2.7E-10	0	0.0E+00	2.7E-10
pentachlorobutadiene	4.2	1.1E-07	3.1E+01	1.9E-06	0	0.0E+00	1.1E-07
tetrachlorobutadiene	4.2	1.1E-07	3.1E+01	1.6E-06	0	0.0E+00	1.1E-07
tetrachloroethene	16	1.9E-05	1.2E+02	1.7E-04	0	0.0E+00	1.9E-05
1,1,2-trichloroethane	15	1.8E-06	3.4E+02	1.7E-04	0	0.0E+00	1.8E-06
trichloroethene	1	6.7E-07	6.9E+02	5.4E-04	0	0.0E+00	6.7E-07
1,1,1,2 tetrachloroethane	100	2.5E-05	4.3E+02	1.1E-04	0	0.0E+00	2.5E-05
1,2-dibromo-3-chloropropane	9.5	1.2E-07	6.0E+02	7.6E-06	0	0.0E+00	1.2E-07

Calculated Air Concentrations ASTM Guidance for Subsurface Soils	Vapour Phase Concentration at Source (g/cm ³)	Emission Rate from Surface of Ground (g/s)	Enclosed Space Concentration (mg/m ³)	Outdoor Air Concentration (mg/m ³)
1,2-dichloroethane	8.3E-07	4.46E-03	2.5E-03	
cis-1,2-dichloroethene	4.9E-06	1.89E-02	1.0E-02	
hexachlorobenzene	1.7E-10	4.88E-07	2.7E-07	
1,2-hexachlorobutadiene	1.2E-07	3.52E-04	1.9E-04	
hexachlorobutadiene	1.2E-07	3.52E-04	1.9E-04	
methylene chloride	8.2E-05	4.31E-01	2.4E-01	
octachlorostyrene	2.7E-10	6.79E-07	3.7E-07	
pentachlorobutadiene	1.1E-07	3.64E-04	2.0E-04	
tetrachlorobutadiene	1.1E-07	3.61E-04	2.0E-04	
tetrachloroethene	1.9E-05	7.23E-02	4.0E-02	
1,1,2-trichloroethane	1.8E-06	7.43E-03	4.1E-03	
trichloroethene	6.7E-07	2.74E-03	1.5E-03	
1,1,1,2 tetrachloroethane	2.5E-05	5.46E-02	3.0E-02	
1,2-dibromo-3-chloropropane	1.2E-07	1.30E-04	7.1E-05	

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Site Specific Physical Input Parameters	Units	Abbrev.	Value	Comments
Depth of Top of Contaminated Soil (BGS)	[m]	d	0.5	Calculated from layers
Thickness of Surface Contamination	[m]	surfd	6	Estimated for soil types
Soil Temperature	[C]	T	17	site-specific assumption
<u>Vadose Zone Characteristics of Top Layer</u>				<u>Ash Sand</u>
Depth of Layer 1	[m]	vd1	0.5	Assume soils at surface with average depth of 0.5m
Moisture Content	[g/g]	mocon	0.1	Assumption for Sandy Clay
Organic Carbon Fraction	-	foc	0.003	Assumption for Sandy Clay
Soil Bulk Density	[g/cm ³]	rhob	1.8	Assumption for Sandy Clay
Density of Solids	[g/cm ³]	sd	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta	0.32	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon	0.180	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon	0.141	theta-wacon
Receptor Specific Input Parameters	Units	Abbrev.	Value	Comments
Outdoor Air Characteristics				
Length of Contaminated Area	[m]	length	20	site-specific assumption
Width of Contaminated Area	[m]	width	20	site-specific assumption
Wind Speed Outdoors	[m/s]	wspd	4.86	Average of 9am/3pm mean windspeed Sydney Airport
Height of Outdoor Mixing Zone	[m]	outboxh	1.5	Default Value

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Chemical Specific Parameters	Water Solubility (mg/L)	MW (g/mol)	Koc (cm ³ /g)	Air Diffusion Coefficient (cm ² /s)	Water Diffusion Coefficient (cm ² /s)	Vapour Pressure (mmHg)	Henry's Law Constant (unitless)
1,2-dichloroethane	8690	98.96	17.4	0.104	9.9E-06	79.1	0.0401
cis-1,2-dichloroethene	3500	96.95	35.5	0.0736	1.1E-05	180	0.167
hexachlorobenzene	0.006	284.79	4.5	0.0542	5.9E-06	0.000011	0.0695
1,2-hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
methylene chloride	13200	84.93	11.7	0.101	1.2E-05	349	0.0898
octachlorostyrene	0.00174	379.68	200000	0.048	4.1E-06	1.30E-05	0.0053
pentachlorobenzene	0.831	250.34	2002	0.057	6.3E-06	0.00101	0.0287
pentachlorobutadiene	2	226.32	5181	0.0622	5.6E-06	0.15	0.421
tetrachlorobutadiene	2	191.87	5181	0.0617	5.5E-06	0.15	0.421
tetrachloroethene	200	165.83	155	0.072	8.2E-06	18.5	0.754
1,1,2-trichloroethane	1100	133.41	67.7	0.078	8.8E-06	22.49	0.0374
trichloroethene	1100	131.4	166	0.079	9.1E-06	74	0.422
1,1,1,2 tetrachloroethane	1070	167.85	96.63	0.0423	9.1E-06	12	0.0989
1,2-dibromo-3-chloropropane	1230	236.33	130	0.0212	7.0E-06	0.58	0.006

Vapour Transport Calculations	Deff Layer 1 (cm ² /s)	Deff Layer 2 (cm ² /s)	Deff Foundations and Cracks (cm ² /s)	Total Effective Diffusion (Subsurface soil to surface) (cm ² /s)
1,2-dichloroethane	1.47E-3	1.47E-3	1.13E-2	1.47E-3
cis-1,2-dichloroethene	1.04E-3	1.04E-3	8.03E-3	1.04E-3
hexachlorobenzene	7.67E-4	7.67E-4	5.91E-3	7.67E-4
1,2-hexachlorobutadiene	7.91E-4	7.91E-4	6.12E-3	7.91E-4
hexachlorobutadiene	7.91E-4	7.91E-4	6.12E-3	7.91E-4
methylene chloride	1.43E-3	1.43E-3	1.10E-2	1.43E-3
octachlorostyrene	6.97E-4	6.97E-4	5.21E-3	6.97E-4
pentachlorobutadiene	8.77E-4	8.77E-4	6.78E-3	8.77E-4
tetrachlorobutadiene	8.70E-4	8.70E-4	6.73E-3	8.70E-4
tetrachloroethene	1.02E-3	1.02E-3	7.85E-3	1.02E-3
1,1,2-trichloroethane	1.11E-3	1.11E-3	8.51E-3	1.11E-3
trichloroethene	1.11E-3	1.11E-3	8.61E-3	1.11E-3
1,1,1,2 tetrachloroethane	5.99E-4	5.99E-4	4.61E-3	5.99E-4
1,2-dibromo-3-chloropropane	3.36E-4	3.36E-4	2.32E-3	3.36E-4

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Subsurface Soils Phase Partitioning Results	Soil Concentration (mg/kg)	Vapour Phase Concentration (g/cm ³)	Saturated Soil Concentration (mg/kg)	Saturated Vapour Concentration (g/cm ³)	Free Phase Mole Fraction (mol/mol)	Concentration above Free Phase (g/cm ³)	Calculation Vapour Phase used in Calculation (g/cm ³)
1,2-dichloroethane	52	1.3E-05	1.3E+03	4.3E-04	0	0.0E+00	1.3E-05
cis-1,2-dichloroethene	110	8.4E-05	7.7E+02	9.6E-04	0	0.0E+00	8.4E-05
hexachlorobenzene	55	3.2E-05	7.1E-04	1.7E-10	0	0.0E+00	1.7E-10
1,2-hexachlorobutadiene	38	1.0E-06	3.1E+01	2.2E-06	0	0.0E+00	1.0E-06
hexachlorobutadiene	38	1.0E-06	3.1E+01	2.2E-06	0	0.0E+00	1.0E-06
methylene chloride	280	1.8E-04	1.9E+03	1.6E-03	0	0.0E+00	1.8E-04
octachlorostyrene	110	9.7E-10	1.0E+00	2.7E-10	0	0.0E+00	2.7E-10
pentachlorobutadiene	35	9.4E-07	3.1E+01	1.9E-06	0	0.0E+00	9.4E-07
tetrachlorobutadiene	35	9.4E-07	3.1E+01	1.6E-06	0	0.0E+00	9.4E-07
tetrachloroethene	1500	1.8E-03	1.2E+02	1.7E-04	0	0.0E+00	1.7E-04
1,1,2-trichloroethane	210	2.6E-05	3.4E+02	1.7E-04	0	0.0E+00	2.6E-05
trichloroethene	17	1.1E-05	6.9E+02	5.4E-04	0	0.0E+00	1.1E-05
1,1,1,2 tetrachloroethane	7500	1.9E-03	4.3E+02	1.1E-04	0	0.0E+00	1.1E-04
1,2-dibromo-3-chloropropane	21	2.6E-07	6.0E+02	7.6E-06	0	0.0E+00	2.6E-07

Calculated Air Concentrations ASTM Guidance for Subsurface Soils	Vapour Phase Concentration at Source (g/cm ³)	Emission Rate from Surface of Ground (g/s)	Enclosed Space Concentration (mg/m ³)	Outdoor Air Concentration (mg/m ³)
1,2-dichloroethane	1.3E-05	3.96E-04		1.1E-02
cis-1,2-dichloroethene	8.4E-05	1.74E-03		4.8E-02
hexachlorobenzene	1.7E-10	2.66E-09		7.3E-08
1,2-hexachlorobutadiene	1.0E-06	1.62E-05		4.4E-04
hexachlorobutadiene	1.0E-06	1.62E-05		4.4E-04
methylene chloride	1.8E-04	5.05E-03		1.4E-01
octachlorostyrene	2.7E-10	3.81E-09		1.0E-07
pentachlorobutadiene	9.4E-07	1.65E-05		4.5E-04
tetrachlorobutadiene	9.4E-07	1.64E-05		4.5E-04
tetrachloroethene	1.7E-04	3.45E-03		9.5E-02
1,1,2-trichloroethane	2.6E-05	5.68E-04		1.6E-02
trichloroethene	1.1E-05	2.53E-04		7.0E-03
1,1,1,2 tetrachloroethane	1.1E-04	1.34E-03		3.7E-02
1,2-dibromo-3-chloropropane	2.6E-07	1.73E-06		4.7E-05

Soil to Air Particulate Emission Factor

(Reference: USEPA Soil Screening Guidance (1996), Supplemental Guidance (2001) and USEPA Region IX PRGs (1999))

$$PEF = \frac{Q/C \bullet 3600}{0.036 \bullet (1-V) \bullet \left(\frac{U_m}{U_t}\right)^3 \bullet F_x}$$

[mg/kg-soil]/[mg/m³ air]

where:

A = area of site (acres)
Q/C = dispersion factor (g/m²/s per kg/m³)
V = fraction of vegetative cover (unitless)
U_m = mean annual windspeed (m/s)
U_t = equivalent threshold value (m/s)
U_t/U_m = ratio of threshold value to windspeed
F_x = windspeed distribution function (unitless)

Site Data	Comments
1.95	Based on largest residential property assessed
53.66	Calculated using equations from USEPA, 2001
0.5	Assumes the properties are partially covered with grass.
4.9	Mean winspeed from 9am and 3pm readings from Sydney Airport
11.3	Equivalent threshold value at 7m (USEPA, 2002)
2.33	Ratio
9.93E-02	Value based on U _t /U _m ratio, Cowherd (1985)

PEF = 1.37E+09

COPC	Soil Concentration (mg/kg)	Particulate Concentration (mg/m ³)
1,2-dichloroethane	52	3.81E-08
cis-1,2-dichloroethene	110	8.06E-08
hexachlorobenzene	55	4.03E-08
1,2-hexachlorobutadiene	38	2.78E-08
hexachlorobutadiene	38	2.78E-08
methylene chloride	280	2.05E-07
octachlorostyrene	110	8.06E-08
pentachlorobutadiene	35	2.56E-08
tetrachlorobutadiene	35	2.56E-08
tetrachloroethene	1500	1.10E-06
1,1,2-trichloroethane	210	1.54E-07
trichloroethene	17	1.25E-08
1,1,1,2-tetrachloroethane	7500	5.49E-06
1,2-dibromo-3-chloropropane	21	1.54E-08

Inhalation of Volatile Chemicals

General Data/ Equations		Exposure Parameters (RME) Inhalation Indoors by Worker						Exposure Parameters (RME) Inhalation Outdoors by Worker					
Exposure Parameters													
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays					240	Exposure for 5 days per week minus 4 weeks holidays				
Exposure Duration (ED)	years	30	Duration of exposure as per NEPM 1999 and USEPA 1989					30	Duration of exposure as per NEPM 1999 and USEPA 1989				
Body Weight (BW)	kg	70	USEPA 1989 and CSMS 1996					70	USEPA 1989 and CSMS 1996				
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996					25550	USEPA 1989 and CSMS 1996				
Averaging Time - Threshold (ATn)	days	10950	USEPA 1989 and CSMS 1996					10950	USEPA 1989 and CSMS 1996				
Inhalation Rate (InhR)	m ³ /hr	1.17	Inhalation rate indoors for adults as per enHealth 2002					2.20	Inhalation rate for adults outdoors similar to walking as per CSMS 1996				
Exposure Time (ET)	hr/day	9	Time spent indoors at work					1	Time spent outdoors at work				
Fraction Inhaled from Contaminated Source (FI)	-	1	Assume all of workplace above groundwater/soils					1	Assume all of workplace above groundwater/soils				
	(mg/kg-day) ^a	(mg/kg/day)	(mg/m ³)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	(mg/m ³)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	
1,2-dichloroethane	9.8E-03		2.46E-03	1.0E-04	2.4E-04	1.0E-6	--	1.09E-02	9.6E-05	2.24E-04	9.4E-7	--	--
cis-1,2-dichloroethene		1.0E-02	1.04E-02	4.4E-04	1.0E-03	--	1.0E-1	4.77E-02	4.2E-04	9.87E-04	--	--	9.9E-2
hexachlorobenzene		1.6E-04	2.68E-07	1.1E-08	2.7E-08	--	1.7E-4	7.29E-08	6.5E-10	1.51E-09	--	--	9.4E-6
1,2-hexachlorobutadiene		2.0E-04	1.94E-04	8.2E-06	1.9E-05	--	9.6E-2	4.43E-04	3.9E-06	9.16E-06	--	--	4.6E-2
hexachlorobutadiene		2.0E-04	1.94E-04	8.2E-06	1.9E-05	--	9.6E-2	4.43E-04	3.9E-06	9.16E-06	--	--	4.6E-2
methylene chloride		2.3E-01	2.37E-01	1.0E-02	2.3E-02	--	1.0E-1	1.39E-01	1.2E-03	2.87E-03	--	--	1.3E-2
octachlorostyrene		3.1E-04	3.73E-07	1.6E-08	3.7E-08	--	1.2E-4	1.04E-07	9.2E-10	2.16E-09	--	--	7.0E-6
pentachlorobutadiene		2.0E-04	2.01E-04	8.5E-06	2.0E-05	--	9.9E-2	4.53E-04	4.0E-06	9.35E-06	--	--	4.7E-2
tetrachlorobutadiene		2.0E-04	1.99E-04	8.4E-06	2.0E-05	--	9.8E-2	4.49E-04	4.0E-06	9.28E-06	--	--	4.6E-2
tetrachloroethene		3.8E-02	3.98E-02	1.7E-03	3.9E-03	--	1.0E-1	9.45E-02	8.4E-04	1.95E-03	--	--	5.2E-2
1,1,2-trichloroethane		4.0E-03	4.09E-03	1.7E-04	4.0E-04	--	1.0E-1	1.56E-02	1.4E-04	3.22E-04	--	--	8.1E-2
trichloroethene	1.5E-03	1.5E-03	1.51E-03	6.4E-05	1.5E-04	9.6E-8	1.0E-1	6.95E-03	6.2E-05	1.44E-04	9.3E-8	--	9.8E-2
1,1,1,2-tetrachloroethane		3.0E-02	3.01E-02	1.3E-03	3.0E-03	--	9.9E-2	3.66E-02	3.2E-04	7.57E-04	--	--	2.5E-2
1,2-dibromo-3-chloropropane	2.4E-03		7.07E-05	3.0E-06	7.0E-06	7.2E-9	--	4.74E-05	4.2E-07	9.80E-07	1.0E-9	--	--

Modelled assuming soils present beneath slab

Modelled based on vapour migration outdoors (no concrete) and particulate emissions
Particulates conservatively assumed to be inspirable and all reach lungs

Exposure to Chemicals via Ingestion of Soils

General Data/ Equations		Exposure Calculations (RME) Ingestion of Soils by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	30	Duration of exposure as per NEPM 1999 and USEPA 1989
Body Weight (BW)	kg	70	USEPA 1989 and CSMS 1996
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	10950	USEPA 1989 and CSMS 1996
Ingestion Rate (IRs)	mg/day	25	Soil intake for adults as per CSMS 1996
Fraction Ingested (FI)	-	100%	All soil ingested from site
Bioavailability (B)	-	100%	Assume 100% bioavailability via ingestion of chemicals in sc
Conversion factor (CF)	mg to kg	1.E-06	Conversion
Intake Factor = $\frac{IRs \cdot FI \cdot B \cdot CF \cdot EF \cdot ED}{BW \cdot AT}$		1.0E-07	NonThreshold
		2.3E-07	Threshold

Daily Intake from Soil = Concentration in Soil x Intake Factor

NonThreshold Risk = Daily Intake for NonThreshold Effects x Slope Factor

Hazard Quotients = (Daily Intake for Threshold Effects/ADI)

Chemical	Toxicity Data		Concentration in Soil Outdoors	Daily Intake		Calculated Risk	
	Non-Threshold Slope Factor	Threshold ADI, TDI or RfD		NonThreshold	Threshold	NonThreshold Risk	Hazard Quotient
	(mg/kg-day) ⁻¹	(mg/kg/day)		(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
1,2-dichloroethane	1.2E-02		5.20E+01	5.2E-06	1.2E-05	6.3E-8	--
cis-1,2-dichloroethene		1.0E-02	1.10E+02	1.1E-05	2.6E-05	--	2.6E-3
hexachlorobenzene		1.6E-04	5.50E+01	5.5E-06	1.3E-05	--	8.1E-2
1,2-hexachlorobutadiene		2.0E-04	3.80E+01	3.8E-06	8.9E-06	--	4.5E-2
hexachlorobutadiene		2.0E-04	3.80E+01	3.8E-06	8.9E-06	--	4.5E-2
methylene chloride		9.6E-04	2.80E+02	2.8E-05	6.6E-05	--	6.8E-2
octachlorostyrene		3.1E-04	1.10E+02	1.1E-05	2.6E-05	--	8.3E-2
pentachlorobutadiene		2.0E-04	3.50E+01	3.5E-06	8.2E-06	--	4.1E-2
tetrachlorobutadiene		2.0E-04	3.50E+01	3.5E-06	8.2E-06	--	4.1E-2
tetrachloroethene		9.2E-03	1.50E+03	1.5E-04	3.5E-04	--	3.8E-2
1,1,2-trichloroethane		4.0E-03	2.10E+02	2.1E-05	4.9E-05	--	1.2E-2
trichloroethene		1.5E-03	1.70E+01	1.7E-06	4.0E-06	--	2.7E-3
1,1,1,2-tetrachloroethane		3.0E-02	7.50E+03	7.5E-04	1.8E-03	--	5.9E-2
1,2-dibromo-3-chloropropane	3.5E-01		2.10E+01	2.1E-06	4.9E-06	7.4E-7	--
						--	--

Dermal Exposure to Chemicals via Contact with Soil

General Data/ Equations		Exposure Calculations (RME)	
Units		Dermal Contact with Soils by Workers	
Exposure Parameters			
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays
Exposure Duration (ED)	years	30	Duration of exposure as per NEPM 1999 and USEPA 1989
Body Weight (BW)	kg	70	USEPA 1989 and CSMS 1996
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996
Averaging Time - Threshold (ATn)	days	10950	USEPA 1989 and CSMS 1996
Surface Area (SAs)	cm ²	1120	Hands only for incidental contact - USEPA 1997 data for adult male (90 percentile)
Adherence Factor (AF)	mg/cm ²	0.51	Default value as per CSMS 1996
Dermal Absorption Rate (Abs)	per hour	0.005	Rate per hour for adults as per Hawley 1985, CSOIL 1995 and 2001 and SED/ISOIL 1996
Exposure Time (ET)	hr/day	12	Assume that soil remains on skin for 12 hours before washing
Matrix Effect (ME)	-	15%	Absorption of chemicals from soil matrix is 15% from pure compound
Conversion Factor (CF)	mg to kg	1.E-06	Conversion
Site-Specific Factor (SS), -		1.00	Not used for intrusive works
Intake Factor = $\frac{SAs \cdot AF \cdot Abs \cdot ET \cdot ME \cdot CF \cdot EF \cdot ED}{BW \cdot AT}$		2.1E-08	NonThreshold
		4.8E-08	Threshold

Daily Intake from Soil = Concentration in Soil x Intake Factor

NonThreshold Risk = Daily Intake for NonThreshold Effects x Slope Factor

Hazard Quotients = (Daily Intake for Threshold Effects/ADI)

Chemical	Toxicity Data		Concentration in Soil Outdoors	Daily Intake		Calculated Risk	
	Non-Threshold Slope Factor	Threshold ADI, TDI or RfD		NonThreshold	Threshold	NonThreshold Risk	Hazard Quotient
	(mg/kg-day) ⁻¹	(mg/kg/day)	(mg/kg)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)
1,2-dichloroethane	1.2E-02		5.20E+01	1.1E-06	2.5E-06	1.3E-8	--
cis-1,2-dichloroethene		1.0E-02	1.10E+02	2.3E-06	5.3E-06	--	5.3E-4
hexachlorobenzene		1.6E-04	5.50E+01	1.1E-06	2.7E-06	--	1.7E-2
1,2-hexachlorobutadiene		2.0E-04	3.80E+01	7.9E-07	1.8E-06	--	9.2E-3
hexachlorobutadiene		2.0E-04	3.80E+01	7.9E-07	1.8E-06	--	9.2E-3
methylene chloride		9.6E-04	2.80E+02	5.8E-06	1.4E-05	--	1.4E-2
octachlorostyrene		3.1E-04	1.10E+02	2.3E-06	5.3E-06	--	1.7E-2
pentachlorobutadiene		2.0E-04	3.50E+01	7.2E-07	1.7E-06	--	8.5E-3
tetrachlorobutadiene		2.0E-04	3.50E+01	7.2E-07	1.7E-06	--	8.5E-3
tetrachloroethene		9.2E-03	1.50E+03	3.1E-05	7.2E-05	--	7.8E-3
1,1,2-trichloroethane		4.0E-03	2.10E+02	4.3E-06	1.0E-05	--	2.5E-3
trichloroethene		1.5E-03	1.70E+01	3.5E-07	8.2E-07	--	5.6E-4
1,1,1,2 tetrachloroethane		3.0E-02	7.50E+03	1.6E-04	3.6E-04	--	1.2E-2
1,2-dibromo-3-chloropropane	3.5E-01		2.10E+01	4.3E-07	1.0E-06	1.5E-7	--
						--	--

Appendix C2

RSBC 1m

Toxicity and Dermal Absorption Parameters

Chemical	Non-Threshold Slope Factor				Threshold ADI, TDI or Reference Dose				Background Intake				
	Oral (mg/kg/day) ¹		Inhalation (mg/kg/day) ¹		Dermal (mg/kg/day) ¹		Oral (mg/kg/day)			Inhalation (mg/kg/day)		Dermal (mg/kg/day)	
1,2-dichloroethane	1.20E-02	NHMRC	9.80E-03	NHMRC	1.20E-02	R					0.00E+00	R	0%
cis-1,2-dichloroethene							1.00E-02	HEAST	1.00E-02	R	1.00E-02	R	0%
hexachlorobenzene							1.60E-04	WHO	1.6E-04	R	1.60E-04	R	0%
1,2-hexachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
hexachlorobutadiene							2.00E-04	NHMRC	2.0E-04	R	2.00E-04	R	0%
methylene chloride							1.20E-03	NHMRC	2.9E-01	ATSDR	1.20E-03	R	20%
octachlorostyrene							3.10E-04	Health Canada	3.10E-04	R	3.10E-04	R	0%
pentachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
tetrachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
tetrachloroethene							1.40E-02	WHO	5.71E-02	WHO	1.40E-02	R	34%
1,1,2-trichloroethane							4.00E-03	USEPA	4.00E-03	R	4.00E-03	R	0%
trichloroethene			1.51E-03	WHO			1.46E-03	WHO	1.46E-03	R	1.46E-03	R	0%
1,1,1,2 tetrachloroethane							3.00E-02	USEPA	3.00E-02	WHO	3.00E-02		0%
1,2-dibromo-3-chloropropane	3.50E-01	WHO	2.40E-03	USEPA	3.50E-01	R							0%

Calculation of Vapour Concentrations from Groundwater Source Guidance from ASTM (1996)

Constituent	Concentration in soil (mg/kg)	NonThreshold Risk (unitless)	Threshold Hazard (unitless)	Target NonThreshold Risk (unitless)	Target Threshold Hazard (unitless)
1,2-dichloroethane	3.3	1.0E-06	--	1E-06	
cis-1,2-dichloroethene	6.8	--	0.10		0.10
hexachlorobenzene	5000	--	0.00		0.10
1,2-hexachlorobutadiene	5	--	0.10		0.10
hexachlorobutadiene	5	--	0.10		0.10
methylene chloride	135	--	0.10		0.10
octachlorostyrene	5000	--	0.00		0.10
pentachlorobutadiene	4.5	--	0.10		0.10
tetrachlorobutadiene	4.5	--	0.10		0.10
tetrachloroethene	16	--	0.10		0.10
1,1,2-trichloroethane	16	--	0.10		0.10
trichloroethene	1	9.3E-08	0.10		
1,1,1,2 tetrachloroethane	100	--	0.10		
1,2-dibromo-3-chloropropane	9.5	7.0E-09	--	1E-06	

Calculation of Vapour Concentrations from Groundwater Source Guidance from ASTM (1996)

Constituent	Concentration in soil (mg/kg)	NonThreshold Risk (unitless)	Threshold Hazard (unitless)	Target NonThreshold Risk (unitless)	Target Threshold Hazard (unitless)
1,2-dichloroethane	110	1.0E-06		1E-06	
cis-1,2-dichloroethene	230	--	0.10		0.10
hexachlorobenzene	5000	--	0.00		0.10
1,2-hexachlorobutadiene	5000	--	0.05		0.10
hexachlorobutadiene	5000	--	0.05		0.10
methylene chloride	5000	--	0.06		0.10
octachlorostyrene	5000	--	0.00		0.10
pentachlorobutadiene	5000	--	0.05		0.10
tetrachlorobutadiene	5000	--	0.04		0.10
tetrachloroethene	5000	--	0.03		0.10
1,1,2-trichloroethane	500	--	0.10		0.10
trichloroethene	36	9.8E-08	0.10		0.10
1,1,1,2 tetrachloroethane	5000	--	0.01		0.10
1,2-dibromo-3-chloropropane	300	7.2E-09	--	1E-06	0.10

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Vapour Migration Indoors				
Site Specific Physical Input Parameters	Units	Abbrev.	Value	Comments
Depth of Top of Contaminated Soil (BGS)	[m]	d	1.01	Calculated from layers
Thickness of Surface Contamination	[m]	surfd	6	Estimated for soil types
Soil Temperature	[C]	T	17	site-specific assumption
<u>Vadose Zone Characteristics of Top Layer</u>				
Depth of Layer 1	[m]	vd1	0.01	<u>Sandy Gravel</u> Assumed depth of fill under foundation
Moisture Content	[g/g]	mocon	0.1	Assumption for sandy gravel
Organic Carbon Fraction	-	foc	0.01	Assumption for sandy gravel
Soil Bulk Density	[g/cm ³]	rhob	1.6	Assumption for sandy gravel
Density of Solids	[g/cm ³]	sd	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta	0.40	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon	0.160	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon	0.236	theta-wacon
<u>Vadose Zone Characteristics at and above Source</u>				
Depth of Layer 2	[m]	vd2	1	<u>Ash Sand</u> Assumed soil type of remediated soils
Moisture Content	[g/g]	mocon2	0.1	Assumption for Sandy Clay
Organic Carbon Fraction	-	foc2	0.003	Assumption for Sandy Clay
Soil Bulk Density	[g/cm ³]	rhob2	1.8	Assumption for Sandy Clay
Density of Solids	[g/cm ³]	sd2	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta2	0.32	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon2	0.180	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon2	0.141	theta-wacon
Receptor Specific Input Parameters	Units	Abbrev.	Value	Comments
<u>Building Characteristics</u>				
Area of Emission - Building Area	[m ²]	emarea	100.0	assumed area of the room
Foundation/wall thickness	[m]	fthick	0.15	Default Value
Height of Room	[m]	boxh	3	Typical height for commercial premises
Hourly Volume Exchange of Fresh Air	[exch/hr]	exchanges	2	Minimum for commercial bldgs AS1668.2
Fraction of Cracks in Walls and foundation	-	cracks	0.001	Value for sound concrete with no vapour barrier
Volumetric Water Content in foundation/wall cracks	[cm ³ /cm ³]	fwacon	0.12	Default Value
Volumetric Air Content in foundation/wall cracks	[cm ³ /cm ³]	facon	0.260	Default Value

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Chemical Specific Parameters	Water Solubility (mg/L)	MW (g/mol)	Koc (cm ² /g)	Air Diffusion Coefficient (cm ² /s)	Water Diffusion Coefficient (cm ² /s)	Vapour Pressure (mmHg)	Henry's Law Constant (unitless)
1,2-dichloroethane	8690	98.96	17.4	0.104	9.9E-06	79.1	0.0401
cis-1,2-dichloroethene	3500	96.95	35.5	0.0736	1.1E-05	180	0.167
hexachlorobenzene	0.006	284.79	4.5	0.0542	5.9E-06	0.000011	0.0695
1,2-hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachloroethane	50	236.74	1820	0.0025	6.8E-06	0.4	0.114
methylene chloride	13200	84.93	11.7	0.101	1.2E-05	349	0.0898
octachlorostyrene	0.00174	379.68	200000	0.048	4.1E-06	1.30E-05	0.0053
pentachlorobutadiene	2	226.32	5181	0.0622	5.6E-06	0.15	0.421
tetrachlorobutadiene	2	191.87	5181	0.0617	5.5E-06	0.15	0.421
tetrachloroethene	200	165.83	155	0.072	8.2E-06	18.5	0.754
1,1,2-trichloroethane	1100	133.41	67.7	0.078	8.8E-06	22.49	0.0374
trichloroethene	1100	131.4	166	0.079	9.1E-06	74	0.422
1,1,1,2 tetrachloroethane	1070	167.85	96.63	0.0423	9.1E-06	12	0.0989
1,2-dibromo-3-chloropropane	1230	236.33	130	0.0212	7.0E-06	0.58	0.006

Vapour Transport Calculations	Deff Layer 1 (cm ² /s)	Deff Layer 2 (cm ² /s)	Deff Foundations and Cracks (cm ² /s)	Total Effective Diffusion (Subsurface soil to surface) (cm ² /s)
1,2-dichloroethane	5.40E-3	1.47E-3	7.43E-3	1.49E-3
cis-1,2-dichloroethene	3.82E-3	1.04E-3	5.26E-3	1.05E-3
hexachlorobenzene	2.81E-3	7.67E-4	3.87E-3	7.73E-4
1,2-hexachlorobutadiene	2.91E-3	7.91E-4	4.01E-3	7.97E-4
hexachlorobutadiene	2.91E-3	7.91E-4	4.01E-3	7.97E-4
methylene chloride	5.24E-3	1.43E-3	7.22E-3	1.44E-3
octachlorostyrene	2.49E-3	6.97E-4	3.41E-3	7.02E-4
pentachlorobutadiene	3.23E-3	8.77E-4	4.44E-3	8.84E-4
tetrachlorobutadiene	3.20E-3	8.70E-4	4.41E-3	8.77E-4
tetrachloroethene	3.74E-3	1.02E-3	5.14E-3	1.02E-3
1,1,2-trichloroethane	4.05E-3	1.11E-3	5.57E-3	1.12E-3
trichloroethene	4.10E-3	1.11E-3	5.65E-3	1.12E-3
1,1,1,2 tetrachloroethane	2.20E-3	5.99E-4	3.02E-3	6.04E-4
1,2-dibromo-3-chloropropane	1.12E-3	3.36E-4	1.52E-3	3.39E-4

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Subsurface Soils Phase Partitioning Results	Soil Concentration (mg/kg)	Vapour Phase Concentration (g/cm ³)	Saturated Soil Concentration (mg/kg)	Saturated Vapour Concentration (g/cm ³)	Free Phase Mole Fraction (mol/mol)	Concentration above Free Phase (g/cm ³)	Calculation Vapour Phase used in Calculation (g/cm ³)
1,2-dichloroethane	3.3	8.5E-07	1.3E+03	4.3E-04	0	0.0E+00	8.5E-07
cis-1,2-dichloroethene	6.8	5.2E-06	7.7E+02	9.6E-04	0	0.0E+00	5.2E-06
hexachlorobenzene	5000	2.9E-03	7.1E-04	1.7E-10	0	0.0E+00	1.7E-10
1,2-hexachlorobutadiene	5	1.3E-07	3.1E+01	2.2E-06	0	0.0E+00	1.3E-07
hexachlorobutadiene	5	1.3E-07	3.1E+01	2.2E-06	0	0.0E+00	1.3E-07
methylene chloride	135	8.5E-05	1.9E+03	1.6E-03	0	0.0E+00	8.5E-05
octachlorostyrene	5000	4.4E-08	1.0E+00	2.7E-10	0	0.0E+00	2.7E-10
pentachlorobutadiene	4.5	1.2E-07	3.1E+01	1.9E-06	0	0.0E+00	1.2E-07
tetrachlorobutadiene	4.5	1.2E-07	3.1E+01	1.6E-06	0	0.0E+00	1.2E-07
tetrachloroethene	16	1.9E-05	1.2E+02	1.7E-04	0	0.0E+00	1.9E-05
1,1,2-trichloroethane	16	2.0E-06	3.4E+02	1.7E-04	0	0.0E+00	2.0E-06
trichloroethene	1	6.7E-07	6.9E+02	5.4E-04	0	0.0E+00	6.7E-07
1,1,1,2 tetrachloroethane	100	2.5E-05	4.3E+02	1.1E-04	0	0.0E+00	2.5E-05
1,2-dibromo-3-chloropropane	9.5	1.2E-07	6.0E+02	7.6E-06	0	0.0E+00	1.2E-07

Calculated Air Concentrations ASTM Guidance for Subsurface Soils	Vapour Phase Concentration at Source (g/cm ³)	Emission Rate from Surface of Ground (g/s)	Enclosed Space Concentration (mg/m ³)	Outdoor Air Concentration (mg/m ³)
1,2-dichloroethane	8.5E-07	1.25E-05	2.5E-03	
cis-1,2-dichloroethene	5.2E-06	5.36E-05	1.1E-02	
hexachlorobenzene	1.7E-10	1.32E-09	2.6E-07	
1,2-hexachlorobutadiene	1.3E-07	1.06E-06	2.1E-04	
hexachlorobutadiene	1.3E-07	1.06E-06	2.1E-04	
methylene chloride	8.5E-05	1.22E-03	2.4E-01	
octachlorostyrene	2.7E-10	1.90E-09	3.6E-07	
pentachlorobutadiene	1.2E-07	1.06E-06	2.1E-04	
tetrachlorobutadiene	1.2E-07	1.05E-06	2.1E-04	
tetrachloroethene	1.9E-05	1.96E-04	3.8E-02	
1,1,2-trichloroethane	2.0E-06	2.16E-05	4.2E-03	
trichloroethene	6.7E-07	7.43E-06	1.5E-03	
1,1,1,2 tetrachloroethane	2.5E-05	1.49E-04	2.9E-02	
1,2-dibromo-3-chloropropane	1.2E-07	3.90E-07	6.9E-05	

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Site Specific Physical Input Parameters	Units	Abbrev.	Value	Comments
Depth of Top of Contaminated Soil (BGS)	[m]	d	1	Calculated from layers
Thickness of Surface Contamination	[m]	surfd	6	Estimated for soil types
Soil Temperature	[C]	T	17	site-specific assumption
<u>Vadose Zone Characteristics of Top Layer</u>				<u>Ash Sand</u>
Depth of Layer 1	[m]	vd1	1	Assumed soil type of remediated soils
Moisture Content	[g/g]	mocon	0.1	Assumption for Sandy Clay
Organic Carbon Fraction	-	foc	0.003	Assumption for Sandy Clay
Soil Bulk Density	[g/cm ³]	rhob	1.8	Assumption for Sandy Clay
Density of Solids	[g/cm ³]	sd	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta	0.32	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon	0.180	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon	0.141	theta-wacon
Receptor Specific Input Parameters	Units	Abbrev.	Value	Comments
<u>Outdoor Air Characteristics</u>				
Length of Contaminated Area	[m]	length	20	site-specific assumption
Width of Contaminated Area	[m]	width	20	site-specific assumption
Wind Speed Outdoors	[m/s]	wspd	4.86	Average of 9am/3pm mean windspeed Sydney Airport
Height of Outdoor Mixing Zone	[m]	outboxh	1.5	Default Value

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Chemical Specific Parameters	Water Solubility (mg/L)	MW (g/mol)	Koc (cm ² /g)	Air Diffusion Coefficient (cm ² /s)	Water Diffusion Coefficient (cm ² /s)	Vapour Pressure (mmHg)	Henry's Law Constant (unitless)
1,2-dichloroethane	8690	98.96	17.4	0.104	9.9E-06	79.1	0.0401
cis-1,2-dichloroethene	3500	96.95	35.5	0.0736	1.1E-05	180	0.167
hexachlorobenzene	0.006	284.79	4.5	0.0542	5.9E-06	0.000011	0.0695
1,2-hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
methylene chloride	13200	84.93	11.7	0.101	1.2E-05	349	0.0898
octachlorostyrene	0.00174	379.68	200000	0.048	4.1E-06	1.30E-05	0.0053
pentachlorobenzene	0.831	250.34	2002	0.057	6.3E-06	0.00101	0.0287
pentachlorobutadiene	2	226.32	5181	0.0622	5.6E-06	0.15	0.421
tetrachlorobutadiene	2	191.87	5181	0.0617	5.5E-06	0.15	0.421
tetrachloroethene	200	165.83	155	0.072	8.2E-06	18.5	0.754
1,1,2-trichloroethane	1100	133.41	67.7	0.078	8.8E-06	22.49	0.0374
trichloroethene	1100	131.4	166	0.079	9.1E-06	74	0.422
1,1,1,2 tetrachloroethane	1070	167.85	96.63	0.0423	9.1E-06	12	0.0989
1,2-dibromo-3-chloropropane	1230	236.33	130	0.0212	7.0E-06	0.58	0.006

Vapour Transport Calculations	Deff Layer 1 (cm ² /s)	Deff Layer 2 (cm ² /s)	Deff Foundations and Cracks (cm ² /s)	Total Effective Diffusion (Subsurface soil to surface) (cm ² /s)
1,2-dichloroethane	1.47E-3	1.47E-3	1.13E-2	1.47E-3
cis-1,2-dichloroethene	1.04E-3	1.04E-3	8.03E-3	1.04E-3
hexachlorobenzene	7.67E-4	7.67E-4	5.91E-3	7.67E-4
1,2-hexachlorobutadiene	7.91E-4	7.91E-4	6.12E-3	7.91E-4
hexachlorobutadiene	7.91E-4	7.91E-4	6.12E-3	7.91E-4
methylene chloride	1.43E-3	1.43E-3	1.10E-2	1.43E-3
octachlorostyrene	6.97E-4	6.97E-4	5.21E-3	6.97E-4
pentachlorobutadiene	8.77E-4	8.77E-4	6.78E-3	8.77E-4
tetrachlorobutadiene	8.70E-4	8.70E-4	6.73E-3	8.70E-4
tetrachloroethene	1.02E-3	1.02E-3	7.85E-3	1.02E-3
1,1,2-trichloroethane	1.11E-3	1.11E-3	8.51E-3	1.11E-3
trichloroethene	1.11E-3	1.11E-3	8.61E-3	1.11E-3
1,1,1,2 tetrachloroethane	5.99E-4	5.99E-4	4.61E-3	5.99E-4
1,2-dibromo-3-chloropropane	3.36E-4	3.36E-4	2.32E-3	3.36E-4

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Subsurface Soils Phase Partitioning Results	Soil Concentration (mg/kg)	Vapour Phase Concentration (g/cm ³)	Saturated Soil Concentration (mg/kg)	Saturated Vapour Concentration (g/cm ³)	Free Phase Mole Fraction (mol/mol)	Concentration above Free Phase (g/cm ³)	Calculation Vapour Phase used in Calculation (g/cm ³)
1,2-dichloroethane	110	2.8E-05	1.3E+03	4.3E-04	0	0.0E+00	2.8E-05
cis-1,2-dichloroethene	230	1.7E-04	7.7E+02	9.6E-04	0	0.0E+00	1.7E-04
hexachlorobenzene	5000	2.9E-03	7.1E-04	1.7E-10	0	0.0E+00	1.7E-10
1,2-hexachlorobutadiene	5000	1.3E-04	3.1E+01	2.2E-06	0	0.0E+00	2.2E-06
hexachlorobutadiene	5000	1.3E-04	3.1E+01	2.2E-06	0	0.0E+00	2.2E-06
methylene chloride	5000	3.2E-03	1.9E+03	1.6E-03	0	0.0E+00	1.6E-03
octachlorostyrene	5000	4.4E-08	1.0E+00	2.7E-10	0	0.0E+00	2.7E-10
pentachlorobutadiene	5000	1.3E-04	3.1E+01	1.9E-06	0	0.0E+00	1.9E-06
tetrachlorobutadiene	5000	1.3E-04	3.1E+01	1.6E-06	0	0.0E+00	1.6E-06
tetrachloroethene	5000	6.0E-03	1.2E+02	1.7E-04	0	0.0E+00	1.7E-04
1,1,2-trichloroethane	500	6.1E-05	3.4E+02	1.7E-04	0	0.0E+00	6.1E-05
trichloroethene	36	2.4E-05	6.9E+02	5.4E-04	0	0.0E+00	2.4E-05
1,1,1,2 tetrachloroethane	5000	1.2E-03	4.3E+02	1.1E-04	0	0.0E+00	1.1E-04
1,2-dibromo-3-chloropropane	300	3.7E-06	6.0E+02	7.6E-06	0	0.0E+00	3.7E-06

Calculated Air Concentrations ASTM Guidance for Subsurface Soils	Vapour Phase Concentration at Source (g/cm ³)	Emission Rate from Surface of Ground (g/s)	Enclosed Space Concentration (mg/m ³)	Outdoor Air Concentration (mg/m ³)
1,2-dichloroethane	2.8E-05	4.19E-04		1.1E-02
cis-1,2-dichloroethene	1.7E-04	1.82E-03		5.0E-02
hexachlorobenzene	1.7E-10	1.33E-09		3.6E-08
1,2-hexachlorobutadiene	2.2E-06	1.71E-05		4.7E-04
hexachlorobutadiene	2.2E-06	1.71E-05		4.7E-04
methylene chloride	1.6E-03	2.34E-02		6.4E-01
octachlorostyrene	2.7E-10	1.90E-09		5.2E-08
pentachlorobutadiene	1.9E-06	1.65E-05		4.5E-04
tetrachlorobutadiene	1.6E-06	1.39E-05		3.8E-04
tetrachloroethene	1.7E-04	1.72E-03		4.7E-02
1,1,2-trichloroethane	6.1E-05	6.77E-04		1.9E-02
trichloroethene	2.4E-05	2.68E-04		7.4E-03
1,1,1,2 tetrachloroethane	1.1E-04	6.68E-04		1.8E-02
1,2-dibromo-3-chloropropane	3.7E-06	1.23E-05		3.4E-04

Inhalation of Volatile Chemicals

General Data/ Equations		Exposure Parameters (RME) Inhalation Indoors by Worker						Exposure Parameters (RME) Inhalation Outdoors by Worker					
Exposure Parameters													
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays					240	Exposure for 5 days per week minus 4 weeks holidays				
Exposure Duration (ED)	years	30	Duration of exposure as per NEPM 1999 and USEPA 1989					30	Duration of exposure as per NEPM 1999 and USEPA 1989				
Body Weight (BW)	kg	70	USEPA 1989 and CSMS 1996					70	USEPA 1989 and CSMS 1996				
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996					25550	USEPA 1989 and CSMS 1996				
Averaging Time - Threshold (ATn)	days	10950	USEPA 1989 and CSMS 1996					10950	USEPA 1989 and CSMS 1996				
Inhalation Rate (InhR)	m ³ /hr	1.17	Inhalation rate indoors for adults as per enHealth 2002					2.20	Inhalation rate for adults outdoors similar to walking as per CSMS 1996				
Exposure Time (ET)	hr/day	9	Time spent indoors at work					1	Time spent outdoors at work				
Fraction Inhaled from Contaminated Source (FI)	-	1	Assume all of workplace above groundwater/soils					1	Assume all of workplace above groundwater/soils				
	(mg/kg-day) ^a	(mg/kg/day)	(mg/m ³)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	(mg/m ³)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	
1,2-dichloroethane	9.8E-03		2.45E-03	1.0E-04	2.4E-04	--	--	1.15E-02	1.0E-04	2.37E-04	1.0E-6	--	
cis-1,2-dichloroethene		1.0E-02	1.05E-02	4.5E-04	1.0E-03	--	1.0E-1	4.99E-02	4.4E-04	1.03E-03	--	1.0E-1	
hexachlorobenzene		1.6E-04	2.60E-07	1.1E-08	2.6E-08	--	1.6E-4	3.64E-08	3.2E-10	7.53E-10	--	4.7E-6	
1,2 hexachlorobutadiene		2.0E-04	2.08E-04	8.8E-06	2.1E-05	--	1.0E-1	4.70E-04	4.2E-06	9.71E-06	--	4.9E-2	
hexachlorobutadiene		2.0E-04	2.08E-04	8.8E-06	2.1E-05	--	1.0E-1	4.70E-04	4.2E-06	9.71E-06	--	4.9E-2	
methylene chloride		2.3E-01	2.38E-01	1.0E-02	2.4E-02	--	1.0E-1	6.42E-01	5.7E-03	1.33E-02	--	5.8E-2	
octachlorostyrene		3.1E-04	3.61E-07	1.5E-08	3.6E-08	--	1.2E-4	5.22E-08	4.6E-10	1.08E-09	--	3.5E-6	
pentachlorobutadiene		2.0E-04	2.08E-04	8.8E-06	2.1E-05	--	1.0E-1	4.52E-04	4.0E-06	9.34E-06	--	4.7E-2	
tetrachlorobutadiene		2.0E-04	2.06E-04	8.7E-06	2.0E-05	--	1.0E-1	3.80E-04	3.4E-06	7.85E-06	--	3.9E-2	
tetrachloroethene		3.8E-02	3.85E-02	1.6E-03	3.8E-03	--	1.0E-1	4.73E-02	4.2E-04	9.77E-04	--	2.6E-2	
1,1,2-trichloroethane		4.0E-03	4.22E-03	1.8E-04	4.2E-04	--	1.0E-1	1.86E-02	1.6E-04	3.84E-04	--	9.6E-2	
trichloroethene	1.5E-03		1.46E-03	6.2E-05	1.4E-04	9.3E-8	9.9E-2	7.36E-03	6.5E-05	1.52E-04	9.8E-8	1.0E-1	
1,1,1,2 tetrachloroethane		3.0E-02	2.91E-02	1.2E-03	2.9E-03	--	9.6E-2	1.83E-02	1.6E-04	3.78E-04	--	1.3E-2	
1,2-dibromo-3-chloropropane	2.4E-03		6.86E-05	2.9E-06	6.8E-06	7.0E-9	--	3.39E-04	3.0E-06	7.00E-06	7.2E-9	--	

Modelled assuming soils present beneath slab

Modelled based on vapour migration outdoors (no concrete) and particulate emissions
Particulates conservatively assumed to be inspirable and all reach lungs

Appendix C3

RSBC 3m

Toxicity and Dermal Absorption Parameters

Chemical	Non-Threshold Slope Factor				Threshold ADI, TDI or Reference Dose				Background Intake				
	Oral (mg/kg/day) ¹		Inhalation (mg/kg/day) ¹		Dermal (mg/kg/day) ¹		Oral (mg/kg/day)			Inhalation (mg/kg/day)		Dermal (mg/kg/day)	
1,2-dichloroethane	1.20E-02	NHMRC	9.80E-03	NHMRC	1.20E-02	R					0.00E+00	R	0%
cis-1,2-dichloroethene							1.00E-02	HEAST	1.00E-02	R	1.00E-02	R	0%
hexachlorobenzene							1.60E-04	WHO	1.6E-04	R	1.60E-04	R	0%
1,2-hexachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
hexachlorobutadiene							2.00E-04	NHMRC	2.0E-04	R	2.00E-04	R	0%
methylene chloride							1.20E-03	NHMRC	2.9E-01	ATSDR	1.20E-03	R	20%
octachlorostyrene							3.10E-04	Health Canada	3.10E-04	R	3.10E-04	R	0%
pentachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
tetrachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
tetrachloroethene							1.40E-02	WHO	5.71E-02	WHO	1.40E-02	R	34%
1,1,2-trichloroethane							4.00E-03	USEPA	4.00E-03	R	4.00E-03	R	0%
trichloroethene			1.51E-03	WHO			1.46E-03	WHO	1.46E-03	R	1.46E-03	R	0%
1,1,1,2 tetrachloroethane							3.00E-02	USEPA	3.00E-02	WHO	3.00E-02		0%
1,2-dibromo-3-chloropropane	3.50E-01	WHO	2.40E-03	USEPA	3.50E-01	R							0%

Calculation of Vapour Concentrations from Groundwater Source Guidance from ASTM (1996)

Constituent	Concentration in soil (mg/kg)	NonThreshold Risk (unitless)	Threshold Hazard (unitless)	Target NonThreshold Risk (unitless)	Target Threshold Hazard (unitless)
1,2-dichloroethane	3.4	1.0E-06	--	1E-06	
cis-1,2-dichloroethene	6.8	--	0.10		0.10
hexachlorobenzene	5000	--	0.00		0.10
1,2-hexachlorobutadiene	5	--	0.10		0.10
hexachlorobutadiene	5	--	0.10		0.10
methylene chloride	135	--	0.10		0.10
octachlorostyrene	5000	--	0.00		0.10
pentachlorobutadiene	4.5	--	0.10		0.10
tetrachlorobutadiene	4.5	--	0.10		0.10
tetrachloroethene	16	--	0.10		0.10
1,1,2-trichloroethane	16	--	0.10		0.10
trichloroethene	1	9.0E-08	0.10		
1,1,1,2 tetrachloroethane	110	--	0.10		
1,2-dibromo-3-chloropropane	10	7.1E-09	--	1E-06	

Calculation of Vapour Concentrations from Groundwater Source Guidance from ASTM (1996)

Constituent	Concentration in soil (mg/kg)	NonThreshold Risk (unitless)	Threshold Hazard (unitless)	Target NonThreshold Risk (unitless)	Target Threshold Hazard (unitless)
1,2-dichloroethane	230	1.0E-06		1E-06	
cis-1,2-dichloroethene	450	--	0.10		0.10
hexachlorobenzene	5000	--	0.00		0.10
1,2-hexachlorobutadiene	5000	--	0.02		0.10
hexachlorobutadiene	5000	--	0.02		0.10
methylene chloride	5000	--	0.03		0.10
octachlorostyrene	5000	--	0.00		0.10
pentachlorobutadiene	5000	--	0.02		0.10
tetrachlorobutadiene	5000	--	0.02		0.10
tetrachloroethene	5000	--	0.01		0.10
1,1,2-trichloroethane	1000	--	0.10		0.10
trichloroethene	70	9.5E-08	0.10		0.10
1,1,1,2 tetrachloroethane	5000	--	0.01		0.10
1,2-dibromo-3-chloropropane	600	7.2E-09	--	1E-06	0.10

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Vapour Migration Indoors				
Site Specific Physical Input Parameters	Units	Abbrev.	Value	Comments
Depth of Top of Contaminated Soil (BGS)	[m]	d	2.01	Calculated from layers
Thickness of Surface Contamination	[m]	surfd	6	Estimated for soil types
Soil Temperature	[C]	T	17	site-specific assumption
<u>Vadose Zone Characteristics of Top Layer</u>				
Depth of Layer 1	[m]	vd1	0.01	<u>Sandy Gravel</u> Assumed depth of fill under foundation
Moisture Content	[g/g]	mocon	0.1	Assumption for sandy gravel
Organic Carbon Fraction	-	foc	0.01	Assumption for sandy gravel
Soil Bulk Density	[g/cm ³]	rhob	1.6	Assumption for sandy gravel
Density of Solids	[g/cm ³]	sd	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta	0.40	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon	0.160	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon	0.236	theta-wacon
<u>Vadose Zone Characteristics at and above Source</u>				
Depth of Layer 2	[m]	vd2	2	<u>Ash Sand</u> Assumed soil type of remediated soils
Moisture Content	[g/g]	mocon2	0.1	Assumption for Sandy Clay
Organic Carbon Fraction	-	foc2	0.003	Assumption for Sandy Clay
Soil Bulk Density	[g/cm ³]	rhob2	1.8	Assumption for Sandy Clay
Density of Solids	[g/cm ³]	sd2	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta2	0.32	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon2	0.180	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon2	0.141	theta-wacon
Receptor Specific Input Parameters	Units	Abbrev.	Value	Comments
<u>Building Characteristics</u>				
Area of Emission - Building Area	[m ²]	emarea	100.0	assumed area of the room
Foundation/wall thickness	[m]	fthick	0.15	Default Value
Height of Room	[m]	boxh	3	Typical height for commercial premises
Hourly Volume Exchange of Fresh Air	[exch/hr]	exchanges	2	Minimum for commercial bldgs AS1668.2
Fraction of Cracks in Walls and foundation	-	cracks	0.001	Value for sound concrete with no vapour barrier
Volumetric Water Content in foundation/wall cracks	[cm ³ /cm ³]	fwacon	0.12	Default Value
Volumetric Air Content in foundation/wall cracks	[cm ³ /cm ³]	facon	0.260	Default Value

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Chemical Specific Parameters	Water Solubility (mg/L)	MW (g/mol)	Koc (cm ³ /g)	Air Diffusion Coefficient (cm ² /s)	Water Diffusion Coefficient (cm ² /s)	Vapour Pressure (mmHg)	Henry's Law Constant (unitless)
1,2-dichloroethane	8690	98.96	17.4	0.104	9.9E-06	79.1	0.0401
cis-1,2-dichloroethene	3500	96.95	35.5	0.0736	1.1E-05	180	0.167
hexachlorobenzene	0.006	284.79	4.5	0.0542	5.9E-06	0.000011	0.0695
1,2-hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachloroethane	50	236.74	1820	0.0025	6.8E-06	0.4	0.114
methylene chloride	13200	84.93	11.7	0.101	1.2E-05	349	0.0898
octachlorostyrene	0.00174	379.68	200000	0.048	4.1E-06	1.30E-05	0.0053
pentachlorobutadiene	2	226.32	5181	0.0622	5.6E-06	0.15	0.421
tetrachlorobutadiene	2	191.87	5181	0.0617	5.5E-06	0.15	0.421
tetrachloroethene	200	165.83	155	0.072	8.2E-06	18.5	0.754
1,1,2-trichloroethane	1100	133.41	67.7	0.078	8.8E-06	22.49	0.0374
trichloroethene	1100	131.4	166	0.079	9.1E-06	74	0.422
1,1,1,2 tetrachloroethane	1070	167.85	96.63	0.0423	9.1E-06	12	0.0989
1,2-dibromo-3-chloropropane	1230	236.33	130	0.0212	7.0E-06	0.58	0.006

Vapour Transport Calculations	Deff Layer 1 (cm ² /s)	Deff Layer 2 (cm ² /s)	Deff Foundations and Cracks (cm ² /s)	Total Effective Diffusion (Subsurface soil to surface) (cm ² /s)
1,2-dichloroethane	5.40E-3	1.47E-3	7.43E-3	1.48E-3
cis-1,2-dichloroethene	3.82E-3	1.04E-3	5.26E-3	1.04E-3
hexachlorobenzene	2.81E-3	7.67E-4	3.87E-3	7.70E-4
1,2-hexachlorobutadiene	2.91E-3	7.91E-4	4.01E-3	7.94E-4
hexachlorobutadiene	2.91E-3	7.91E-4	4.01E-3	7.94E-4
methylene chloride	5.24E-3	1.43E-3	7.22E-3	1.43E-3
octachlorostyrene	2.49E-3	6.97E-4	3.41E-3	7.00E-4
pentachlorobutadiene	3.23E-3	8.77E-4	4.44E-3	8.81E-4
tetrachlorobutadiene	3.20E-3	8.70E-4	4.41E-3	8.74E-4
tetrachloroethene	3.74E-3	1.02E-3	5.14E-3	1.02E-3
1,1,2-trichloroethane	4.05E-3	1.11E-3	5.57E-3	1.11E-3
trichloroethene	4.10E-3	1.11E-3	5.65E-3	1.12E-3
1,1,1,2 tetrachloroethane	2.20E-3	5.99E-4	3.02E-3	6.02E-4
1,2-dibromo-3-chloropropane	1.12E-3	3.36E-4	1.52E-3	3.37E-4

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Subsurface Soils Phase Partitioning Results	Soil Concentration (mg/kg)	Vapour Phase Concentration (g/cm ³)	Saturated Soil Concentration (mg/kg)	Saturated Vapour Concentration (g/cm ³)	Free Phase Mole Fraction (mol/mol)	Concentration above Free Phase (g/cm ³)	Calculation Vapour Phase used in Calculation (g/cm ³)
1,2-dichloroethane	3.4	8.8E-07	1.3E+03	4.3E-04	0	0.0E+00	8.8E-07
cis-1,2-dichloroethene	6.8	5.2E-06	7.7E+02	9.6E-04	0	0.0E+00	5.2E-06
hexachlorobenzene	5000	2.9E-03	7.1E-04	1.7E-10	0	0.0E+00	1.7E-10
1,2-hexachlorobutadiene	5	1.3E-07	3.1E+01	2.2E-06	0	0.0E+00	1.3E-07
hexachlorobutadiene	5	1.3E-07	3.1E+01	2.2E-06	0	0.0E+00	1.3E-07
methylene chloride	135	8.5E-05	1.9E+03	1.6E-03	0	0.0E+00	8.5E-05
octachlorostyrene	5000	4.4E-08	1.0E+00	2.7E-10	0	0.0E+00	2.7E-10
pentachlorobutadiene	4.5	1.2E-07	3.1E+01	1.9E-06	0	0.0E+00	1.2E-07
tetrachlorobutadiene	4.5	1.2E-07	3.1E+01	1.6E-06	0	0.0E+00	1.2E-07
tetrachloroethene	16	1.9E-05	1.2E+02	1.7E-04	0	0.0E+00	1.9E-05
1,1,2-trichloroethane	16	2.0E-06	3.4E+02	1.7E-04	0	0.0E+00	2.0E-06
trichloroethene	1	6.7E-07	6.9E+02	5.4E-04	0	0.0E+00	6.7E-07
1,1,1,2 tetrachloroethane	110	2.7E-05	4.3E+02	1.1E-04	0	0.0E+00	2.7E-05
1,2-dibromo-3-chloropropane	10	1.2E-07	6.0E+02	7.6E-06	0	0.0E+00	1.2E-07

Calculated Air Concentrations ASTM Guidance for Subsurface Soils	Vapour Phase Concentration at Source (g/cm ³)	Emission Rate from Surface of Ground (g/s)	Enclosed Space Concentration (mg/m ³)	Outdoor Air Concentration (mg/m ³)
1,2-dichloroethane	8.8E-07	6.46E-06	2.4E-03	
cis-1,2-dichloroethene	5.2E-06	2.69E-05	1.0E-02	
hexachlorobenzene	1.7E-10	6.63E-10	2.5E-07	
1,2-hexachlorobutadiene	1.3E-07	5.31E-07	2.0E-04	
hexachlorobutadiene	1.3E-07	5.31E-07	2.0E-04	
methylene chloride	8.5E-05	6.08E-04	2.3E-01	
octachlorostyrene	2.7E-10	9.50E-10	3.5E-07	
pentachlorobutadiene	1.2E-07	5.30E-07	2.0E-04	
tetrachlorobutadiene	1.2E-07	5.25E-07	2.0E-04	
tetrachloroethene	1.9E-05	9.80E-05	3.7E-02	
1,1,2-trichloroethane	2.0E-06	1.08E-05	4.1E-03	
trichloroethene	6.7E-07	3.72E-06	1.4E-03	
1,1,1,2 tetrachloroethane	2.7E-05	8.19E-05	3.1E-02	
1,2-dibromo-3-chloropropane	1.2E-07	2.05E-07	7.0E-05	

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Site Specific Physical Input Parameters	Units	Abbrev.	Value	Comments
Depth of Top of Contaminated Soil (BGS)	[m]	d	2	Calculated from layers
Thickness of Surface Contamination	[m]	surfd	6	Estimated for soil types
Soil Temperature	[C]	T	17	site-specific assumption
<u>Vadose Zone Characteristics of Top Layer</u>				<u>Ash Sand</u>
Depth of Layer 1	[m]	vd1	2	Assumed soil type of remediated soils
Moisture Content	[g/g]	mocon	0.1	Assumption for Sandy Clay
Organic Carbon Fraction	-	foc	0.003	Assumption for Sandy Clay
Soil Bulk Density	[g/cm ³]	rhob	1.8	Assumption for Sandy Clay
Density of Solids	[g/cm ³]	sd	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta	0.32	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon	0.180	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon	0.141	theta-wacon
Receptor Specific Input Parameters	Units	Abbrev.	Value	Comments
<u>Outdoor Air Characteristics</u>				
Length of Contaminated Area	[m]	length	20	site-specific assumption
Width of Contaminated Area	[m]	width	20	site-specific assumption
Wind Speed Outdoors	[m/s]	wspd	4.86	Average of 9am/3pm mean windspeed Sydney Airport
Height of Outdoor Mixing Zone	[m]	outboxh	1.5	Default Value

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Chemical Specific Parameters	Water Solubility (mg/L)	MW (g/mol)	Koc (cm ² /g)	Air Diffusion Coefficient (cm ² /s)	Water Diffusion Coefficient (cm ² /s)	Vapour Pressure (mmHg)	Henry's Law Constant (unitless)
1,2-dichloroethane	8690	98.96	17.4	0.104	9.9E-06	79.1	0.0401
cis-1,2-dichloroethene	3500	96.95	35.5	0.0736	1.1E-05	180	0.167
hexachlorobenzene	0.006	284.79	4.5	0.0542	5.9E-06	0.000011	0.0695
1,2-hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
methylene chloride	13200	84.93	11.7	0.101	1.2E-05	349	0.0898
octachlorostyrene	0.00174	379.68	200000	0.048	4.1E-06	1.30E-05	0.0053
pentachlorobenzene	0.831	250.34	2002	0.057	6.3E-06	0.00101	0.0287
pentachlorobutadiene	2	226.32	5181	0.0622	5.6E-06	0.15	0.421
tetrachlorobutadiene	2	191.87	5181	0.0617	5.5E-06	0.15	0.421
tetrachloroethene	200	165.83	155	0.072	8.2E-06	18.5	0.754
1,1,2-trichloroethane	1100	133.41	67.7	0.078	8.8E-06	22.49	0.0374
trichloroethene	1100	131.4	166	0.079	9.1E-06	74	0.422
1,1,1,2 tetrachloroethane	1070	167.85	96.63	0.0423	9.1E-06	12	0.0989
1,2-dibromo-3-chloropropane	1230	236.33	130	0.0212	7.0E-06	0.58	0.006

Vapour Transport Calculations	Deff Layer 1 (cm ² /s)	Deff Layer 2 (cm ² /s)	Deff Foundations and Cracks (cm ² /s)	Total Effective Diffusion (Subsurface soil to surface) (cm ² /s)
1,2-dichloroethane	1.47E-3	1.47E-3	1.13E-2	1.47E-3
cis-1,2-dichloroethene	1.04E-3	1.04E-3	8.03E-3	1.04E-3
hexachlorobenzene	7.67E-4	7.67E-4	5.91E-3	7.67E-4
1,2-hexachlorobutadiene	7.91E-4	7.91E-4	6.12E-3	7.91E-4
hexachlorobutadiene	7.91E-4	7.91E-4	6.12E-3	7.91E-4
methylene chloride	1.43E-3	1.43E-3	1.10E-2	1.43E-3
octachlorostyrene	6.97E-4	6.97E-4	5.21E-3	6.97E-4
pentachlorobutadiene	8.77E-4	8.77E-4	6.78E-3	8.77E-4
tetrachlorobutadiene	8.70E-4	8.70E-4	6.73E-3	8.70E-4
tetrachloroethene	1.02E-3	1.02E-3	7.85E-3	1.02E-3
1,1,2-trichloroethane	1.11E-3	1.11E-3	8.51E-3	1.11E-3
trichloroethene	1.11E-3	1.11E-3	8.61E-3	1.11E-3
1,1,1,2 tetrachloroethane	5.99E-4	5.99E-4	4.61E-3	5.99E-4
1,2-dibromo-3-chloropropane	3.36E-4	3.36E-4	2.32E-3	3.36E-4

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Subsurface Soils Phase Partitioning Results	Soil Concentration (mg/kg)	Vapour Phase Concentration (g/cm ³)	Saturated Soil Concentration (mg/kg)	Saturated Vapour Concentration (g/cm ³)	Free Phase Mole Fraction (mol/mol)	Concentration above Free Phase (g/cm ³)	Calculation Vapour Phase used in Calculation (g/cm ³)
1,2-dichloroethane	230	5.9E-05	1.3E+03	4.3E-04	0	0.0E+00	5.9E-05
cis-1,2-dichloroethene	450	3.4E-04	7.7E+02	9.6E-04	0	0.0E+00	3.4E-04
hexachlorobenzene	5000	2.9E-03	7.1E-04	1.7E-10	0	0.0E+00	1.7E-10
1,2-hexachlorobutadiene	5000	1.3E-04	3.1E+01	2.2E-06	0	0.0E+00	2.2E-06
hexachlorobutadiene	5000	1.3E-04	3.1E+01	2.2E-06	0	0.0E+00	2.2E-06
methylene chloride	5000	3.2E-03	1.9E+03	1.6E-03	0	0.0E+00	1.6E-03
octachlorostyrene	5000	4.4E-08	1.0E+00	2.7E-10	0	0.0E+00	2.7E-10
pentachlorobutadiene	5000	1.3E-04	3.1E+01	1.9E-06	0	0.0E+00	1.9E-06
tetrachlorobutadiene	5000	1.3E-04	3.1E+01	1.6E-06	0	0.0E+00	1.6E-06
tetrachloroethene	5000	6.0E-03	1.2E+02	1.7E-04	0	0.0E+00	1.7E-04
1,1,2-trichloroethane	1000	1.2E-04	3.4E+02	1.7E-04	0	0.0E+00	1.2E-04
trichloroethene	70	4.7E-05	6.9E+02	5.4E-04	0	0.0E+00	4.7E-05
1,1,1,2 tetrachloroethane	5000	1.2E-03	4.3E+02	1.1E-04	0	0.0E+00	1.1E-04
1,2-dibromo-3-chloropropane	600	7.3E-06	6.0E+02	7.6E-06	0	0.0E+00	7.3E-06

Calculated Air Concentrations ASTM Guidance for Subsurface Soils	Vapour Phase Concentration at Source (g/cm ³)	Emission Rate from Surface of Ground (g/s)	Enclosed Space Concentration (mg/m ³)	Outdoor Air Concentration (mg/m ³)
1,2-dichloroethane	5.9E-05	4.38E-04		1.2E-02
cis-1,2-dichloroethene	3.4E-04	1.78E-03		4.9E-02
hexachlorobenzene	1.7E-10	6.64E-10		1.8E-08
1,2-hexachlorobutadiene	2.2E-06	8.56E-06		2.3E-04
hexachlorobutadiene	2.2E-06	8.56E-06		2.3E-04
methylene chloride	1.6E-03	1.17E-02		3.2E-01
octachlorostyrene	2.7E-10	9.52E-10		2.6E-08
pentachlorobutadiene	1.9E-06	8.24E-06		2.3E-04
tetrachlorobutadiene	1.6E-06	6.93E-06		1.9E-04
tetrachloroethene	1.7E-04	8.61E-04		2.4E-02
1,1,2-trichloroethane	1.2E-04	6.77E-04		1.9E-02
trichloroethene	4.7E-05	2.61E-04		7.2E-03
1,1,1,2 tetrachloroethane	1.1E-04	3.34E-04		9.2E-03
1,2-dibromo-3-chloropropane	7.3E-06	1.23E-05		3.4E-04

Inhalation of Volatile Chemicals

General Data/ Equations		Exposure Parameters (RME) Inhalation Indoors by Worker						Exposure Parameters (RME) Inhalation Outdoors by Worker					
Exposure Parameters													
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays					240	Exposure for 5 days per week minus 4 weeks holidays				
Exposure Duration (ED)	years	30	Duration of exposure as per NEPM 1999 and USEPA 1989					30	Duration of exposure as per NEPM 1999 and USEPA 1989				
Body Weight (BW)	kg	70	USEPA 1989 and CSMS 1996					70	USEPA 1989 and CSMS 1996				
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996					25550	USEPA 1989 and CSMS 1996				
Averaging Time - Threshold (ATn)	days	10950	USEPA 1989 and CSMS 1996					10950	USEPA 1989 and CSMS 1996				
Inhalation Rate (InhR)	m ³ /hr	1.17	Inhalation rate indoors for adults as per enHealth 2002					2.20	Inhalation rate for adults outdoors similar to walking as per CSMS 1996				
Exposure Time (ET)	hr/day	9	Time spent indoors at work					1	Time spent outdoors at work				
Fraction Inhaled from Contaminated Source (FI)	-	1	Assume all of workplace above groundwater/soils					1	Assume all of workplace above groundwater/soils				
	(mg/kg-day) ^a	(mg/kg/day)	(mg/m ³)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	(mg/m ³)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	(unitless)
1,2-dichloroethane	9.8E-03		2.44E-03	1.0E-04	2.4E-04	--	--	1.20E-02	1.1E-04	2.48E-04	1.0E-6	--	--
cis-1,2-dichloroethene		1.0E-02	1.02E-02	4.3E-04	1.0E-03	--	1.0E-1	4.88E-02	4.3E-04	1.01E-03	--	--	1.0E-1
hexachlorobenzene		1.6E-04	2.51E-07	1.1E-08	2.5E-08	--	1.6E-4	1.82E-08	1.6E-10	3.77E-10	--	--	2.4E-6
1,2 hexachlorobutadiene		2.0E-04	2.02E-04	8.5E-06	2.0E-05	--	1.0E-1	2.35E-04	2.1E-06	4.85E-06	--	--	2.4E-2
hexachlorobutadiene		2.0E-04	2.02E-04	8.5E-06	2.0E-05	--	1.0E-1	2.35E-04	2.1E-06	4.85E-06	--	--	2.4E-2
methylene chloride		2.3E-01	2.31E-01	9.8E-03	2.3E-02	--	1.0E-1	3.21E-01	2.8E-03	6.64E-03	--	--	2.9E-2
octachlorostyrene		3.1E-04	3.50E-07	1.5E-08	3.5E-08	--	1.1E-4	2.61E-08	2.3E-10	5.39E-10	--	--	1.7E-6
pentachlorobutadiene		2.0E-04	2.01E-04	8.5E-06	2.0E-05	--	1.0E-1	2.26E-04	2.0E-06	4.67E-06	--	--	2.3E-2
tetrachlorobutadiene		2.0E-04	2.00E-04	8.5E-06	2.0E-05	--	9.9E-2	1.90E-04	1.7E-06	3.93E-06	--	--	2.0E-2
tetrachloroethene		3.8E-02	3.73E-02	1.6E-03	3.7E-03	--	9.8E-2	2.36E-02	2.1E-04	4.88E-04	--	--	1.3E-2
1,1,2-trichloroethane		4.0E-03	4.09E-03	1.7E-04	4.0E-04	--	1.0E-1	1.86E-02	1.6E-04	3.84E-04	--	--	9.6E-2
trichloroethene	1.5E-03	1.5E-03	1.41E-03	6.0E-05	1.4E-04	9.0E-8	9.6E-2	7.16E-03	6.3E-05	1.48E-04	9.5E-8	--	1.0E-1
1,1,1,2 tetrachloroethane		3.0E-02	3.10E-02	1.3E-03	3.1E-03	--	1.0E-1	9.16E-03	8.1E-05	1.89E-04	--	--	6.3E-3
1,2-dibromo-3-chloropropane	2.4E-03		7.02E-05	3.0E-06	6.9E-06	7.1E-9	--	3.39E-04	3.0E-06	7.00E-06	7.2E-9	--	--

Modelled assuming soils present beneath slab

Modelled based on vapour migration outdoors (no concrete) and particulate emissions
Particulates conservatively assumed to be inspirable and all reach lungs

Appendix C4

RSBC 3m

Toxicity and Dermal Absorption Parameters

Chemical	Non-Threshold Slope Factor				Threshold ADI, TDI or Reference Dose				Background Intake				
	Oral (mg/kg/day) ¹		Inhalation (mg/kg/day) ¹		Dermal (mg/kg/day) ¹		Oral (mg/kg/day)			Inhalation (mg/kg/day)		Dermal (mg/kg/day)	
1,2-dichloroethane	1.20E-02	NHMRC	9.80E-03	NHMRC	1.20E-02	R					0.00E+00	R	0%
cis-1,2-dichloroethene							1.00E-02	HEAST	1.00E-02	R	1.00E-02	R	0%
hexachlorobenzene							1.60E-04	WHO	1.6E-04	R	1.60E-04	R	0%
1,2-hexachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
hexachlorobutadiene							2.00E-04	NHMRC	2.0E-04	R	2.00E-04	R	0%
methylene chloride							1.20E-03	NHMRC	2.9E-01	ATSDR	1.20E-03	R	20%
octachlorostyrene							3.10E-04	Health Canada	3.10E-04	R	3.10E-04	R	0%
pentachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
tetrachlorobutadiene							2.00E-04	S	2.0E-04	R	2.00E-04	R	0%
tetrachloroethene							1.40E-02	WHO	5.71E-02	WHO	1.40E-02	R	34%
1,1,2-trichloroethane							4.00E-03	USEPA	4.00E-03	R	4.00E-03	R	0%
trichloroethene			1.51E-03	WHO			1.46E-03	WHO	1.46E-03	R	1.46E-03	R	0%
1,1,1,2 tetrachloroethane							3.00E-02	USEPA	3.00E-02	WHO	3.00E-02		0%
1,2-dibromo-3-chloropropane	3.50E-01	WHO	2.40E-03	USEPA	3.50E-01	R							0%

Calculation of Vapour Concentrations from Groundwater Source Guidance from ASTM (1996)

Constituent	Concentration in soil (mg/kg)	NonThreshold Risk (unitless)	Threshold Hazard (unitless)	Target NonThreshold Risk (unitless)	Target Threshold Hazard (unitless)
1,2-dichloroethane	3.5	1.0E-06	--	1E-06	
cis-1,2-dichloroethene	6.8	--	0.10		0.10
hexachlorobenzene	5000	--	0.00		0.10
1,2-hexachlorobutadiene	5	--	0.10		0.10
hexachlorobutadiene	5	--	0.10		0.10
methylene chloride	135	--	0.10		0.10
octachlorostyrene	5000	--	0.00		0.10
pentachlorobutadiene	4.5	--	0.10		0.10
tetrachlorobutadiene	4.5	--	0.10		0.10
tetrachloroethene	17	--	0.10		0.10
1,1,2-trichloroethane	16	--	0.10		0.10
trichloroethene	1.1	9.6E-08	0.10		
1,1,1,2 tetrachloroethane	110	--	0.10		
1,2-dibromo-3-chloropropane	10	6.9E-09	--	1E-06	

Calculation of Vapour Concentrations from Groundwater Source Guidance from ASTM (1996)

Constituent	Concentration in soil (mg/kg)	NonThreshold Risk (unitless)	Threshold Hazard (unitless)	Target NonThreshold Risk (unitless)	Target Threshold Hazard (unitless)
1,2-dichloroethane	330	1.0E-06		1E-06	
cis-1,2-dichloroethene	660	--	0.10		0.10
hexachlorobenzene	5000	--	0.00		0.10
1,2-hexachlorobutadiene	5000	--	0.02		0.10
hexachlorobutadiene	5000	--	0.02		0.10
methylene chloride	5000	--	0.02		0.10
octachlorostyrene	5000	--	0.00		0.10
pentachlorobutadiene	5000	--	0.02		0.10
tetrachlorobutadiene	5000	--	0.01		0.10
tetrachloroethene	5000	--	0.01		0.10
1,1,2-trichloroethane	5000	--	0.09		0.10
trichloroethene	100	9.1E-08	0.10		0.10
1,1,1,2 tetrachloroethane	5000	--	0.00		0.10
1,2-dibromo-3-chloropropane	5000	5.0E-09	--	1E-06	0.10

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Vapour Migration Indoors				
Site Specific Physical Input Parameters	Units	Abbrev.	Value	Comments
Depth of Top of Contaminated Soil (BGS)	[m]	d	3.01	Calculated from layers
Thickness of Surface Contamination	[m]	surfd	6	Estimated for soil types
Soil Temperature	[C]	T	17	site-specific assumption
<u>Vadose Zone Characteristics of Top Layer</u>				
Depth of Layer 1	[m]	vd1	0.01	<u>Sandy Gravel</u> Assumed depth of fill under foundation
Moisture Content	[g/g]	mocon	0.1	Assumption for sandy gravel
Organic Carbon Fraction	-	foc	0.01	Assumption for sandy gravel
Soil Bulk Density	[g/cm ³]	rhob	1.6	Assumption for sandy gravel
Density of Solids	[g/cm ³]	sd	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta	0.40	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon	0.160	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon	0.236	theta-wacon
<u>Vadose Zone Characteristics at and above Source</u>				
Depth of Layer 2	[m]	vd2	3	<u>Ash Sand</u> Assumed soil type of remediated soils
Moisture Content	[g/g]	mocon2	0.1	Assumption for Sandy Clay
Organic Carbon Fraction	-	foc2	0.003	Assumption for Sandy Clay
Soil Bulk Density	[g/cm ³]	rhob2	1.8	Assumption for Sandy Clay
Density of Solids	[g/cm ³]	sd2	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta2	0.32	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon2	0.180	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon2	0.141	theta-wacon
Receptor Specific Input Parameters	Units	Abbrev.	Value	Comments
<u>Building Characteristics</u>				
Area of Emission - Building Area	[m ²]	emarea	100.0	assumed area of the room
Foundation/wall thickness	[m]	fthick	0.15	Default Value
Height of Room	[m]	boxh	3	Typical height for commercial premises
Hourly Volume Exchange of Fresh Air	[exch/hr]	exchanges	2	Minimum for commercial bldgs AS1668.2
Fraction of Cracks in Walls and foundation	-	cracks	0.001	Value for sound concrete with no vapour barrier
Volumetric Water Content in foundation/wall cracks	[cm ³ /cm ³]	fwacon	0.12	Default Value
Volumetric Air Content in foundation/wall cracks	[cm ³ /cm ³]	facon	0.260	Default Value

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Chemical Specific Parameters	Water Solubility (mg/L)	MW (g/mol)	Koc (cm ³ /g)	Air Diffusion Coefficient (cm ² /s)	Water Diffusion Coefficient (cm ² /s)	Vapour Pressure (mmHg)	Henry's Law Constant (unitless)
1,2-dichloroethane	8690	98.96	17.4	0.104	9.9E-06	79.1	0.0401
cis-1,2-dichloroethene	3500	96.95	35.5	0.0736	1.1E-05	180	0.167
hexachlorobenzene	0.006	284.79	4.5	0.0542	5.9E-06	0.000011	0.0695
1,2-hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachloroethane	50	236.74	1820	0.0025	6.8E-06	0.4	0.114
methylene chloride	13200	84.93	11.7	0.101	1.2E-05	349	0.0898
octachlorostyrene	0.00174	379.68	200000	0.048	4.1E-06	1.30E-05	0.0053
pentachlorobutadiene	2	226.32	5181	0.0622	5.6E-06	0.15	0.421
tetrachlorobutadiene	2	191.87	5181	0.0617	5.5E-06	0.15	0.421
tetrachloroethene	200	165.83	155	0.072	8.2E-06	18.5	0.754
1,1,2-trichloroethane	1100	133.41	67.7	0.078	8.8E-06	22.49	0.0374
trichloroethene	1100	131.4	166	0.079	9.1E-06	74	0.422
1,1,1,2 tetrachloroethane	1070	167.85	96.63	0.0423	9.1E-06	12	0.0989
1,2-dibromo-3-chloropropane	1230	236.33	130	0.0212	7.0E-06	0.58	0.006

Vapour Transport Calculations	Deff Layer 1 (cm ² /s)	Deff Layer 2 (cm ² /s)	Deff Foundations and Cracks (cm ² /s)	Total Effective Diffusion (Subsurface soil to surface) (cm ² /s)
1,2-dichloroethane	5.40E-3	1.47E-3	7.43E-3	1.48E-3
cis-1,2-dichloroethene	3.82E-3	1.04E-3	5.26E-3	1.04E-3
hexachlorobenzene	2.81E-3	7.67E-4	3.87E-3	7.69E-4
1,2-hexachlorobutadiene	2.91E-3	7.91E-4	4.01E-3	7.93E-4
hexachlorobutadiene	2.91E-3	7.91E-4	4.01E-3	7.93E-4
methylene chloride	5.24E-3	1.43E-3	7.22E-3	1.43E-3
octachlorostyrene	2.49E-3	6.97E-4	3.41E-3	6.99E-4
pentachlorobutadiene	3.23E-3	8.77E-4	4.44E-3	8.80E-4
tetrachlorobutadiene	3.20E-3	8.70E-4	4.41E-3	8.73E-4
tetrachloroethene	3.74E-3	1.02E-3	5.14E-3	1.02E-3
1,1,2-trichloroethane	4.05E-3	1.11E-3	5.57E-3	1.11E-3
trichloroethene	4.10E-3	1.11E-3	5.65E-3	1.12E-3
1,1,1,2 tetrachloroethane	2.20E-3	5.99E-4	3.02E-3	6.01E-4
1,2-dibromo-3-chloropropane	1.12E-3	3.36E-4	1.52E-3	3.37E-4

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Subsurface Soils Phase Partitioning Results	Soil Concentration (mg/kg)	Vapour Phase Concentration (g/cm ³)	Saturated Soil Concentration (mg/kg)	Saturated Vapour Concentration (g/cm ³)	Free Phase Mole Fraction (mol/mol)	Concentration above Free Phase (g/cm ³)	Calculation Vapour Phase used in Calculation (g/cm ³)
1,2-dichloroethane	3.5	9.0E-07	1.3E+03	4.3E-04	0	0.0E+00	9.0E-07
cis-1,2-dichloroethene	6.8	5.2E-06	7.7E+02	9.6E-04	0	0.0E+00	5.2E-06
hexachlorobenzene	5000	2.9E-03	7.1E-04	1.7E-10	0	0.0E+00	1.7E-10
1,2-hexachlorobutadiene	5	1.3E-07	3.1E+01	2.2E-06	0	0.0E+00	1.3E-07
hexachlorobutadiene	5	1.3E-07	3.1E+01	2.2E-06	0	0.0E+00	1.3E-07
methylene chloride	135	8.5E-05	1.9E+03	1.6E-03	0	0.0E+00	8.5E-05
octachlorostyrene	5000	4.4E-08	1.0E+00	2.7E-10	0	0.0E+00	2.7E-10
pentachlorobutadiene	4.5	1.2E-07	3.1E+01	1.9E-06	0	0.0E+00	1.2E-07
tetrachlorobutadiene	4.5	1.2E-07	3.1E+01	1.6E-06	0	0.0E+00	1.2E-07
tetrachloroethene	17	2.1E-05	1.2E+02	1.7E-04	0	0.0E+00	2.1E-05
1,1,2-trichloroethane	16	2.0E-06	3.4E+02	1.7E-04	0	0.0E+00	2.0E-06
trichloroethene	1.1	7.4E-07	6.9E+02	5.4E-04	0	0.0E+00	7.4E-07
1,1,1,2 tetrachloroethane	110	2.7E-05	4.3E+02	1.1E-04	0	0.0E+00	2.7E-05
1,2-dibromo-3-chloropropane	10	1.2E-07	6.0E+02	7.6E-06	0	0.0E+00	1.2E-07

Calculated Air Concentrations ASTM Guidance for Subsurface Soils	Vapour Phase Concentration at Source (g/cm ³)	Emission Rate from Surface of Ground (g/s)	Enclosed Space Concentration (mg/m ³)	Outdoor Air Concentration (mg/m ³)
1,2-dichloroethane	9.0E-07	4.44E-06	2.4E-03	
cis-1,2-dichloroethene	5.2E-06	1.79E-05	9.9E-03	
hexachlorobenzene	1.7E-10	4.42E-10	2.4E-07	
1,2-hexachlorobutadiene	1.3E-07	3.54E-07	2.0E-04	
hexachlorobutadiene	1.3E-07	3.54E-07	2.0E-04	
methylene chloride	8.5E-05	4.06E-04	2.2E-01	
octachlorostyrene	2.7E-10	6.34E-10	3.4E-07	
pentachlorobutadiene	1.2E-07	3.53E-07	2.0E-04	
tetrachlorobutadiene	1.2E-07	3.50E-07	1.9E-04	
tetrachloroethene	2.1E-05	6.95E-05	3.8E-02	
1,1,2-trichloroethane	2.0E-06	7.21E-06	4.0E-03	
trichloroethene	7.4E-07	2.73E-06	1.5E-03	
1,1,1,2 tetrachloroethane	2.7E-05	5.46E-05	3.0E-02	
1,2-dibromo-3-chloropropane	1.2E-07	1.37E-07	6.8E-05	

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Site Specific Physical Input Parameters	Units	Abbrev.	Value	Comments
Depth of Top of Contaminated Soil (BGS)	[m]	d	3	Calculated from layers
Thickness of Surface Contamination	[m]	surfd	6	Estimated for soil types
Soil Temperature	[C]	T	17	site-specific assumption
<u>Vadose Zone Characteristics of Top Layer</u>				<u>Ash Sand</u>
Depth of Layer 1	[m]	vd1	3	Assumed soil type of remediated soils
Moisture Content	[g/g]	mocon	0.1	Assumption for Sandy Clay
Organic Carbon Fraction	-	foc	0.003	Assumption for Sandy Clay
Soil Bulk Density	[g/cm ³]	rhob	1.8	Assumption for Sandy Clay
Density of Solids	[g/cm ³]	sd	2.65	Default
Total Soil Porosity	[cm ³ /cm ³]	theta	0.32	1 - (rhob/sd)
Volumetric Water Content	[cm ³ /cm ³]	wacon	0.180	mocon*rhob
Volumetric Air Content	[cm ³ /cm ³]	acon	0.141	theta-wacon
Receptor Specific Input Parameters	Units	Abbrev.	Value	Comments
<u>Outdoor Air Characteristics</u>				
Length of Contaminated Area	[m]	length	20	site-specific assumption
Width of Contaminated Area	[m]	width	20	site-specific assumption
Wind Speed Outdoors	[m/s]	wspd	4.86	Average of 9am/3pm mean windspeed Sydney Airport
Height of Outdoor Mixing Zone	[m]	outboxh	1.5	Default Value

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Chemical Specific Parameters	Water Solubility (mg/L)	MW (g/mol)	Koc (cm ² /g)	Air Diffusion Coefficient (cm ² /s)	Water Diffusion Coefficient (cm ² /s)	Vapour Pressure (mmHg)	Henry's Law Constant (unitless)
1,2-dichloroethane	8690	98.96	17.4	0.104	9.9E-06	79.1	0.0401
cis-1,2-dichloroethene	3500	96.95	35.5	0.0736	1.1E-05	180	0.167
hexachlorobenzene	0.006	284.79	4.5	0.0542	5.9E-06	0.000011	0.0695
1,2-hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
hexachlorobutadiene	2	260.76	5181	0.0561	6.2E-06	0.15	0.421
methylene chloride	13200	84.93	11.7	0.101	1.2E-05	349	0.0898
octachlorostyrene	0.00174	379.68	200000	0.048	4.1E-06	1.30E-05	0.0053
pentachlorobenzene	0.831	250.34	2002	0.057	6.3E-06	0.00101	0.0287
pentachlorobutadiene	2	226.32	5181	0.0622	5.6E-06	0.15	0.421
tetrachlorobutadiene	2	191.87	5181	0.0617	5.5E-06	0.15	0.421
tetrachloroethene	200	165.83	155	0.072	8.2E-06	18.5	0.754
1,1,2-trichloroethane	1100	133.41	67.7	0.078	8.8E-06	22.49	0.0374
trichloroethene	1100	131.4	166	0.079	9.1E-06	74	0.422
1,1,1,2 tetrachloroethane	1070	167.85	96.63	0.0423	9.1E-06	12	0.0989
1,2-dibromo-3-chloropropane	1230	236.33	130	0.0212	7.0E-06	0.58	0.006

Vapour Transport Calculations	Deff Layer 1 (cm ² /s)	Deff Layer 2 (cm ² /s)	Deff Foundations and Cracks (cm ² /s)	Total Effective Diffusion (Subsurface soil to surface) (cm ² /s)
1,2-dichloroethane	1.47E-3	1.47E-3	1.13E-2	1.47E-3
cis-1,2-dichloroethene	1.04E-3	1.04E-3	8.03E-3	1.04E-3
hexachlorobenzene	7.67E-4	7.67E-4	5.91E-3	7.67E-4
1,2-hexachlorobutadiene	7.91E-4	7.91E-4	6.12E-3	7.91E-4
hexachlorobutadiene	7.91E-4	7.91E-4	6.12E-3	7.91E-4
methylene chloride	1.43E-3	1.43E-3	1.10E-2	1.43E-3
octachlorostyrene	6.97E-4	6.97E-4	5.21E-3	6.97E-4
pentachlorobutadiene	8.77E-4	8.77E-4	6.78E-3	8.77E-4
tetrachlorobutadiene	8.70E-4	8.70E-4	6.73E-3	8.70E-4
tetrachloroethene	1.02E-3	1.02E-3	7.85E-3	1.02E-3
1,1,2-trichloroethane	1.11E-3	1.11E-3	8.51E-3	1.11E-3
trichloroethene	1.11E-3	1.11E-3	8.61E-3	1.11E-3
1,1,1,2 tetrachloroethane	5.99E-4	5.99E-4	4.61E-3	5.99E-4
1,2-dibromo-3-chloropropane	3.36E-4	3.36E-4	2.32E-3	3.36E-4

**VAPOUR PARTITIONING, EMISSION AND AIR DISPERSION MODEL FOR CONTAMINATED SOILS
UTILISING ASTM GUIDANCE E 1739-95E**

Subsurface Soils Phase Partitioning Results	Soil Concentration (mg/kg)	Vapour Phase Concentration (g/cm ³)	Saturated Soil Concentration (mg/kg)	Saturated Vapour Concentration (g/cm ³)	Free Phase Mole Fraction (mol/mol)	Concentration above Free Phase (g/cm ³)	Calculation Vapour Phase used in Calculation (g/cm ³)
1,2-dichloroethane	330	8.5E-05	1.3E+03	4.3E-04	0	0.0E+00	8.5E-05
cis-1,2-dichloroethene	660	5.0E-04	7.7E+02	9.6E-04	0	0.0E+00	5.0E-04
hexachlorobenzene	5000	2.9E-03	7.1E-04	1.7E-10	0	0.0E+00	1.7E-10
1,2-hexachlorobutadiene	5000	1.3E-04	3.1E+01	2.2E-06	0	0.0E+00	2.2E-06
hexachlorobutadiene	5000	1.3E-04	3.1E+01	2.2E-06	0	0.0E+00	2.2E-06
methylene chloride	5000	3.2E-03	1.9E+03	1.6E-03	0	0.0E+00	1.6E-03
octachlorostyrene	5000	4.4E-08	1.0E+00	2.7E-10	0	0.0E+00	2.7E-10
pentachlorobutadiene	5000	1.3E-04	3.1E+01	1.9E-06	0	0.0E+00	1.9E-06
tetrachlorobutadiene	5000	1.3E-04	3.1E+01	1.6E-06	0	0.0E+00	1.6E-06
tetrachloroethene	5000	6.0E-03	1.2E+02	1.7E-04	0	0.0E+00	1.7E-04
1,1,2-trichloroethane	5000	6.1E-04	3.4E+02	1.7E-04	0	0.0E+00	1.7E-04
trichloroethene	100	6.7E-05	6.9E+02	5.4E-04	0	0.0E+00	6.7E-05
1,1,1,2 tetrachloroethane	5000	1.2E-03	4.3E+02	1.1E-04	0	0.0E+00	1.1E-04
1,2-dibromo-3-chloropropane	5000	6.1E-05	6.0E+02	7.6E-06	0	0.0E+00	7.6E-06

Calculated Air Concentrations ASTM Guidance for Subsurface Soils	Vapour Phase Concentration at Source (g/cm ³)	Emission Rate from Surface of Ground (g/s)	Enclosed Space Concentration (mg/m ³)	Outdoor Air Concentration (mg/m ³)
1,2-dichloroethane	8.5E-05	4.19E-04		1.1E-02
cis-1,2-dichloroethene	5.0E-04	1.74E-03		4.8E-02
hexachlorobenzene	1.7E-10	4.43E-10		1.2E-08
1,2-hexachlorobutadiene	2.2E-06	5.71E-06		1.6E-04
hexachlorobutadiene	2.2E-06	5.71E-06		1.6E-04
methylene chloride	1.6E-03	7.80E-03		2.1E-01
octachlorostyrene	2.7E-10	6.34E-10		1.7E-08
pentachlorobutadiene	1.9E-06	5.49E-06		1.5E-04
tetrachlorobutadiene	1.6E-06	4.62E-06		1.3E-04
tetrachloroethene	1.7E-04	5.74E-04		1.6E-02
1,1,2-trichloroethane	1.7E-04	6.12E-04		1.7E-02
trichloroethene	6.7E-05	2.48E-04		6.8E-03
1,1,1,2 tetrachloroethane	1.1E-04	2.23E-04		6.1E-03
1,2-dibromo-3-chloropropane	7.6E-06	8.50E-06		2.3E-04

Inhalation of Volatile Chemicals

General Data/ Equations		Exposure Parameters (RME) Inhalation Indoors by Worker						Exposure Parameters (RME) Inhalation Outdoors by Worker					
Exposure Parameters													
Exposure Frequency (EF)	days/year	240	Exposure for 5 days per week minus 4 weeks holidays					240	Exposure for 5 days per week minus 4 weeks holidays				
Exposure Duration (ED)	years	30	Duration of exposure as per NEPM 1999 and USEPA 1989					30	Duration of exposure as per NEPM 1999 and USEPA 1989				
Body Weight (BW)	kg	70	USEPA 1989 and CSMS 1996					70	USEPA 1989 and CSMS 1996				
Averaging Time - NonThreshold (ATc)	days	25550	USEPA 1989 and CSMS 1996					25550	USEPA 1989 and CSMS 1996				
Averaging Time - Threshold (ATn)	days	10950	USEPA 1989 and CSMS 1996					10950	USEPA 1989 and CSMS 1996				
Inhalation Rate (InhR)	m ³ /hr	1.17	Inhalation rate indoors for adults as per enHealth 2002					2.20	Inhalation rate for adults outdoors similar to walking as per CSMS 1996				
Exposure Time (ET)	hr/day	9	Time spent indoors at work					1	Time spent outdoors at work				
Fraction Inhaled from Contaminated Source (FI)	-	1	Assume all of workplace above groundwater/soils					1	Assume all of workplace above groundwater/soils				
	(mg/kg-day) ^a	(mg/kg/day)	(mg/m ³)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	(mg/m ³)	(mg/kg/day)	(mg/kg/day)	(unitless)	(unitless)	
1,2-dichloroethane	9.8E-03		2.44E-03	1.0E-04	2.4E-04	1.0E-6	--	1.15E-02	1.0E-04	2.37E-04	1.0E-6	--	
cis-1,2-dichloroethene		1.0E-02	9.88E-03	4.2E-04	9.8E-04	--	9.8E-2	4.77E-02	4.2E-04	9.87E-04	--	9.9E-2	
hexachlorobenzene		1.6E-04	2.44E-07	1.0E-08	2.4E-08	--	1.5E-4	1.21E-08	1.1E-10	2.51E-10	--	1.6E-6	
1,2 hexachlorobutadiene		2.0E-04	1.96E-04	8.3E-06	1.9E-05	--	9.7E-2	1.57E-04	1.4E-06	3.24E-06	--	1.6E-2	
hexachlorobutadiene		2.0E-04	1.96E-04	8.3E-06	1.9E-05	--	9.7E-2	1.57E-04	1.4E-06	3.24E-06	--	1.6E-2	
methylene chloride		2.3E-01	2.24E-01	9.5E-03	2.2E-02	--	9.7E-2	2.14E-01	1.9E-03	4.42E-03	--	1.9E-2	
octachlorostyrene		3.1E-04	3.39E-07	1.4E-08	3.4E-08	--	1.1E-4	1.74E-08	1.5E-10	3.60E-10	--	1.2E-6	
pentachlorobutadiene		2.0E-04	1.95E-04	8.3E-06	1.9E-05	--	9.6E-2	1.51E-04	1.3E-06	3.11E-06	--	1.6E-2	
tetrachlorobutadiene		2.0E-04	1.94E-04	8.2E-06	1.9E-05	--	9.6E-2	1.27E-04	1.1E-06	2.62E-06	--	1.3E-2	
tetrachloroethene		3.8E-02	3.84E-02	1.6E-03	3.8E-03	--	1.0E-1	1.58E-02	1.4E-04	3.26E-04	--	8.6E-3	
1,1,2-trichloroethane		4.0E-03	3.96E-03	1.7E-04	3.9E-04	--	9.8E-2	1.68E-02	1.5E-04	3.47E-04	--	8.7E-2	
trichloroethene	1.5E-03		1.51E-03	6.4E-05	1.5E-04	9.6E-8	1.0E-1	6.82E-03	6.0E-05	1.41E-04	9.1E-8	9.6E-2	
1,1,1,2 tetrachloroethane		3.0E-02	3.01E-02	1.3E-03	3.0E-03	--	9.9E-2	6.11E-03	5.4E-05	1.26E-04	--	4.2E-3	
1,2-dibromo-3-chloropropane	2.4E-03		6.83E-05	2.9E-06	6.8E-06	6.9E-9	--	2.33E-04	2.1E-06	4.82E-06	5.0E-9	--	

Modelled assuming soils present beneath slab

Modelled based on vapour migration outdoors (no concrete) and particulate emissions
Particulates conservatively assumed to be inspirable and all reach lungs