

APPENDIX K

CANCER RISK ESTIMATES USING PROPOSED DIOXIN CSF

**TABLE K.1
CANCER RISK SUMMARY
TRESPASSER EXPOSURE SURFACE** SOIL/SLUDGE AREA 1 - 9-18 YEARS OLD
ENGINEERING EVALUATION/COST ANALYSIS
MOHAWK TANNERY SITE
NASHUA, NEW HAMPSHIRE**

COPCs	EPC mg/kg	Max or UCL	Location of Maximum detected Concentration	Oral ABS ¹	Source	Dermal ABS ^{1,2}	Oral Exposure Factor d ⁻¹	Dermal Exposure Factor d ⁻¹	CSFadm ³ mg/kg-d	GI ABS used in toxicity study ⁴	CSFabs ⁵ mg/kg-d	Ingestion Cancer Risk	Dermal Cancer Risk	Total Cancer Risk
4-Methylphenol	1300	Max		*		0.1	2.04E-08	2.19E-05		1.00E+00				
Methylnaphthalene	21	Max		*		0.13	2.04E-08	2.84E-05		1.00E+00				
Pentachlorophenol	32	Max		*		0.25	2.04E-08	5.47E-05	1.20E-01	1.00E+00	1.20E-01	7.82E-08	2.10E-04	2.10E-04
Dioxin TEQ	0.0016	Max		0.5	⁶	0.03	1.02E-08	6.56E-06	1.00E+06	1.00E+00	1.00E+06	1.63E-05	1.05E-02	1.05E-02
Antimony	4	Max		*			2.04E-08			1.50E-01				
Arsenic	7.6	Max		1	⁷	0.03	2.04E-08	6.56E-06	1.50E+00	1.00E+00	1.50E+00	2.32E-07	7.48E-05	7.50E-05
Chromium	25200	Max		*			2.04E-08			1.30E-02				
Manganese	13300	Max		*			2.04E-08			4.00E-02				
														1.08E-02

NOTES:

Oral Exposure Factor = Ingestion Rate * Fraction Ingested * Exposure Frequency * Exposure Duration * ABS_{oral} * Conversion Factor / Body Weight * Averaging Time
= (100 mg-y/kg-d * 1 * 26 d/y * 10 y * ABS_{oral} * 10-6 kg/mg)/(50 kg * 70 y * 365 d/y)

Dermal Exposure Factor = Exposed Surface Area * Soil Adherence Factor * Exposure Frequency * Exposure Duration * ABS_{dermal} * Conversion Factor / Body Weight * Averaging Time
= (4650 cm² * 231 mg/cm²-ev * 1 ev/d * 26 d/y * 10 y * ABS_{dermal} * 10-6 kg/mg)/(50 kg * 70y * 365 d/y)

CSFabs = CSFadm / GI ABS used in toxicity study

Cancer Risk = EPC*Exposure Factor*CSF

1 Oral ABS and Dermal ABS are absorption factors based on exposures to soils.

2 Table 3.4 US EPA, 2001 RAGS E, Dermal Risk Assessment Guidance.

3 Administered CSFs are used in conjunction with administered oral intakes when oral soil absorption factors are not available.

4 Table 4.1 US EPA, 2001 RAGS E, Dermal Risk Assessment Guidance. These values represent absorption factors for the route of administration used in the toxicity study, generally food or water.

5 Absorbed CSFs are used in conjunction with absorbed intakes when soil absorption factors are available for the route of exposure.

6 Personal communication with A. Burke.

7 USEPA Office of Health and Environmental Assessment, Washington, DC, Relevant Absorption Factors for Risk Assessment, Review Draft, September, 1993.

* At this time there is insufficient data to develop a gastrointestinal absorption value for oral exposure to these compounds from soil. Thus it is assumed that the gastrointestinal absorption from the oral-soil route is equal to the gastrointestinal absorption in the toxicity study. As a result the exposure dose-oral for these compounds is combined with the CSFadministered. When oral GI soil absorption data becomes available for these compounds this information can be used to adjust the exposure dose-oral to an absorbed dose and justify the combination of this variable with an absorbed CSF.

** The sludge samples from Area 1 were composites of materials from 0 to 10-12 feet bgs.

TABLE K.2a
CANCER RISK SUMMARY
TRESPASSER EXPOSURE SURFACE SOIL/SLUDGE AREAS 2-7 - 9-18 YEARS OLD**
ENGINEERING EVALUATION/COST ANALYSIS
MOHAWK TANNERY SITE
NASHUA, NEW HAMPSHIRE

COPCs	EPC mg/kg	Max or UCL	Location of Maximum detected Concentration	Oral ABS ¹	Source	Dermal ABS ^{1,2}	Oral Exposure Factor d ⁻¹	Dermal Exposure Factor d ⁻¹	Inhalation Exposure Factor d ⁻¹	CSFadm ³ mg/kg-d	GI ABS used in toxicity study ⁴	CSFabs ⁵ mg/kg-d	CSFinhal mg/kg-d	Ingestion Cancer Risk	Dermal Cancer Risk	Inhalation Cancer Risk	Total Cancer Risk
Aroclor 1242	0.28	Max		*		0.14	2.04E-08	5.30E-08	7.40E-19	2.00E+00	1.00E+00	2.00E+00	2.00E+00	1.14E-08	2.97E-08	4.14E-19	4.11E-08
Dioxin TEQ	0.0013	Max		0.5	⁶	0.03	1.02E-08	1.14E-08	7.40E-19	1.00E+06	1.00E+00	1.00E+06	1.00E+06	1.32E-05	1.48E-05	9.62E-16	2.80E-05
Antimony	44.4	Max		*			2.04E-08		7.40E-19		1.50E-01						
Arsenic	15.7	Max		1	⁷	0.03	2.04E-08	1.14E-08	7.40E-19	1.50E+00	1.00E+00	1.50E+00	1.50E+01	4.79E-07	2.67E-07	1.74E-16	7.47E-07
Barium	657	Max		*			2.04E-08		7.40E-19		7.00E-02						
Cadmium	16.8	Max		*		0.001	2.04E-08	3.79E-10	7.40E-19		2.50E-02		6.30E+00			7.83E-17	7.83E-17
Lead	427	Max		*			2.04E-08		7.40E-19								
Manganese	207	Max		*			2.04E-08		7.40E-19		4.00E-02						
Mercury	4.5	Max		*			2.04E-08		7.40E-19		1.00E+00						
2.88E-05																	

NOTES:

Oral Exposure Factor = Ingestion Rate * Fraction Ingested * Exposure Frequency * Exposure Duration * ABS_{oral} * Conversion Factor / Body Weight * Averaging Time
= (100 mg-y/kg-d * 1 * 26 d/y * 10 y * ABS_{oral} * 10⁻⁶ kg/mg)/(50 kg * 70 y * 365 d/y)

Dermal Exposure Factor = Exposed Surface Area * Soil Adherence Factor * Exposure Frequency * Exposure Duration * ABS_{dermal} * Conversion Factor / Body Weight * Averaging Time
= (4650 cm² * 0.4 mg/cm²-ev * 1 ev/d * 26 d/y * 10 y * ABS_{dermal} * 10⁻⁶ kg/mg)/(50 kg * 70y * 365 d/y)

Inhalation Exposure Factor = ((1/PEF)*Inhalation Rate * Exposure Time * Exposure Frequency * Exposure Duration) / (Body Weight * Averaging Time)
= ((1/1320000000) * 1.2 m³/hr * 4 hr/d * 26 d/y * 10 y)/(50 kg * 70 y * 365 d/y)

CSFabs = CSFadm / GI ABS used in toxicity study

Cancer Risk = EPC*Exposure Factor*CSF

1 Oral ABS and Dermal ABS are absorption factors based on exposures to soils.

2 Table 3.4 US EPA, 2001 RAGS E, Dermal Risk Assessment Guidance.

3 Administered CSFs are used in conjunction with administered oral intakes when oral soil absorption factors are not available.

4 Table 4.1 US EPA, 2001 RAGS E, Dermal Risk Assessment Guidance. These values represent absorption factors for the route of administration used in the toxicity study, generally food or water.

5 Absorbed CSFs are used in conjunction with absorbed intakes when soil absorption factors are available for the route of exposure.

6 Personal communication with A. Burke.

7 USEPA Office of Health and Environmental Assessment, Washington, DC, Relevant Absorption Factors for Risk Assessment, Review Draft, September, 1993.

* At this time there is insufficient data to develop a gastrointestinal absorption value for oral exposure to these compounds from soil. Thus it is assumed that the gastrointestinal absorption from the oral-soil route is equal to the gastrointestinal absorption in the toxicity study. As a result the exposure dose-oral for these compounds is combined with the CSFadministered. When oral GI soil absorption data becomes available for these compounds this information can be used to adjust the exposure dose-oral to an absorbed dose and justify the combination of this variable with an absorbed CSF.

** Since very few samples were collected from only surface materials (0 to 2 feet bgs) and many of the samples were composites of materials from 0 to as much as 20 feet bgs, the surface dataset includes any sample with a top depth of 0 feet bgs, most samples extending below 2 feet bgs.

**TABLE K.2b
CANCER RISK SUMMARY
FUTURE RESIDENTIAL EXPOSURE SURFACE** SOIL/SLUDGE AREAS 2-7
ENGINEERING EVALUATION/COST ANALYSIS
MOHAWK TANNERY SITE
NASHUA, NEW HAMPSHIRE**

COPCs	EPC mg/kg	Max or UCL	Location of Maximum detected Concentration	Oral ABS ¹	Source	Dermal ABS ^{1,2}	Oral Exposure Factor d ⁻¹	Dermal Exposure Factor d ⁻¹	CSFadm ³ mg/kg-d	GI ABS used in toxicity study ⁴	CSFabs ⁵ mg/kg-d	Ingestion Cancer Risk	Dermal Cancer Risk	Total Cancer Risk
Aroclor 1242	0.28	Max		*		0.14	6.69E-07	2.96E-07	2.00E+00	1.00E+00	2.00E+00	3.75E-07	1.66E-07	5.40E-07
Dioxin TEQ	0.0013	Max		0.5	⁶	0.03	3.35E-07	6.34E-08	1.00E+06	1.00E+00	1.00E+06	4.35E-04	8.24E-05	5.17E-04
Antimony	44.4	Max		*			6.69E-07			1.50E-01				
Arsenic	15.7	Max		1	⁷	0.03	6.69E-07	6.34E-08	1.50E+00	1.00E+00	1.50E+00	1.58E-05	1.49E-06	1.73E-05
Barium	657	Max		*			6.69E-07			7.00E-02				
Cadmium	16.8	Max		*		0.001	6.69E-07	2.11E-09		2.50E-02				
Lead	427	Max		*			6.69E-07							
Manganese	207	Max		*			6.69E-07			4.00E-02				
Mercury	4.5	Max		*			6.69E-07			1.00E+00				

NOTES:

Age-Adjusted Ingestion Rate = ((200 mg/d * 6 y)/15 kg) + ((100 mg/d * 24 y)/70 kg) = 114 mg-y/kg-d

Age-Adjusted Dermal Contact Rate = ((2800 cm² * 0.2 mg/cm²-ev * 6 y)/15 kg) + ((5700 cm² * 0.07 mg/cm²-ev * 24 y)/70 kg) = 360 mg-y/kg-event

Oral Exposure Factor = Age-adjusted Ingestion Rate * Fraction Ingested * Exposure Frequency * ABS_{oral} * Conversion Factor / Averaging Time
= (114 mg-y/kg-d * 1.0 * 150 d/y * ABS_{oral} * 10-6 kg/mg) / (70 y * 365 d/y)

Dermal Exposure Factor = Age-adjusted Dermal Contact Rate * Exposure Frequency * ABS_{dermal} * Conversion Factor / Averaging Time
= (360 mg-y/kg-ev * 1 ev/d * 150 d/y * ABS_{dermal} * 10-6 kg/mg) / (70 y * 365 d/y)

CSFabs = CSFadm / GI ABS used in toxicity study

Cancer Risk = EPC * Exposure Factor * CSF

1 Oral ABS and Dermal ABS are absorption factors based on exposures to soils.

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** Since very few samples were collected from only surface materials (0 to 2 feet bgs) and many of the samples were composites of materials from 0 to as much as 20 feet bgs, the surface dataset includes any sample with a top depth of 0 feet bgs, most samples extending below 2 feet bgs.

5.35E-04

**TABLE K.3
CANCER RISK SUMMARY
FUTURE RESIDENTIAL EXPOSURE ALL** SOIL/SLUDGE AREAS 1-7
ENGINEERING EVALUATION/COST ANALYSIS
MOHAWK TANNERY SITE
NASHUA, NEW HAMPSHIRE**

COPCs	EPC mg/kg	Max or UCL	Location of Maximum detected Concentration	Oral ABS ¹	Source	Dermal ABS ^{1,2}	Oral Exposure Factor d ⁻¹	Dermal Exposure Factor d ⁻¹	CSFadm ³ mg/kg-d	GI ABS used in toxicity study ⁴	CSFabs ⁵ mg/kg-d	Ingestion Cancer Risk	Dermal Cancer Risk	Total Cancer Risk
1,4-Dichlorobenzene	1	95%UCL		*		0.1	6.69E-07	2.11E-07	2.40E-02	1.00E+00	2.40E-02	1.61E-08	5.07E-09	2.11E-08
Chlorobenzene	1.7	95%UCL		*		0.1	6.69E-07	2.11E-07		1.00E+00				
4-Methylphenol	1300	Max		*		0.1	6.69E-07	2.11E-07		1.00E+00				
Benzo(a)Pyrene	0.66	Max		*		0.13	6.69E-07	2.75E-07	7.30E+00	1.00E+00	7.30E+00	3.22E-06	1.32E-06	4.55E-06
2-Methylnaphthalene	21	Max		*		0.13	6.69E-07	2.75E-07		1.00E+00				
Naphthalene	61	Max		*		0.13	6.69E-07	2.75E-07		1.00E+00				
Pentachlorophenol	120	95%UCL		*		0.25	6.69E-07	5.28E-07	1.20E-01	1.00E+00	1.20E-01	9.64E-06	7.61E-06	1.72E-05
Aroclor 1242	0.028	95%UCL		*		0.14	6.69E-07	2.96E-07	2.00E+00	1.00E+00	2.00E+00	3.75E-08	1.66E-08	5.40E-08
Dioxin TEQ	0.0026	Max		0.5	⁶	0.03	3.35E-07	6.34E-08	1.00E+06	1.00E+00	1.00E+06	8.70E-04	1.65E-04	1.03E-03
Antimony	506	95%UCL		*			6.69E-07			1.50E-01				
Arsenic	8.6	95%UCL		1	⁷	0.03	6.69E-07	6.34E-08	1.50E+00	1.00E+00	1.50E+00	8.63E-06	8.18E-07	9.45E-06
Barium	154	95%UCL		*			6.69E-07			7.00E-02				
Cadmium	0.78	95%UCL		*		0.001	6.69E-07	2.11E-09		2.50E-02				
Chromium	67800	Max		*			6.69E-07			1.30E-02				
Lead	67.6	95%UCL		*			6.69E-07							
Manganese	1810	95%UCL		*			6.69E-07			4.00E-02				
Mercury	0.76	95%UCL		*			6.69E-07			1.00E+00				
Thallium	0.81	95%UCL		*			6.69E-07			1.00E+00				
Vanadium	32.1	95%UCL		*			6.69E-07			2.60E-02				
														1.07E-03

NOTES:

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 Age-Adjusted Dermal Contact Rate = ((2800 cm² * 0.2 mg/cm²-ev * 6 y)/15 kg) + ((5700 cm² * 0.07 mg/cm²-ev * 24 y)/70 kg) = 360 mg-y/kg-event

Oral Exposure Factor = Age-adjusted Ingestion Rate * Fraction Ingested * Exposure Frequency * ABS_{oral} * Conversion Factor / Averaging Time
 = (114 mg-y/kg-d * 1.0 * 150 d/y * ABS_{oral} * 10-6 kg/mg) / (70 y * 365 d/y)

Dermal Exposure Factor = Age-adjusted Dermal Contact Rate * Exposure Frequency * ABS_{dermal} * Conversion Factor / Averaging Time
 = (360 mg-y/kg-ev * 1 ev/d * 150 d/y * ABS_{dermal} * 10-6 kg/mg) / (70 y * 365 d/y)

CSFabs = CSFadm / GI ABS used in toxicity study

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** Since very few samples were collected from only 0 to 10 feet bgs and many of the samples were composites of materials from a wide range of depths, the "all soil" dataset includes any sample with a top depth of less than 10 feet bgs. Many of the samples in this dataset actually extend to depths greater than 10 feet bgs.