Soil Cleanup Levels for Industrial Land Use

Table 745-1

Notes on the Development of Method A Cleanup Levels WAC 173-340-720, 740, and 745

The following tables were prepared as part of the rule-making process for the amended MTCA rule adopted February 12, 2001. The information in the tables was used when Ecology developed the Method A Cleanup Levels for the revised regulation.

The tables compile cleanup level calculations for various exposure pathways for both carcinogenic and noncarcinogenic heath effects, applicable state and federal laws, laboratory practical quantitation limits and other relevant information that was used to develop the Method A cleanup levels. While this is useful background information, **the values in these tables are not the adopted rule and should not be used as Method A cleanup levels**. Use the tables, footnotes and accompanying text in the adopted regulation to develop Method A cleanup levels.

NOTE: Some columns in these tables refer to "current" and "proposed" Method A values. "Current" as used in these tables refers to the cleanup levels as they existed prior to the adoption of the February 12, 2001 rule amendments. "Proposed" as used in these tables are the cleanup levels that were adopted on February 12, 2001.

February 9, 2001
November 23, 2004 revision (1)

TO: Interested Persons

FROM: Pete Kmet, Senior Environmental Engineer
Toxics Cleanup Program

SUBJECT: Calculations for Table 745-1
Method A Soil Cleanup Levels for Industrial Properties

Attached are several tables in excel format providing information on the development of the Method A soil cleanup levels for industrial properties in Table 745-1, WAC 173-340-900.

Table 1: A quick summary providing Method A cleanup levels for industrial properties (Table 745-1) and a brief explanation of the reasoning in the development of Method A values.

Table 2: A detailed compilation of the information considered in the development of Method A soil cleanup levels for unrestricted land uses. This information includes:

- The Method B direct contact exposure pathway soil values for each substance. This includes values for both soil ingestion and soil ingestion plus dermal adsorption (adsorption through the skin) for both carcinogens and non-carcinogens, where sufficient information was available for the calculations as of February, 2001;
- The results for the soil leaching pathway from the 3 and 4 phase models as of February, 2001;
- Terrestrial ecological evaluation values from Tables 749-2 and 749-3;
- Regulatory values from other laws as of February, 2001; and
- Natural background, practical quantitation limits and other relevant information available as of February, 2001.

Table 3: Describes the assumptions used to calculate the standard Method C soil direct contact cleanup values for industrial land uses for carcinogens using equation 745-2 in WAC 173-340-745(5)(b)(iii)(B)(II).

Table 4: Describes the assumptions used to calculate the standard Method C soil direct contact cleanup values for industrial land uses for non-carcinogens using equation 745-1 in WAC 173-340-745(5)(b)(iii)(B)(I).

Table 5: Describes the assumptions and equation used to calculate the modified Method C values for industrial land uses assuming concurrent soil ingestion plus dermal (skin) absorption for carcinogens using equation 745-5 in WAC173-340-745(3)(b)(iii)(B).

Table 6: Describes the assumptions and equation used to calculate the modified Method C values for industrial land uses assuming concurrent soil ingestion plus dermal (skin) absorption for noncarcinogens using equation 745-4 in WAC173-340-745(3)(b)(iii)(A).

Table 7: Describes the assumptions and equations used to calculate soil concentrations protective of ground water for drinking water use, using the 3 phase leaching model.

Tables 8-10: 4-phase model results summary sheets for 2 brands of fresh gasoline and these same gasolines using various weathered compositions.

(1) This memo and attached excel tables explain the basis for the Method A cleanup levels in the MTCA rule adopted February 12, 2001. The memos and tables have been slightly revised from the originals issued on February 9, 2001 to clarify certain information in response to questions received since issuance of the original memos and tables. The original memos and tables can be found in appendix D of the concise explanatory statement for the February 12, 2001 rule amendments (http://www.ecy.wa.gov/programs/tcp/regs/reg_main.html)

Table 1: Quick Summary -- Basis for Method A Industrial Land Use Soil Values

Hazardous Substance	CAS Number	1991 Method A Cleanup Level mg/kg	2001 adopted Cleanup Level mg/kg	Basis for Standard
Arsenic	7440-38-2	200	20	Protection of drinking water, adjusted for background (1)
Benzene	71-43-2	0.5	0.03	Protection of drinking water--based on both 3 and 4 phase models.
Benzo(a)Pyrene	50-32-8	none	2	Protection of drinking water--3 phase model.
Cadmium	7440-43-9	10	2	Protection of drinking water, adjusted for PQL.
Chromium (total)	7440-47-3	500.0	none	Replaced by values for Cr III and Cr VI.
Chromium VI	18540-29-9		19	Protection of drinking water--3 phase model.
Chromium III	16065-83-1		2000	Protection of drinking water--3 phase model.
DDT	50-29-3	5	4	Protection of drinking water--3 phase model.
Ethylbenzene	100-41-4	20	6	Protection of drinking water--3 phase model.
Ethylene dibromide (EDB)	106-93-4	0.001	0.005	Protection of drinking water, adjusted for PQL
Lead	7439-92-1	1000.0	1000	Ingestion (3)
Lindane	58-89-9	20	0.01	Protection of drinking water, adjusted for PQL
Methylene chloride	75-09-2	0.5	0.02	Protection of drinking water--3 phase model.
Mercury (inorganic)	7439-97-6	1	2	Protection of drinking water--3 phase model.
MTBE	1634-04-4	none	0.1	Protection of drinking water--3 phase model.
Naphthalenes	91-20-3	none	5	Protection of drinking water--3 phase model. Total of naphthalene, 1-methyl naphthalene & 2-methyl naphthalene
PAHs (carcinogenic)		20	none	Replaced by benzo(a)pyrene.
PCB Mixtures	1336-36-3	10.0	10	ARAR. This is a total value for all PCBs in the soil sample.
Tetrachloroethylene	127-18-4	0.5	0.05	Protection of drinking water--3 phase model.
Toluene	108-88-3	40	7	Protection of drinking water--3 phase model.
1,1,1 Trichloroethane	71-55-6	20	2	Protection of drinking water--3 phase model.
Trichloroethylene	79-01-5	0.5	0.03	Protection of drinking water--3 phase model.
Xylenes	1330-20-7	20	9	Protection of drinking water--3 phase model. Total of all m, o & p xylene.
TPH (total)	14280-30-9			
Gasoline range organics	6842-59-6			
GRO with benzene		100	30	Protection of drinking water--4 phase model, assuming weathered gasoline composition.
GRO w/o benzene		100	100 (5)	Protection of drinking water--4 phase model, assuming highly weathered gasoline composition.
Diesel Range Organics		200	2000	Protection of drinking water--residual saturation
Heavy Oils		200	2000	Protection of drinking water--residual saturation for diesel.
Electrical Insulating Mineral Oil		200 (4)	4000	Protection of drinking water--residual saturation

(1) Based on background value in table 740-1. Ecology intends to review and, if appropriate, update this value in a future rulemaking.
(2) This can also be used as the total toxic equivalents for all cPAHs. See WAC 173-340-708(8).
(3) Ecology decision not to change at this time. Ecology intends to review and, if appropriate, update this value in a future rulemaking.
(4) Ecology also issued a fact sheet in 1995 (#95-157-TCP) allowing the use of 2000 mg/kg at electrical substations and switchyards.
With the adoption of the rule in 2001, this fact sheet has been withdrawn.
(5) To use this value no benzene must be present in the soil and the total of ethyl benzene, toluene & xylene must be less than 1% of the gasoline mixture.

Table 2: Summary Table for Method A Industrial Soil Cleanup Values in Table 745-1

Method A Soil Cleanup Levels -for Industrial Land Uses													
		2001 adopted			Dermal +	Dermal +	Leaching	100 X					
		Method A	Ingestion	Ingestion	Ingestion	Ingestion	3-Phase	Ground water					
Hazardous Substance	CAS Number	Cleanup Level	Carcinogen	Noncarc.	Carcinogen	Noncarc.	M odel	C/U level	Vapor	Other			
		mg/kg (1)	mg/kg (2)	mg/kg (3)	mg/kg (4)	mg/kg (5)	mg/kg (6)	mg/kg (7)	mg/kg (8)	mg/kg (9)			
Arsenic	7440-38-2	200.0	88.0	1,050	39	466	2.9	0.5					
Benzene	71-43-2	0.5	4,526	10,500	2,627		0.028	0.5		0.1			
Benzo(a)Pyrene	50-32-8	none	18		4.3		0.23/1.9	0.01					
Cadmium	7440-43-9	10.0		3,500		1,460	0.69	0.5					
Chromium (total)	7440-47-3	500.0											
Chromium VI	18540-29-9			10,500		1,226	19	5		500			
Chromium III	16065-83-1			pure		352,726	2,000	10					
DDT	50-29-3	5.0	386	1,750	158	715	4.1	0.03					
Ethylbenzene	100-41-4	20.0		350,000		148,655	6.1	70					
Ethylene dibromide (EDB)	106-93-4	0.001	1.5		0.66		0.00005	0.001					
Lead	7439-92-1	1000.0	1,000 (10)				3,000	1.5					
Lindane	58-89-9	20.0	101	1,050	33	341	0.0062	0.02					
Methylene chloride	75-09-2	0.5	17,500	210,000	10,157	121,878	0.022	0.5					
Mercury (inorganic)	7439-97-6	1.0		1,050		252	2.1	0.2					
MTBE	1634-04-4	none					0.085	2					
Naphthalene	91-20-3	none		70,000		16,613	4.5	16					
PAHs (carcinogenic)(11)		20.0	18		4.3		0.23	0.01					
PCB Mixtures (12)	1336-36-3	10.0	66/328/1,875	70/245	14/70/401	15/52	0.2/1.6	0.01					
Tetrachloroethylene	127-18-4	0.5	2,574	35,000	1,093		0.053	0.5					
Toluene	108-88-3	40.0		700,000		297,309	7.3	100					
1,1,1 Trichloroethane	71-55-6	20.0		pure		pure	1.6	20					
Trichloroethylene	79-01-5	0.5	11,932		5,068	pure	0.033	0.5					
Xylenes	1330-20-7	20.0		pure			9.1	100					

(1) From WAC 173-340-740 Table 2 [1/26/96 revision].
(2) Calculated using equation 745-2.
(3) Calculated using equation 745-1.
(4) Calculated using equation 745-5. For comparison only. Not used in setting cleanup levels since defaults not changed for other pathways.
(5) Calculated using equation 745-4. For comparison only. Not used in setting cleanup levels since defaults not changed for other pathways.
(6) Calculated using equation 747-1 and proposed Table 720-1 ground water cleanup levels. Except for Cr III used 100 ppb and for PAHs used Methods A and B values for B(a)P.
(7) Calculated using 100 X table 720-1 ground water cleanup level. Except for Cr III used 100 ppb and cPAH used current Method A value.
(8) Vapor values not calculated.
(9) Benzene from 4 phase leaching model; Chromium VI is dust value documented in 1991 MTCA responsiveness summary.
(10) Value documented in 1991 MTCA responsiveness summary.
(11) Based on benzo (a) pyrene. For leaching, first value is based on Method B ground water cleanup level, second value is based on Method A ground water cleanup level for B(a)P.
(12) PCB values based on various arochlors and IRIS values for PCB mixtures.

Table 2: Summary Table for Method A Industrial Soil Cleanup Values in Table 745-1

Method A Soil Cleanup Levels -for Industrial Land Uses														
		2001 adopted		Dermal +	Leaching		100 X							
		Method A	Ingestion	Ingestion	Using	Residual	Ground water							
Hazardous Substance	CAS Number	Cleanup Level	Noncarc.	Noncarc.	4-phase Model	Saturation	C/U level	Vapor						
		mg/kg (1)	mg/kg (2)	mg/kg (3)	mg/kg (4)	mg/kg (5)	mg/kg (6)	mg/kg (7)						
TPH (total)	14280-30-9													
Gasoline range organics	6842-59-6	100												
GRO with benzene			210,000	150,000	1 / 23 to 28	1,000	80	unknown						
GRO without benzene					105	1,000	100	unknown						
Diesel Range Organics		200	170,000	39,000	No upper limit	2,000	50	>10,000						
Heavy Oils (8)		200	170,000	39,000	No upper limit	2,000	50	>10,000						
Electrical Insulating Mineral Oil		2000 (9)	340,000	70,000	No upper limit	4,000	100	Not volatile						

(1) From WAC 173-340-740 Table 2 [1/26/96 revision].
(2) Calculated using surrogates. See 1/29/99 Steve Robb memo.
(3) Calculated using surrogates and equation 740-4. See 1/29/99 Steve Robb memo.
(4) Calculated using 4 phase model. For GRO with benzene, 1st value assumes fresh gas (3% benzene); 2nd values assume weathered gas (~0.1% ber
For GRO without benzene, assumes no benzene present in gasoline mixture and that ethyl benzene, toluene and xylene are less than 1% of the gas
For diesel, heavy oils and mineral oil, "no upper limit" means HI of 1 never exceeded. This is true only if the soil is above the water table.
(5) Residual saturation for coarse soils from Coen and Mercer for gas and diesel and BPA study for mineral oil.
(6) Calculated using 1991 method of 100 X table 720-1 proposed ground water cleanup level.
(7) Gasoline vapors not calculated. The current Method A value of 100 ppm thought to be protective for vapor pathway. Diesel vapors based on qualitative observations at sites by PLIA.
(8) Based on diesel composition.
(9) Ecology also issued a fact sheet in 1995 (#95-157-TCP) allowing the use of 2000 mg/kg at electrical substations and switchyards.
With the adoption of the rule in 2001, this fact sheet has been withdrawn.

Table 2: Summary Table for Method A Industrial Soil Cleanup Values in Table 745-1

Method A Soil Cleanup Levels -for Industrial Land Uses										
	Ecological Simplified Evaluation mg/kg (1)	Ecological Indicator Concentration mg/kg (2)	Most Stringent Non-Eco Path mg/kg	Controlling Non-Eco Pathway	ARARs mg/kg	PQL mg/kg (3)	Background mg/kg (4)	1991 Method A Cleanup Level mg/kg	2001 adopted Method A Cleanup Level mg/kg	Basis for Standard
Arsenic	20	7	2.9	Leaching		1 (SW7060)	7 & 20	200.0	20	Leaching, adjusted for background (5)
Benzene			0.1	Leaching		0.005 (SW8260)		0.5	0.1	Protection of drinking water--4 phase model
Benzo(a)Pyrene	300	12	1.9	Leaching		0.05 (SW8270)		none	2	Protection of drinking water--3 phase model (6)
Cadmium	36	14	0.69	Leaching		2 (SW6010A)	1	10.0	2	Leaching, adjusted for PQL. (7)
Chromium (total)	135	67				2 (SW6010A)	42	500.0		
Chromium VI			19	Leaching		1 (SW3060A)			19	Protection of drinking water--3 phase model
Chromium III			2,000	Leaching		2 (SW6010A)			2000	Protection of drinking water--3 phase model
DDT	1	0.75	4.1	Leaching		0.05 (SW8081)		5.0	4	Protection of drinking water--3 phase model
Ethylbenzene			6.1	Leaching		0.005 (SW8260)		20.0	6	Protection of drinking water--3 phase model
Ethylene dibromide (EDB)			0.00005	Leaching		0.005 (SW8260)		0.001	0.001	Leaching, adjusted for PQL
Lead	220	118	1,000	Ingestion		5.0 (SW6010A)	17	1000.0	1000	Ingestion (8)
Lindane	10	6	0.0062	Leaching		0.01 (SW8081)		20.0	0.01	Leaching, adjusted for PQL
Methylene chloride			0.022	Leaching		0.005 (SW8260)		0.5	0.02	Protection of drinking water--3 phase model
Mercury (inorganic)	9	5.5	2.1	Leaching		0.1 (SW7471)	0.07	1.0	2	Protection of drinking water--3 phase model
MTBE			0.085	Leaching		0.005 (SW8260)		none	0.1	Protection of drinking water--3 phase model
Naphthalenes			4.5	Leaching		0.5 (SW8260)		none	5	Protection of drinking water--3 phase model (10)
PAHs (carcinogenic)	300	12	1.9	Leaching		0.05 (SW8270)		20.0	none	Replaced with benzo(a)pyrene.
PCB Mixtures	2	0.65	0.2	Leaching	10	0.04 (SW8082)		10.0	10	ARAR (9)
Tetrachloroethylene			0.053	Leaching		0.005 (SW8260)		0.5	0.05	Protection of drinking water--3 phase model
Toluene			7.3	Leaching		0.005 (SW8260)		40.0	7	Protection of drinking water--3 phase model
1,1,1 Trichloroethane			1.6	Leaching		0.005 (SW8260)		20.0	2	Protection of drinking water--3 phase model
Trichloroethylene			0.033	Leaching		0.005 (SW8260)		0.5	0.03	Protection of drinking water--3 phase model
Xylenes			9.1	Leaching		0.015 (SW8260)		20.0	9	Protection of drinking water--3 phase model

(1) Value from Table 749-2 for industrial land use. For reference only, not used in developing Method A values.
(2) Wildlife protection value from Table 749-3. For reference only, not used in developing Method A values.
(3) From Manchester Lab
(4) For arsenic, 1st value from upper 90% for WA State, documented in report #94-115 and 2nd value from a 1989 report by PTI Environmental Services. All others upper 90% in WA State from report # 94-115.
(5) Based on background value in table 740-1. Ecology intends to review and, if appropriate, update this value in a future rulemaking.
(6) This can also be used as the total toxic equivalents for all cPAHs. See WAC 173-340-708(8).
(7) For cadmium, there are two possible PQLs: 0.1 PPM using SW7131 and 2 PPM using SW6010A. The later has been used since this is the more commonly used test method.
(8) Ecology decision not to change current rule value at this time. Ecology intends to review and, if appropriate, update this value in a future rulemaking.
(9) Cleanup level is sum of all PCBs. ARAR is for low occupancy areas with a cap, from 40 CFR Part 761.61 (EPA rule governing disposal and cleanup of PCB contaminated facilities under TSCA).
(10) This is a total of all naphthalene, 1-Methyl naphthalene & 2-Methyl Naphthalene. Also, use SW 8270C to measure all three types of naphthalene.

Table 2: Summary Table for Method A Industrial Soil Cleanup Values in Table 745-1

Method A Soil Cleanup Levels -for Industrial Land Uses										
	Ecological Simplified Evaluation mg/kg (1)	Ecological Indicator Concentration mg/kg (2)	Most Stringent Non-Eco Path mg/kg	Controlling Non-Eco Pathway	ARARs mg/kg	PQL mg/kg (3)	Background mg/kg	1991 Method A Cleanup Level mg/kg	2001 adopted Method A Cleanup Level mg/kg	Basis for Standard
TPH (total)										
Gasoline range organics										
GRO with benzene	1,000 to 12,000	1,000 to 5,000	23 to 28	Leaching		5 (NWTPH-Gx)		100	30	Protection of drinking water(4)
GRO without benzene	1,000 to 12,000	1,000 to 5,000	105	Leaching		5 (NWTPH-Gx)		100	100	Protection of drinking water(5)
Diesel Range Organics	2,000 to 15,000	2,000 to 6,000	2000	Leaching		25 (NWTPH-Dx)		200	2000	Residual Saturation
Heavy Oils (6)	2,000 to 15,000	2,000 to 6,000	2000	Leaching		100 (NWTPH-Dx)		200	2000	Residual Saturation
Electrical Insulating Mineral Oil			4000	Leaching		100 (NWTPH-Dx)		200 (7)	4000	Residual Saturation

(1) Value from Table 749-2 for unrestricted land use. For reference only, not used in developing Method A values.
(2) Most stringent indicator value from Table 749-3. For reference only, not used in developing Method A values.
(3) From Manchester Lab.
(4) Based on 4-phase model results for weathered gasoline with 0.1% benzene, a typical value for gasoline contaminated sites.
(5) Based on 4-phase model results for weathered gasoline assuming no benzene present in soil and that ethyl benzene, toluene & xylene are less than 1% of the gasoline mixture.
(6) Based on diesel composition.
(7) Ecology also issued a fact sheet in 1995 (#95-157-TCP) allowing the use of 2000 mg/kg at electrical substations and switchyards.
With the adoption of the rule in 2001, this fact sheet has been withdrawn.

Table 3: Method C Industrial Soil Calculations for Carcinogens

Risk Calculations--Carcinogenic Effects of Soil Ingestion

Parameter	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Lifetime (years)	Unit Conv. Factor (ug/mg)	Cancer Potency Factor (kg-day/mg)	G.I. Abs. Fraction (unitless)	Soil Ing. Rate (mg/day)	Duration of Exposure (years)	Frequency of Contact (unitless)	Method C Carcinogen (mg/kg)	ARAR (3) (mg/kg)	Risk @ ARAR(4) (unitless)
Arsenic (5)	7440-38-2	0.00001	70	75	1,000,000	1.5	1.0	50	20	0.4	88		
Benzene	71-43-2	0.00001	70	75	1,000,000	0.029	1.0	50	20	0.4	4,526		
Cadmium	7440-43-9					not available							
T Chromium	7440-47-3												
Chromium III	16065-83-1					not available							
Chromium VI	18540-29-9					not available							
DDT	50-29-3	0.00001	70	75	1,000,000	0.34	1.0	50	20	0.4	386		
Ethylbenzene	100-41-4					not available							
Ethylene dibromide (EDB)	106-93-4	0.00001	70	75	1,000,000	85	1.0	50	20	0.4	1.5		
Lead	7439-92-1					not available							
Lindane	58-89-9	0.00001	70	75	1,000,000	1.3	1.0	50	20	0.4	101		
Methylene chloride	75-09-2	0.00001	70	75	1,000,000	0.0075	1.0	50	20	0.4	17,500		
Mercury (inorganic)	7439-97-6					not available							
MTBE	1634-04-4					not available							
Naphthalene	91-20-3					not available							
cPAH Mixtures	na												
Benzo[a]anthracene	56-55-3					not available							
Benzo[b]fluoranthene	205-99-2					not available							
Benzo[k]fluoranthene	207-08-9					not available							
Benzo[a]pyrene	50-32-8	0.00001	70	75	1,000,000	7.3	1.0	50	20	0.4	18		
Chrysene	218-01-9					not available							
Dibenzo[a,h]anthracene	53-70-3					not available							
Ideno[1,2,3-cd]pyrene	207-08-9					not available							

(1) Source of Cancer Potency Factor is the oral slope factors fromEPA's IRIS database, except for Lindane which is from HEAST.
(2) Value calculated using equation 745-2 and default assumptions in that equation.
(3) Applicable, relevant and appropriate requirement.
(4) ARAR divided by Method B value in column K. Bolded values indicate ARAR exceeds MTCA requirement that risk not exceed 1 X 10-5 [i.e. >10].
(5) The MTCA 2.0 CLARC tables (Feb, 1996 edition) use a GI absorbtion fraction of 0.4. That number is no longer thought to be valid and 1.0 is used here.

Table 3: Method C Industrial Soil Calculations for Carcinogens

Risk Calculations--Carcinogenic Effects of Soil Ingestion

Parameter	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Lifetime (years)	Unit Conv. Factor (ug/mg)	Cancer Potency Factor (kg-day/mg)	G.I. Abs. Fraction (unitless)	Soil Ing. Rate (mg/day)	Duration of Exposure (years)	Frequency of Contact (unitless)	Method C Carcinogen (mg/kg)	ARAR (3) (mg/kg)	Risk @ ARAR(4) (unitless)
PCB mixtures	1336-36-3											1.0	
High Risk & Persistence		0.00001	70	75	1,000,000	2.0	1.0	50	20	0.4	66	1.0	0.02
Low Risk & Persistence		0.00001	70	75	1,000,000	0.4	1.0	50	20	0.4	328	1.0	0.003
Lowest Risk & Persistence		0.00001	70	75	1,000,000	0.07	1.0	50	20	0.4	1,875	1.0	0.001
Aroclor 1016	12674-11-2					not available							
Arochlor 1248	12672-29-6					not available							
Arochlor 1254	11097-69-1					not available							
Arochlor 1260						not available							
Tetrachloroethylene (PCE)	127-18-4	0.00001	70	75	1,000,000	0.051	1.0	50	20	0.4	2,574		
Toluene	108-88-3					not available							
1,1,1 Trichloroethane	71-55-6					not available							
Trichloroethylene	79-01-6	0.00001	70	75	1,000,000	0.011	1.0	50	20	0.4	11,932		
Xylenes	1330-20-7					not available							
m-Xylene	108-38-3					not available							
o-xylene	95-47-6					not available							
p-xylene						not available							

(1) Source of Cancer Potency Factor is the oral slope factors from EPA's IRIS database, except for tetrachloroethylene, trichlorothylene and vinyl chloride which are from HEAST.
(2) Value calculated using equation 745-2 and default assumptions in that equation.
(3) Applicable, relevant and appropriate requirement. Source for PCBs is 40 CFR Part 761.61(a)(4)(i)(A).
(4) ARAR divided by Method B value in column K. Bolded values indicate ARAR exceeds MTCA requirement that risk not exceed 1 X 10-5 [i.e. >10].

Table 4: Soil Ingestion -- Method C Industrial Soil Calculations for Noncarcinogens

Risk Calculations--Noncarcinogenic Effects of Soil Ingestion

Parameter	CAS No.	Reference Dose (1) (mg/kg-day)	Avg. Body Weight (kg)	Unit Conv. Factor (ug/mg)	Hazard Quotient (unitless)	Soil Ing. Rate (mg/day)	G.I. Abs. Fraction (unitless)	Frequency of Contact (unitless)	Method C Noncarc(2) (mg/kg)	ARAR (3) (mg/kg)	HQ @ ARAR (4) (unitless)
Arsenic (5)	7440-38-2	0.0003	70	1,000,000	1	50	1.0	0.4	1,050		
Benzene	71-43-2	0.003	70	1,000,000	1	50	1.0	0.4	10,500		
Cadmium	7440-43-9	0.001	70	1,000,000	1	50	1.0	0.4	3,500		
T Chromium	7440-47-3	not available									
Chromium III	16065-83-1	1.5	70	1,000,000	1	50	1.0	0.4	5,250,000		
Chromium VI	18540-29-9	0.003	70	1,000,000	1	50	1.0	0.4	10,500		
DDT	50-29-3	0.0005	70	1,000,000	1	50	1.0	0.4	1,750		
Ethylbenzene	100-41-4	0.1	70	1,000,000	1	50	1.0	0.4	350,000		
Ethylene dibromide (EDB)	106-93-4	not available									
Lead	7439-92-1	not available									
Lindane	58-89-9	0.0003	70	1,000,000	1	50	1.0	0.4	1,050		
Methylene chloride	75-09-2	0.06	70	1,000,000	1	50	1.0	0.4	210,000		
Mercury (inorganic)	7439-97-6	0.0003	70	1,000,000	1	50	1.0	0.4	1,050		
MTBE	1634-04-4	not available									
Naphthalene	91-20-3	0.02	70	1,000,000	1	50	1.0	0.4	70,000		
cPAH Mixtures	na	not available									
Benzo[a]anthracene	56-55-3	not available									
Benzo[b]fluoranthene	205-99-2	not available									
Benzo[k]fluoranthene	207-08-9	not available									
Benzo[a]pyrene	50-32-8	not available									
Chrysene	218-01-9	not available									
Dibenzo[a,h]anthracene	53-70-3	not available									
Ideno[1,2,3-cd]pyrene	207-08-9	not available									

(1) Source of RfDs is EPA's IRIS database except for benzene which is from EPA's NCEA.
(2) Value calculated using equation 740-1 and default assumptions in that equation.
(3) Applicable, relevant and appropriate requirement.
(4) ARAR divided by Method B value in column K. Bolded values indicate ARAR exceeds MTCA requirement that HQ not exceed 1.0.
(5) The MTCA 2.0 CLARC tables (Feb, 1996 edition) use a GI absorbtion fraction of 0.4. That number is no longer thought to be valid and 1.0 is used here.

Table 4: Soil Ingestion -- Method C Industrial Soil Calculations for Noncarcinogens

Risk Calculations--Noncarcinogenic Effects of Soil Ingestion

Parameter	CAS No.	Reference Dose (1) (mg/kg-day)	Avg. Body Weight (kg)	Unit Conv. Factor (ug/mg)	Hazard Quotient (unitless)	Soil Ing. Rate (mg/day)	G.I. Abs. Fraction (unitless)	Frequency of Contact (unitless)	Method C Noncarc(2) (mg/kg)	ARAR (3) (mg/kg)	HQ @ ARAR (4) (unitless)
PCB mixtures	1336-36-3	not available								1.0	
High Risk & Persistence		not available									
Low Risk & Persistence		not available									
Lowest Risk & Persistence		not available									
Aroclor 1016	12674-11-2	0.00007	70	1,000,000	1	50	1.0	0.4	245.0	1.0	0.004
Arochlor 1248	12672-29-6	not available									
Arochlor 1254	11097-69-1	0.00002	70	1,000,000	1	50	1.0	0.4	70.0	1.0	0.01
Arochlor 1260		not available									
Tetrachloroethylene (PCE)	127-18-4	0.01	70	1,000,000	1	50	1.0	0.4	35,000		
Toluene	108-88-3	0.2	70	1,000,000	1	50	1.0	0.4	700,000		
1,1,1 Trichloroethane	71-55-6	0.9	70	1,000,000	1	50	1.0	0.4	3,150,000		
Trichloroethylene	79-01-6	not available									
Xylenes	1330-20-7	2.0	70	1,000,000	1	50	1.0	0.4	7,000,000		
m-Xylene	108-38-3	not available									
o-xylene	95-47-6	not available									
p-xylene		not available									

(1) Source of RfDs is EPA's IRIS database except for 1,1,1, TCE which is from HEAST.
(2) Value calculated using equation 740-1 and default assumptions in that equation.
(3) Applicable, relevant and appropriate requirement. Source for PCBs is 40 CFR Part 761.61(a)(4)(i)(A).
(4) ARAR divided by Method B value in column K. Bolded values indicate ARAR exceeds MTCA requirement that HQ not exceed 1.0.

Table 5: Method C Industrial Calculations for Carcinogens for Soil Ingestion plus Dermal Contact

Risk Calculations--Carcinogenic Effects of Soil Ingestion + Dermal Contact

Parameter	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Averaging Time (days)	Exposure Frequency (days/yr)	Exposure Duration (yrs)	Soil Ing. Rate (mg/day)	G.I. Abs. Fraction (unitless)	Oral CPF (1) (kg-day/mg)	Unit Conv. Factor (ug/mg)	Surface Area (cm^2)	Adherence Factor (mg/cm^2-day)	Dermal Abs. Fraction (unitless)	G.I. Conv. Factor (unitless)	Dermal CPF (2) (kg-day/mg)	Method C (3) Carcinogen (mg/kg)
Arsenic	7440-38-2	0.00001	70	27,375	250	20	50	1.0	1.5	1,000,000	2,500	0.2	0.03	0.95	1.6	38.84
Benzene	71-43-2	0.00001	70	27,375	250	20	50	1.0	0.029	1,000,000	2,500	0.2	0.0005	0.80	0.036	2,627
Cadmium	7440-43-9								not available							
T Chromium	7440-47-3															
Chromium III	16065-83-1								not available							
Chromium VI	18540-29-9								not available							
DDT	50-29-3	0.00001	70	27,375	250	20	50	1.0	0.34	1,000,000	2,500	0.2	0.03	0.70	0.49	157.8
Ethylbenzene	100-41-4								not available							
Ethylene dibromide (EDB)	106-93-4	0.00001	70	27,375	250	20	50	1.0	85	1,000,000	2,500	0.2	0.03	0.80	106	0.656
Lead	7439-92-1								not available							
Lindane	58-89-9	0.00001	70	27,375	250	20	50	1.0	1.3	1,000,000	2,500	0.2	0.04	0.50	2.6	32.76
Methylene chloride	75-09-2	0.00001	70	27,375	250	20	50	1.0	0.0075	1,000,000	2,500	0.2	0.0005	0.80	0.0094	10,157
Mercury (inorganic)	7439-97-6								not available							
MTBE	1634-04-4								not available							
Naphthalene	91-20-3								not available							
cPAH Mixtures	na															
Benzo[a]anthracene	56-55-3								not available							
Benzo[b]fluoranthene	205-99-2								not available							
Benzo[k]fluoranthene	207-08-9								not available							
Benzo[a]pyrene	50-32-8	0.00001	70	27,375	250	20	50	1.0	7.3	1,000,000	2,500	0.2	0.13	0.89	8.2	4.27
Chrysene	218-01-9								not available							
Dibenzo[a,h]anthracene	53-70-3								not available							
Ideno[1,2,3-cd]pyrene	207-08-9								not available							

(1) Source of Cancer Potency Factor is the oral slope factors fromEPA's IRIS database, except for Lindane which is from HEAST.
(2) Dermal CPF = Oral CPF/ GI abs conversion factor. The GI abs. factor is chemical specific. See equation 745-5 for defaults and 1/25/99 memo for chemical specific factors used here.
(3) Calculated using equation 745-5 and default assumptions.

Table 5: Method C Industrial Calculations for Carcinogens for Soil Ingestion plus Dermal Contact

Risk Calculations--Carcinogenic Effects of Soil Ingestion + Dermal Contact

Parameter	CAS No.	Risk (unitless)	Avg. Body Weight (kg)	Averaging Time (days)	Exposure Frequency (days/yr)	Exposure Duration (yrs)	Soil Ing. Rate (mg/day)	G.I. Abs. Fraction (unitless)	Oral CPF (1) (kg-day/mg)	Unit Conv. Factor (ug/mg)	Surface Area (cm^2)	Adherence Factor (mg/cm^2-day)	Dermal Abs. Fraction (unitless)	G.I. Conv. Factor (unitless)	Dermal CPF (2) (kg-day/mg)	Method C (3) Carcinogen (mg/kg)
PCB mixtures	1336-36-3															
High Risk & Persistence		0.00001	70	27,375	250	20	50	1.0	2.0	1,000,000	2,500	0.2	0.14	0.81	2.5	14.05
Low Risk & Persistence		0.00001	70	27,375	250	20	50	1.0	0.4	1,000,000	2,500	0.2	0.14	0.81	0.49	70.2
Lowest Risk & Persistence		0.00001	70	27,375	250	20	50	1.0	0.07	1,000,000	2,500	0.2	0.14	0.81	0.0864	401
Aroclor 1016	12674-11-2								not available							
Arochlor 1248	12672-29-6								not available							
Arochlor 1254	11097-69-1								not available					0.81		
Arochlor 1260									not available							
Tetrachloroethylene (PCE)	127-18-4	0.00001	70	27,375	250	20	50	1.0	0.051	1,000,000	2,500	0.2	0.03	0.80	0.064	1,093
Toluene	108-88-3								not available							
1,1,1 Trichloroethane	71-55-6								not available							
Trichloroethylene	79-01-6	0.00001	70	27,375	250	20	50	1.0	0.011	1,000,000	2,500	0.2	0.03	0.80	0.014	5,068
Xylenes	1330-20-7								not available							
m-Xylene	108-38-3								not available							
o-xylene	95-47-6								not available							
p-xylene									not available							

(1) Source of Cancer Potency Factor is the oral slope factors from EPA's IRIS database, except for tetrachloroethylene, trichlorothylene and vinyl chloride which are from HEAST.
(2) Dermal CPF = Oral CPF/ GI abs conversion factor. The GI abs. factor is chemical specific. See equation 745-5 for defaults and 1/25/99 memo for chemical specific factors used here.
(3) Calculated using equation 745-5 and default assumptions.

Table 6: Method C Industrial Calculations for Noncarcinogens for Soil Ingestion plus Dermal Contact

Risk Calculations--Noncarcinogenic Effects of Soil Ingestion + Dermal Contact

Parameter	CAS No.	Hazard Index (unitless)	Avg. Body Weight (kg)	Averaging Time (days)	Exposure Frequency (days/yr)	Exposure Duration (years)	Oral Ref. Dose (1) (mg/kg-day)	Soil Ing. Rate (mg/day)	G.I. Abs. Fraction (unitless)	Unit Conv. Factor (mg/kg)	G.I. Conv. Factor (unitless)	Dermal Rfd (2) (mg/kg-day)	Surface Area (cm^2)	Adherence Factor (mg/cm^2)	Dermal Abs. Fraction (unitless)	Method C Noncarc(2) (mg/kg)
Arsenic	7440-38-2	1	70	7,300	250	20	0.0003	50	1	1,000,000	0.95	0.00029	2,500	0.2	0.03	466
Benzene	71-43-2	1	70	7,300	250	20	0.003	50	1	1,000,000	0.80	0.0024	2,500	0.2	0.0005	
Cadmium	7440-43-9	1	70	7,300	250	20	0.001	50	1	1,000,000	0.025	0.000025	2,500	0.2	0.001	1,460
T Chromium	7440-47-3						not available									
Chromium III	16065-83-1	1	70	7,300	250	20	1.5	50	1	1,000,000	0.013	0.020	2,500	0.2	0.01	352,726
Chromium VI	18540-29-9	1	70	7,300	250	20	0.003	50	1	1,000,000	0.025	0.000075	2,500	0.2	0.01	1,226
DDT	50-29-3	1	70	7,300	250	20	0.0005	50	1	1,000,000	0.70	0.00035	2,500	0.2	0.03	715
Ethylbenzene	100-41-4	1	70	7,300	250	20	0.1	50	1	1,000,000	0.80	0.080	2,500	0.2	0.03	148,655
Ethylene dibromide (EDB)	106-93-4						not available									
Lead	7439-92-1						not available									
Lindane	58-89-9	1	70	7,300	250	20	0.0003	50	1	1,000,000	0.50	0.00015	2,500	0.2	0.04	341
Methylene chloride	75-09-2	1	70	7,300	250	20	0.06	50	1	1,000,000	0.80	0.048	2,500	0.2	0.0005	121,878
Mercury (inorganic)	7439-97-6	1	70	7,300	250	20	0.0003	50	1	1,000,000	0.07	0.000021	2,500	0.2	0.01	252
MTBE	1634-04-4						not available									
Naphthalene	91-20-3	1	70	7,300	250	20	0.02	50	1	1,000,000	0.89	0.018	2,500	0.2	0.13	16,613
cPAH Mixtures	na						not available									
Benzo[a]anthracene	56-55-3						not available									
Benzo[b]fluoranthene	205-99-2						not available									
Benzo[k]fluoranthene	207-08-9						not available									
Benzo[a]pyrene	50-32-8						not available									
Chrysene	218-01-9						not available									
Dibenzo[a,h]anthracene	53-70-3						not available									
Ideno[1,2,3-cd]pyrene	207-08-9						not available									

(1) Source of oral RfDs is EPA's IRIS database except for benzene which is from EPA's NCEA.
(2) Dermal RfD = Oral RfD X GI abs. conversion factor. The GI abs. factor is chemical specific. See equation 745-4 for defaults and 1/25/99 memo for chemical specific factors used here.
(3) Calculated using equation 745-4 and default assumptions.

Table 6: Method C Industrial Calculations for Noncarcinogens for Soil Ingestion plus Dermal Contact

Risk Calculations--Noncarcinogenic Effects of Soil Ingestion + Dermal Contact

Parameter	CAS No.	Hazard Index (unitless)	Avg. Body Weight (kg)	Averaging Time (days)	Exposure Frequency (unitless)	Exposure Duration (years)	Oral Ref. Dose (1) (mg/kg-day)	Soil Ing. Rate (mg/day)	G.I. Abs. Fraction (unitless)	Unit Conv. Factor (mg/kg)	G.I. Conv. Factor (unitless)	Dermal Rfd (2) (mg/kg-day)	Surface Area (mg/cm^2)	Adherence Factor (mg/cm^2)	Dermal Abs. Fraction (unitless)	Method C Noncarc(2) (mg/kg)
PCB mixtures	1336-36-3						not available									
High Risk & Persistence							not available									
Low Risk & Persistence							not available									
Lowest Risk & Persistence							not available									
Aroclor 1016	12674-11-2	1	70	7,300	250	20	0.00007	50	1	1,000,000	0.81	0.000057	2,500	0.2	0.14	52.4
Arochlor 1248	12672-29-6						not available									
Arochlor 1254	11097-69-1	1	70	7,300	250	20	0.00002	50	1	1,000,000	0.81	0.000016	2,500	0.2	0.14	15.0
Arochlor 1260							not available									
Tetrachloroethylene (PCE)	127-18-4	1	70	7,300	250	20	0.01	50	1	1,000,000	0.80	0.0080	2,500	0.2	0.03	14,865
Toluene	108-88-3	1	70	7,300	250	20	0.2	50	1	1,000,000	0.80	0.16	2,500	0.2	0.03	297,309
1,1,1 Trichloroethane	71-55-6	1	70	7,300	250	20	0.9	50	1	1,000,000	0.80	0.72	2,500	0.2	0.0005	1,828,174
Trichloroethylene	79-01-6						not available									
Xylenes	1330-20-7	1	70	7,300	250	20	2.0	50	1	1,000,000	0.80	1.6	2,500	0.2	0.03	2,973,091
m-Xylene	108-38-3						not available									
o-xylene	95-47-6						not available									
p-xylene							not available									

(1) Source of oral RfDs is EPA's IRIS database except for benzene which is from EPA's NCEA.
(2) Dermal RfD = Oral RfD X GI abs. conversion factor. This factor is chemical specific. See equation 745-4.
(3) Calculated using equation 745-4 and default assumptions.

Table 7: 3-Phase Model Assumptions and Results

3-Phase Model Results											
		Gd H_2O								Dilution	Soil
	CAS No.	C/U Level	Bulk Density	Soil Water	Soil Air	H'	Koc	foc	Kd	Factor	C/U Level
		(mg/l) (1)	(g/cc) (2)	(cc/cc) (2)	(cc/cc) (2)	(cc/cc) (3)	(ml/g) (3)	(%) (4)	(cc/g) (5)	(dimensionless)	(mg/kg) (6)
Arsenic	7440-38-2	0.005	1.5	0.3	0.13	0	-	-	29	20	2.92
Benzene	71-43-2	0.005	1.5	0.3	0.13	0.228	61.7	0.1%	0.062	20	0.028
Cadmium	7440-43-9	0.005	1.5	0.3	0.13	0	-	-	6.7	20	0.69
Chromium (total)	7440-47-3										
Chromium VI	18540-29-9	0.05	1.5	0.3	0.13	0	-	-	19	20	19
Chromium III	16065-83-1	0.10	1.5	0.3	0.13	0	-	-	1000	20	2000
DDT	50-29-3	0.0003	1.5	0.3	0.13	0.000332	386,977	0.1%	387	20	2.32
Ethyl Benzene	100-41-4	0.7	1.5	0.3	0.13	0.323	204	0.1%	0.204	20	6.05
Ethylene dibromide (EDB)	106-93-4	0.00001	1.5	0.3	0.13	0.0336	66	0.1%	0.066	20	0.000054
Lead	7439-92-1	0.015	1.5	0.3	0.13	0	-	-	10000	20	3000
Lindane	58-89-9	0.0002	1.5	0.3	0.13	0.000574	1,352	0.1%	1.4	20	0.0062
Methylene Chloride	75-09-2	0.005	1.5	0.3	0.13	0.0898	10	0.1%	0.010	20	0.022
Mercury (inorganic)	7439-97-6	0.002	1.5	0.3	0.13	0.467	-	-	52	20	2.09
MTBE	1634-04-4	0.02	1.5	0.3	0.13	0.018	11	0.1%	0.011	20	0.085
Naphthalene	91-20-3	0.16	1.5	0.3	0.13	0.0198	1,191	0.1%	1.191	20	4.46
cPAH Mistures	na										
Benzo[a]anthracene	56-55-3	0.000012	1.5	0.3	0.13	0.000137	357,537	0.1%	358	20	0.086
Benzo[b]fluoranthene	205-99-2	0.000012	1.5	0.3	0.13	0.00455	1,230,000	0.1%	1,230	20	0.30
Benzo[k]fluoranthene	207-08-9	0.000012	1.5	0.3	0.13	0.000034	1,230,000	0.1%	1,230	20	0.30
Benzo[a]pryene	50-32-8	0.000012	1.5	0.3	0.13	0.0000463	968,774	0.1%	969	20	0.23
Chrysene	218-01-9	0.000012	1.5	0.3	0.13	0.00388	398,000	0.1%	398	20	0.10
Dibenzo[a,h]anthracene	53-70-3	0.000012	1.5	0.3	0.13	6.03E-07	1,789,101	0.1%	1,789	20	0.43
Indeno[1,2,3-cd]pyrene	207-08-9	0.000012	1.5	0.3	0.13	0.0000656	3,470,000	0.1%	3470.00	20	0.83

Table 7: 3-Phase Model Assumptions and Results

3-Phase Model Results											
		Gd H_2O								Dilution	Soil
	CAS No.	C/U Level	Bulk Density	Soil Water	Soil Air	H'	Koc	foc	Kd	Factor	C/U Level
		(mg/l) (1)	(g/cc) (2)	(cc/cc) (2)	(cc/cc) (2)	(cc/cc) (3)	(ml/g) (3)	(%) (4)	(cc/g) (5)	(dimensionless)	(mg/kg) (6)
PCB Mixtures	1336-36-3										
Arochlor 1016	12674-11-2	0.0001	1.5	0.3	0.13	0.119	107,285	0.1%	107	20	0.21
Arochlor 1260		0.0001	1.5	0.3	0.13	0.189	822,422	0.1%	822	20	1.65
Tetrachlorothylene (PCE)	127-18-4	0.005	1.5	0.3	0.13	0.754	265	0.1%	0.265	20	0.053
Toluene	108-88-3	1.0	1.5	0.3	0.13	0.272	140	0.1%	0.140	20	7.27
1,1,1 Trichlorothane	71-55-6	0.2	1.5	0.3	0.13	0.705	135	0.1%	0.135	20	1.58
Trichlorocthylene	79-01-6	0.005	1.5	0.3	0.13	0.422	94	0.1%	0.094	20	0.033
Xylenes	1330-20-7	1.0	1.5	0.3	0.13	0.279	233	0.1%	0.233	20	9.14
m-xylene	108-38-3	1.0	1.5	0.3	0.13	0.301	196	0.1%	0.196	20	8.44
o-xylene	95-47-6	1.0	1.5	0.3	0.13	0.213	241	0.1%	0.241	20	9.19
p-xylene		1.0	1.5	0.3	0.13	0.314	311	0.1%	0.311	20	10.76

(1) Ground water cleanup level used for calculation. From proposed table 720-1 except for Cr III used 0.1 mg/l and for PAHs used Method B value for B(a)P.
If the Method A ground water cleanup level for B(a)P of 0.1 ug/l is used, the soil cleanup level becomes 1.94 mg/kg for B(a)P.
(2) From equation 747-1. Based on Soil Screening Guidance: Technical Background Document. EPA/540/R-95/12B. May, 1996
(3) Source: Soil Screening Guidance: Technical Background Document. EPA/540/R-95/12B. May, 1996. Exceptions are:
EDB values from ATSDR Toxicological Profile (TP 91/13);
MTBE from USGS final draft report on fuel oxygenates (March, 1996)
Arochlor values for Henry's constant and solubility limit from ATSDR Toxlicological Profile (Dec, 1998); Arochlor Koc from EPA 1994 draft of soil screening guidance
Values for total xylenes are a weighted average of m,o & p xylene based on gasoline composition data from TPH Criterial Working Group--Volume 2 (May 1998).
That is: m = 51% of total xylene; o = 28% of total xylene; and , p = 21% of total xylene.
H' for all metals except mercury assumed = zero. H' for mercury from EPA Soil Screening Guidance.
DDT value for Koc based on 1994 Draft Soil Screening Guidance. If 1996 guidance is used, Koc = 677,934 and soil cleanup level equals 4.07 mg/kg.
(4) Based on review of data available from the literature and WA State sites.
(5) From equation 747-2 for organics. For metals, based on review of data available from the literature and WA State sites.
(6) Calculated using equation 747-1 (3-phase model) with model defaults (as shown in this table) and ground water cleanup level shown in this table.

Table 7: 3-Phase Model Assumptions and Results

3-Phase Model Results														
		Pore Water		NAPL			Pore Water		Vapor		Soil		Sum
	CAS No.	Concentration	Solubility	in	Csat		Concentration	Water Mass	Concentration	Vapor Mass	Concentration	Soil Mass	Mass
		(mg/l) (7)	(mg/l) (3)	Soil? (8)	(mg/kg) (9)		(mg/l) (7)	(mg/kg) (10)	(mg/m^3) (11)	(mg/kg) (12)	(mg/kg) (13)	(mg/kg) (14)	(mg/kg) (15)
Arsenic	7440-38-2	-	-	n/a	-		0.10	0.020	-	-	2.90	2.90	2.92
Benzene	71-43-2	0.10	1,750	No	493		0.10	0.020	22.8	0.0020	0.0062	0.0062	0.028
Cadmium	7440-43-9	0.10	-	n/a	-		0.10	0.020	-	-	0.67	0.67	0.69
Chromium (total)	7440-47-3												
Chromium VI	18540-29-9	1.0	-	n/a	-		1.0	0.20	-	-	19	19	19
Chromium III	16065-83-1	2.0	-	n/a	-		2.0	0.40	-	-	2000	2,000	2000
DDT	50-29-3	0.0060	0.0250	No	10		0.0060	0.0012	0.0020	1.73E-07	2.32	2.32	2.32
Ethyl Benzene	100-41-4	14	169	No	73		14	2.8	4522	0.39	2.86	2.86	6.05
Ethylene dibromide (EDB)	106-93-4	0.00020	4,000	No	1,076		0.00020	0.000040	0.0067	5.82E-07	0.000013	0.000013	0.000054
Lead	7439-92-1	0.30	-	n/a	-		0.30	0.060	-	-	3000	3000	3000
Lindane	58-89-9	0.0040	6.8	No	11		0.0040	0.00080	0.0023	1.99E-07	0.0054	0.0054	0.006
Methylene Chloride	75-09-2	0.10	13,000	No	2,831		0.10	0.020	9.0	0.00078	0.0010	0.0010	0.022
Mercury (inorganic)	7439-97-6	0.040	-	n/a	-		0.040	0.008	19	0.0016	2.08	2.08	2.09
MTBE	1634-04-4	0.40	50,000	No	10,628		0.40	0.080	7.2	0.00062	0.0044	0.0044	0.085
Naphthalene	91-20-3	3.2	31	No	43		3.2	0.64	63	0.0055	3.81	3.81	4.46
cPAH Mistures	na												
Benzo[a]anthracene	56-55-3	0.00024	0.0094	No	3.4		0.00024	0.000048	3.29E-05	2.85E-09	0.09	0.086	0.09
Benzo[b]fluoranthene	205-99-2	0.00024	0.0015	No	1.8		0.00024	0.000048	1.09E-03	9.46E-08	0.30	0.30	0.30
Benzo[k]fluoranthene	207-08-9	0.00024	0.0008	No	1.0		0.00024	0.000048	8.16E-06	7.07E-10	0.30	0.30	0.30
Benzo[a]pryene	50-32-8	0.00024	0.00162	No	1.6		0.00024	0.000048	1.11E-05	9.63E-10	0.23	0.23	0.23
Chrysene	218-01-9	0.00024	0.0016	No	0.64		0.00024	0.000048	9.31E-04	8.07E-08	0.10	0.096	0.10
Dibenzo[a,h]anthracene	53-70-3	0.00024	0.00249	No	4.5		0.00024	0.000048	1.45E-07	1.25E-11	0.43	0.43	0.43
Indeno[1,2,3-cd]pyrene	207-08-9	0.00024	0.000022	Yes	0.076		0.00024	0.000048	1.57E-05	1.36E-09	0.83	0.83	0.83

Table 7: 3-Phase Model Assumptions and Results

3-Phase Model Results														
		Pore Water		NAPL			Pore Water		Vapor		Soil		Sum
	CAS No.	Concentration	Solubility	in	Csat		Concentration	Water Mass	Concentration	Vapor Mass	Concentration	Soil Mass	Mass
		(mg/l) (7)	(mg/l) (3)	Soil? (8)	(mg/kg) (9)		(mg/l) (7)	(mg/kg) (10)	(mg/m^3) (11)	(mg/kg) (12)	(mg/kg) (13)	(mg/kg) (14)	(mg/kg) (15)
PCB Mixtures	1336-36-3												
Arochlor 1016	12674-11-2	0.0020	0.42	No	45		0.0020	0.00040	0.24	2.06E-05	0.21	0.21	0.21
Arochlor 1260		0.0020	0.08	No	66		0.0020	0.00040	0.38	3.28E-05	1.64	1.64	1.65
Tetrachlorothylene (PCE)	127-18-4	0.10	200	No	106		0.10	0.020	75	0.0065	0.0265	0.0265	0.053
Toluene	108-88-3	20	526	No	191		20	4.0	5440	0.47	2.80	2.80	7.3
1,1,1 Trichlorothane	71-55-6	4.0	1,330	No	527		4.0	0.80	2820	0.24	0.54	0.54	1.58
Trichlorocthylene	79-01-6	0.10	1,100	No	364		0.10	0.020	42	0.0037	0.0094	0.0094	0.033
Xylenes	1330-20-7	20	171	No	78		20	4.0	5580	0.48	4.66	4.66	9.1
m-xylene	108-38-3	20	161	No	68		20	4.0	6020	0.52	3.92	3.92	8.4
o-xylene	95-47-6	20	178	No	82		20	4.0	4260	0.37	4.82	4.82	9.2
p-xylene		20	185	No	100		20	4.0	6280	0.54	6.22	6.22	10.8

(7) Pore water concentration = ground water cleanup level X dilution factor

(8) There is NAPL in the soil if the pore water concentration exceeds the solubility limit.

(9) C sat is the soil concentration above which there is NAPL in the soil. It is calculated by substituting the solubility limit for the [ground water cleanup level X DF] in equation 747-1.

(10) Water mass = [Pore water concentration X soil water fraction] / soil bulk density. This is the mass of contaminant in the water phase.

(11) Vapor concentration = Pore water concentration X Henry's Constant X 1000.

(12) Vapor mass = [Vapor concentration X soil air fraction] / soil bulk density. This is the mass of contaminant in the vapor phase.

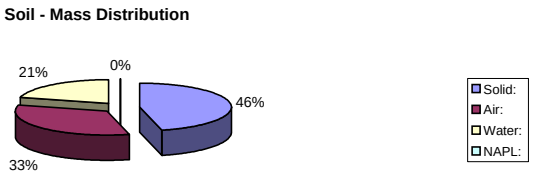
(13) Soil concentration = Pore water concentration X Kd

(14) Soil mass = [Pore water concentration X Kd X soil bulk density] / soil bulk density. This is the mass of contaminant in the soil phase.

(15) Sum mass = water mass + vapor mass + soil mass. This value equals the soil cleanup level.

Table 8: 4-Phase Model Results using Fresh ARCO Gasoline

Solid:	46.1%
Air:	33.0%
Water:	20.9%
NAPL:	NONE
	100.0%



	Equilibrium Composition %	Protective Soil ppm	Predicted G.W. ug/l
Aliphatics	**ARCO 1**		
EC >5-6	29.93%	0.27	3.49
EC >6-8	15.31%	0.14	1
EC >8-10	3.77%	0.03	0.0
EC >10-12	2.56%	0.02	0.00
EC >12-16		0.00	0.00
EC >16-21		0.00	0.00
Aromatics		0.00	
Benzene	3.67%	0.033	**5.86**
Toluene	14.62%	0.13	18
Ethylbenzene	2.73%	0.02	3
Xylenes	13.45%	0.12	13
EC >8-10	4.15%	0.04	1
EC >10-12	7.47%	0.07	1
EC >12-16	0.0191	0.02	0
EC >16-21		0.00	0
EC >21-35		0.00	0
Naphthalene	0.43%	0.00	0
MTBE		0.00	0
Total	100.00%	0.90	47

Total soil porosity: default is 0.43	n	0.430	Unitless
Volumetric water content: default is 0.3	Qw	0.300	Unitless
Initial volumetric air content: default is 0.13	Qa	0.130	Unitless
Soil bulk density measured: default is 1.5	rb	1.500	kg/l
*or, use soil bulk density computed @solid density=2.65kg/l:		1.811	kg/l
Fraction Organic Carbon: default is 0.001	foc	0.0010	Unitless
Dilution Factor: default is 20	DF	20.0	Unitless

Soil Concentration: **0.90**

Predicted Ground Water TPH (ug/l): **47**

HI @ Predicted G.W. Concentration: 0.27

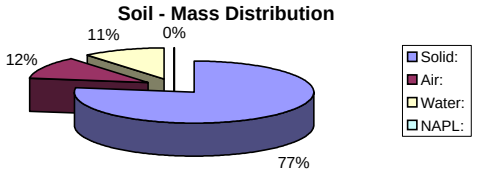
Volumetric NAPL Content, QNAPL :	NAPL phase is not existing!	
NAPL Saturation (%), QNAPL/n:	N/A	
Type of model used for computation:	3-Phase Model	
Computation completed?	Yes!	
TPH Distribution @ 4-phase in soil pore system:		
Total Mass distributed in Water Phase:	20.89%	in Solid: 46.11%
Total Mass distributed in Air Phase:	33.00%	in NAPL: NONE

Soil Concentration = 0.90

Gasoline composition from 9/3/98 neat product analysis conducted by Northcreek Analytical, Inc under contract to Ecology.
This is a summary sheet from an Excel program created by Hun Seak Park while at the Pollution Liability Insurance Agency (PLIA) and modified by Ecology staff.
For this particular composition, the allowable soil concentration is controlled by the predicted concentration of benzene (5.86 ug/l) in the ground water.

Table 9: 4-Phase Model Results using ARCO #5 (ARCO composition closest to 0.1% benzene)

Solid:	77.2%
Air:	11.8%
Water:	11.1%
NAPL:	NONE
	100.0%



	Equilibrium Composition %	Protective Soil ppm	Predicted G.W. ug/l
Aliphatics	**ARCO 5**		
EC >5-6	1.36%	0.38	4.93
EC >6-8	13.4%	3.74	22
EC >8-10	12.8%	3.59	4.6
EC >10-12	10.8%	3.02	0.58
EC >12-16		0.00	0.00
EC >16-21		0.00	0.00
Aromatics		0.00	
Benzene	0.066%	0.019	3.29
Toluene	2.8%	0.80	109
Ethylbenzene	1.8%	0.51	59
Xylenes	10.0%	2.81	308
EC >8-10	11.6%	3.26	89
EC >10-12	26.3%	7.35	135
EC >12-16	7.7%	2.16	21
EC >16-21		0.00	0
EC >21-35		0.00	0
Naphthalene	1.27%	0.35	17
MTBE		0.00	0
Total	100.00%	28.00	774

Total soil porosity: default is 0.43	n	0.430	Unitless
Volumetric water content: default is 0.3	Qw	0.300	Unitless
Initial volumetric air content: default is 0.13	Qa	0.130	Unitless
Soil bulk density measured: default is 1.5	rb	1.500	kg/l
*or, use soil bulk density computed @solid density=2.65kg/l:		1.811	kg/l
Fraction Organic Carbon: default is 0.001	foc	0.0010	Unitless
Dilution Factor: default is 20	DF	20.0	Unitless

Soil Concentration: **28.00**

Predicted Ground Water TPH (ug/l: **774**

HI @ Predicted G.W. Concentration: 1.01

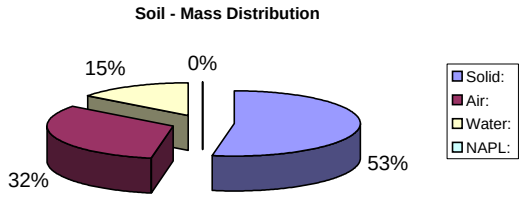
Volumetric NAPL Content, QNAPL :	NAPL phase is not existing!
NAPL Saturation (%), QNAPL/n:	N/A
Type of model used for computation:	3-Phase Model
Computation completed?	Yes!
TPH Distribution @ 4-phase in soil pore system:	
Total Mass distributed in Water Phase: 11.05%	in Solid: 77.18%
Total Mass distributed in Air Phase: 11.76%	in NAPL: NONE

Soil Concentration = 28.00

Gasoline composition is fresh product weathered to approximately 0.1% benzene, simulated by removal of mass in dissolved and vapor phases by successive model runs.
This benzene composition is typical of soil benzene concentrations found in soils at gasoline contaminated sites in WA State.
This is a summary sheet from an Excel program created by Hun Seak Park while at the Pollution Liability Insurance Agency (PLIA) and modified by Ecology staff.
For this particular composition, the allowable soil concentration is controlled by the predicted hazard index of the gasoline mixture in the ground water.

Table 10: 4-Phase Model Results using Fresh BP Gasoline

Solid:	52.9%
Air:	32.4%
Water:	14.8%
NAPL:	NONE
	100.0%



	Equilibrium Composition %	Protective Soil ppm	Predicted G.W. ug/l
Aliphatics	**Fresh BP**		
EC >5-6	28.48%	0.28	3.69
EC >6-8	17.2%	0.17	1
EC >8-10	4.6%	0.05	0.1
EC >10-12	5.5%	0.06	0.01
EC >12-16		0.00	0.00
EC >16-21		0.00	0.00
Aromatics		0.00	
Benzene	2.9%	0.029	**5.16**
Toluene	7.7%	0.08	11
Ethylbenzene	1.7%	0.02	2
Xylenes	8.9%	0.09	10
EC >8-10	5.5%	0.06	2
EC >10-12	9.2%	0.09	2
EC >12-16	6.6%	0.07	1
EC >16-21	0.0%	0.00	0
EC >21-35	0.0%	0.00	0
Naphthalene	1.6%	0.02	1
MTBE	0.0%	0.00	0
Total	100.0%	1.00	37

Total soil porosity: default is 0.43	n	0.430	Unitless
Volumetric water content: default is 0.3	Qw	0.300	Unitless
Initial volumetric air content: default is 0.13	Qa	0.130	Unitless
Soil bulk density measured: default is 1.5	rb	1.500	kg/l
*or, use soil bulk density computed @solid density=2.65kg/l:		1.811	kg/l
Fraction Organic Carbon: default is 0.001	foc	0.0010	Unitless
Dilution Factor: default is 20	DF	20.0	Unitless

Soil Concentration: **1.00**

Predicted Ground Water TPH (ug/l): **37**

HI @ Predicted G.W. Concentration: 0.24

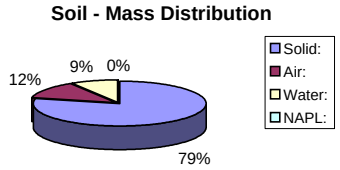
Volumetric NAPL Content, QNAPL :	NAPL phase is not existing!		
NAPL Saturation (%), QNAPL/n:	N/A		
Type of model used for computation:	3-Phase Model		
Computation completed?	Yes!		
TPH Distribution @ 4-phase in soil pore system:			
Total Mass distributed in Water Phase:	14.75%	in Solid:	52.87%
Total Mass distributed in Air Phase:	32.38%	in NAPL:	NONE

Soil Concentration = 1.00

Gasoline composition from 9/3/98 neat product analysis conducted by Northcreek Analytical, Inc under contract to Ecology.
This is a summary sheet from an Excel program created by Hun Seak Park while at the Pollution Liability Insurance Agency (PLIA) and modified by Ecology staff.
For this particular composition, the allowable soil concentration is controlled by the predicted concentration of benzene (5.16 ug/l) in the ground water.

Table 11: 4-Phase Model Results for BP #4 (BP composition closest to 0.1% benzene)

Solid:	78.7%
Air:	12.4%
Water:	8.9%
NAPL:	NONE
	100.0%



	Equilibrium Composition %	Protective Soil ppm	Predicted G.W. ug/l
Aliphatics	**BP #4**		
EC >5-6	2.640%	0.58	7.53
EC >6-8	14.131%	3.11	18
EC >8-10	9.935%	2.19	2.8
EC >10-12	13.808%	3.04	0.58
EC >12-16		0.00	0.00
EC >16-21		0.00	0.00
Aromatics			
Benzene	0.127%	0.028	4.95
Toluene	2.003%	0.44	61
Ethylbenzene	1.135%	0.25	29
Xylenes	6.427%	1.41	155
EC >8-10	10.248%	2.25	62
EC >10-12	20.242%	4.45	82
EC >12-16	16.106%	3.54	34
EC >16-21	0.000%	0.00	0
EC >21-35	0.000%	0.00	0
Naphthalene	3.198%	0.70	34
MTBE	0.000%	0.00	0
			0
Total	100.000%	22.00	490

Total soil porosity: default is 0.43	n	0.430	Unitless
Volumetric water content: default is 0.3	Qw	0.300	Unitless
Initial volumetric air content: default is 0.13	Qa	0.130	Unitless
Soil bulk density measured: default is 1.5	rb	1.500	kg/l
*or, use soil bulk density computed @solid density=2.65kg/l:		1.811	kg/l
Fraction Organic Carbon: default is 0.001	foc	0.0010	Unitless
Dilution Factor: default is 20	DF	20.0	Unitless

Soil Concentration: **22.00**

Predicted Ground Water TPH (ug/l): **490**

HI @ Predicted G.W. Concentration: 0.92

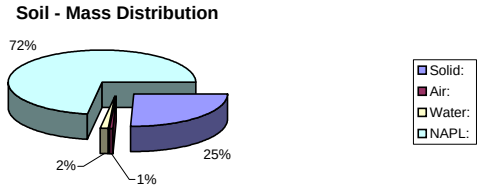
Volumetric NAPL Content, QNAPL :	NAPL phase is not existing!		
NAPL Saturation (%), QNAPL/n:	N/A		
Type of model used for computation:	3-Phase Model	78.72%	
Computation completed?	Yes!		
TPH Distribution @ 4-phase in soil pore system:			
Total Mass distributed in Water Phase:	8.90%	in Solid:	NONE
Total Mass distributed in Air Phase:	12.37%	in NAPL:	

Soil Concentration = 22.00

Gasoline composition is fresh product weathered to approximately 0.1% benzene, simulated by removal of mass in dissolved and vapor phases by successive model runs.
This benzene composition is typical of soil benzene concentrations found in soils at gasoline contaminated sites in WA State.
This is a summary sheet from an Excel program created by Hun Seak Park while at the Pollution Liability Insurance Agency (PLIA) and modified by Ecology staff.
For this particular composition, the allowable soil concentration is controlled by the predicted concentration of benzene (4.95 ug/l) in the ground water.

Table 12: 4-Phase Model Results for BP #24 (least weathered composition with HI<1 at 100 PPM in the Soil)

Solid:	25.5%
Air:	0.6%
Water:	1.5%
NAPL:	72.4%
	100.0%



	Equilibrium Composition %	Protective Soil ppm	Predicted G.W. ug/l
Aliphatics	**BP #24**		
EC >5-6	0.0%	0.00	0.00
EC >6-8	0.1%	0.06	0
EC >8-10	10.5%	10.98	2.8
EC >10-12	31.4%	32.94	0.61
EC >12-16	0.0%	0.00	0.00
EC >16-21	0.0%	0.00	0.00
Aromatics		0.00	
Benzene	0.0%	0.000	0.00
Toluene	0.0%	0.00	0
Ethylbenzene	0.0%	0.00	0
Xylenes	0.0%	0.01	1
EC >8-10	3.7%	3.93	71
EC >10-12	21.2%	22.31	206
EC >12-16	31.3%	32.84	88
EC >16-21	0.0%	0.00	0
EC >21-35	0.0%	0.00	0
Naphthalene	1.8%	1.92	30
MTBE	0.0%	0.00	0
Total	100.0%	105.00	399

Total soil porosity: default is 0.43	n	0.430	Unitless
Volumetric water content: default is 0.3	Qw	0.300	Unitless
Initial volumetric air content: default is 0.13	Qa	0.130	Unitless
Soil bulk density measured: default is 1.5	rb	1.500	kg/l
*or, use soil bulk density computed @solid density=2.65kg/l:		1.811	kg/l
Fraction Organic Carbon: default is 0.001	foc	0.0010	Unitless
Dilution Factor: default is 20	DF	20.0	Unitless

Soil Concentration: **105.00**

Predicted Ground Water TPH (ug/l: **399**

HI @ Predicted G.W. Concentration: 1.00

Volumetric NAPL Content, QNAPL :	0.000
NAPL Saturation (%), QNAPL/n:	0.03%
Type of model used for computation:	4-Phase Model
Computation completed?	Yes!

TPH Distribution @ 4-phase in soil pore system:

Total Mass distributed in Water Phase: 1.52% in Solid: 25.49%

Total Mass distributed in Air Phase: 0.62% in NAPL: 72.37%

Soil Concentration = 105.00

Gasoline composition is fresh product weathered until 100 PPM in the soil will pass, simulated by removal of mass in dissolved and vapor phases by successive model runs.
This composition represents highly weathered gasoline with no detectable benzene in the soil.
This is a summary sheet from an Excel program created by Hun Seak Park while at the Pollution Liability Insurance Agency (PLIA) and modified by Ecology staff.
For this particular composition, the allowable soil concentration is controlled by the predicted hazard index of the gasoline mixture in the ground water.