

Soil Cleanup Levels For Unrestricted Land Use

Table 740-1

Notes on Developing Method A Table Values
Washington State Department of Ecology
Clare Notes

Method A Notes.doc

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 health 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 740-1
Method A Soil Cleanup Levels for Unrestricted Land Uses

Attached are several tables in excel format providing information on the development of the Method A soil cleanup levels for unrestricted land uses in Table 740-1, WAC 173-340-900.

Table 1: A quick summary providing Method A cleanup levels for unrestricted land uses (Table 740-1) 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 B soil direct contact cleanup values for unrestricted land uses for carcinogens using equation 740-2 in WAC 173-340-740(3)(b)(iii)(B)(II).

Table 4: Describes the assumptions used to calculate the standard Method B soil direct contact cleanup values for unrestricted land uses for non-carcinogens using equation 740-1 in WAC 173-340-740(3)(b)(iii)(B)(I).

Table 5: Describes the assumptions and equation used to calculate the modified Method B values for unrestricted land uses assuming concurrent soil ingestion plus dermal (skin) absorption for carcinogens using equation 740-5 in WAC 173-340-740(3)(b)(iii)(B).

Table 6: Describes the assumptions and equation used to calculate the modified Method B values for unrestricted land uses assuming concurrent soil ingestion plus dermal (skin) absorption for noncarcinogens using equation 740-4 in WAC 173-340-740(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, Table 740-1, Unrestricted Land Use Soil Values

Hazardous Substance	CAS Number	1991 Method A Cleanup Level mg/kg	2001 adopted Method A Cleanup Level mg/kg	Basis for Standard
Arsenic	7440-38-2	20.0	20	Soil ingestion using equation 740-2, and leaching using 3-phase model, adjusted for natural 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	0.1	Soil ingestion using equation 740-2. This can also be used as the total toxic equivalents for all cPAHs. See WAC 173-340-708(8).
Cadmium	7440-43-9	2	2	Protection of drinking water, adjusted for PQL.
Chromium (total)	7440-47-3	100.0	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	1	3	Soil ingestion using equation 740-2.
Ethylbenzene	100-41-4	20.0	6	Protection of drinking water--3 phase model.
Ethylene dibromide (EDB)	106-93-4	0.001	0.005	Protection of drinking water--3 phase model, adjusted for PQL.
Lead	7439-92-1	250.0	250	Soil ingestion. See 1991 responsiveness summary for explanation of calculation. (1)
Lindane	58-89-9	1	0.01	Protection of drinking water--3 phase model, 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 all naphthalene, 1-methyl naphthalene and 2-methyl naphthalene.
PAHs (carcinogenic)		1.0	none	Replaced by Benzo(a)Pyrene, above.
PCB Mixtures	1336-36-3	1	1	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	40.0	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	20.0	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 (3)	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 (2)	4000	Protection of drinking water--residual saturation

(1) Ecology decided not to change 1991 Method A value although the "natural background" value of 20 is now known to be based on data from areas impacted by the former Tacoma smelter. Ecology intends

(2) 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.

(3) 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 of Exposure Pathways Considered in Establishing the Method A Soil Cleanup Values in Table 740-1

Method A Soil Cleanup Levels -for Unrestricted Land Uses										
Hazardous Substance	CAS Number	1991			Dermal +	Dermal +	Leaching	100 X		
		Method A Cleanup Level mg/kg (1)	Ingestion Carcinogen mg/kg (2)	Ingestion Noncarc. mg/kg (3)	Ingestion Carcinogen mg/kg (4)	Ingestion Noncarc. mg/kg (5)	3-Phase Model mg/kg (6)	Ground water C/U level mg/kg (7)	Vapor mg/kg (8)	Other mg/kg (9)
Arsenic	7440-38-2	20.0	0.67	24	0.62	22	2.9	0.5		
Benzene	71-43-2	0.5	34	240	34		0.028	0.5		0.028
Benzo(a)Pyrene	50-32-8	none	0.14		0.10		0.23/1.9 (11)	0.01		
Cadmium	7440-43-9	2.0		80		74	0.69	0.5		
Chromium (total)	7440-47-3	100.0								
	18540-29-9			240		128	19	5		100
Chromium VI	16065-83-1			120,000		45,000	2,000	10		
Chromium III										
DDT	50-29-3	1.0	2.9	40	2.7	37	4.1	0.03		
Ethylbenzene	100-41-4	20.0		8,000		7,400	6.1	70		
Ethylene dibromide (EDB)	106-93-4	0.001	0.012		0.011		0.00005	0.001		
Lead	7439-92-1	250.0		250/370(10)			3,000	1.5		
Lindane	58-89-9	1.0	0.77	24	0.65	20	0.0062	0.02		
Methylene chloride	75-09-2	0.5	130	4,800	130	4,800	0.022	0.5		
Mercury (inorganic)	7439-97-6	1.0		24		18	2.1	0.2		
MTBE	1634-04-4	none					0.085	2		
Naphthalene	91-20-3	none		1,600		1,200	4.5	16		
PAHs (carcinogenic)(11)		1.0	0.14		0.10		0.23/1.9 (11)	0.01		
PCB Mixtures (12)	1336-36-3	1.0	0.5/2.5/14	1.6/5.6	0.4/1.8/10	1.2/4.1	0.2/1.6	0.01		
Tetrachloroethylene	127-18-4	0.5	20	800	18	740	0.053	0.5		
Toluene	108-88-3	40.0		16,000		15,000	7.3	100		
1,1,1 Trichloroethane	71-55-6	20.0		72,000		72,000	1.6	20		
Trichloroethylene	79-01-5	0.5	91		84		0.033	0.5		
Xylenes	1330-20-7	20.0		160,000		150,000	9.1	100		
(1) From WAC 173-340-740 Table 2 [1/26/96 revision].										
(2) Calculated using equation 740-2.										
(3) Calculated using equation 740-1.										
(4) Calculated using equation 740-5. Except for petroleum mixtures, not used in setting cleanup levels since defaults not changed for other pathways.										
(5) Calculated using equation 740-4. Except for petroleum mixtures, 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 Method B value for B(a)P.										
(7) Calculated using 1991 method of 100 X table 720-1 ground water cleanup level. Except for Cr III used 100 ppb.										
(8) Vapor values not calculated.										
(9) Benzene from 4 phase leaching model, assuming part of weathered gasoline mixture; Chromium VI is dust value documented in 1991 MTCA responsiveness summary.										
(10) 1st value using IEUBK model with 200 mg/day soil ingestion rate and is also value documented in 1991 responsiveness summary; 2nd value using IEUBK model with EPA defaults.										
(11) Based on benzo (a) pyrene. First value for 3-phase model results is using the Method B ground water cleanup level, the second value is using the Method A value in proposed Table 720-1.										
(12) PCB values based on various arochlors and IRIS values for PCB mixtures.										

Table 2: Summary Table of Exposure Pathways Considered in Establishing the Method A Soil Cleanup Values in Table 740-1

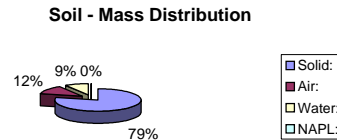
Method A Soil Cleanup Levels -for Unrestricted Land Uses										
Hazardous Substance	Ecological Simplified Evaluation	Ecological Indicator Concentration	Most Stringent Non-Eco Path	Controlling Non-Eco Pathway	ARARs	PQL	Background	1991 Method A Cleanup Level	2001 Adopted Method A	Basis for Standard
	mg/kg (1)	mg/kg (2)	mg/kg		mg/kg	mg/kg (3)	mg/kg (4)	mg/kg	mg/kg	
Arsenic	20	7	0.7	Ingestion		1 (SW7060)	7 & 20	20	20	Natural background. (5)
Benzene			0.03	Leaching		0.005 (SW8260B)		0.5	0.03	Protection of drinking water--4 phase model
Benzo(a)Pyrene	30	12	0.1	Ingestion		0.05 (SW8270C)		none	0.1	Ingestion (7)
Cadmium	25	4	0.69	Leaching		2 (SW6010A)	1	2.0	2	Leaching, adjusted for PQL. (6)
Chromium (total)	42	42				2 (SW6010A)	42	100		
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.
Chromium III	1	0.75	2.9	Ingestion		0.05 (SW8081)		1.0	3	Ingestion.
Ethylbenzene			6.1	Leaching		0.005 (SW8260B)		20	6	Protection of drinking water--3 phase model.
Ethylene dibromide (EDB)			0.00005	Leaching		0.005 (SW8260B)		0.001	0.005	Leaching, adjusted for PQL
Lead	220	50	250	Ingestion		5.0 (SW6010A)	17	250	250	Ingestion (5)
Lindane	10	6	0.0062	Leaching		0.01 (SW8081)		1.0	0.01	Leaching, adjusted for PQL
Methylene chloride			0.022	Leaching		0.005 (SW8260B)		0.5	0.02	Protection of drinking water--3 phase model.
Mercury (inorganic)	9	0.1	2.1	Leaching		0.1 (SW7471)	0.07	1.0	2	Protection of drinking water--3 phase model.
MTBE			0.085	Leaching		0.005 (SW8260B)		none	0.1	Protection of drinking water--3 phase model.
Naphthalenes			4.5	Leaching		0.5 (SW8260B)		none	5	Protection of drinking water--3 phase model. (9)
PAHs (carcinogenic)	30	12	0.1	Ingestion		0.05 (SW8270C)		1.0	none	Replaced with benzo(a)pyrene.
PCB Mixtures	2	0.65	0.2	Leaching	1.0	0.04 (SW8082)		1.0	1	ARAR (8)
Tetrachloroethylene			0.05	Leaching		0.005 (SW8260B)		0.5	0.05	Protection of drinking water--3 phase model.
Toluene		200	7.3	Leaching		0.005 (SW8260B)		40	7	Protection of drinking water--3 phase model.
1,1,1 Trichloroethane			1.6	Leaching		0.005 (SW8260B)		20	2	Protection of drinking water--3 phase model.
Trichloroethylene			0.033	Leaching		0.005 (SW8260B)		0.5	0.03	Protection of drinking water--3 phase model.
Xylenes			9.1	Leaching		0.015 (SW8260B)		20	9	Protection of drinking water--3 phase model.
(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) 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) Ecology decision not to change at this time. Ecology intends to review and, if appropriate, update these values in a future rulemaking.										
(6) 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.										
(7) This can also be used as the total toxic equivalents for all cPAHs. See WAC 173-340-708(8).										
(8) Cleanup level is sum of all PCBs. ARAR is for high occupancy areas with no cap, from 40 CFR Part 761.61 (EPA rule governing disposal and cleanup of PCB contaminated facilities under TSCA).										
(9) 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 of Exposure Pathways Considered in Establishing the Method A Soil Cleanup Values in Table 740-1

Method A Soil Cleanup Levels -for Unrestricted Land Uses										
Hazardous Substance	Ecological Simplified	Ecological Indicator	Most Stringent	Controlling	ARARs	PQL	Background	1991 Method A Cleanup Level	2001 Adopted Method A	Basis for Standard
	mg/kg (1)	mg/kg (2)	mg/kg	Pathway	mg/kg	mg/kg (3)	mg/kg	mg/kg	mg/kg	
TPH (total)										
Gasoline range organics										
GRO with benzene	200	100	23 to 28	Leaching		5 (NWTPH-Gx)	0	100	30	Protection of drinking water (4)
GRO without benzene	200	100	105	Leaching		5 (NWTPH-Gx)	0	100	100	Protection of drinking water (5)
Diesel Range Organics	460	200	2000	Leaching		25 (NWTPH-Dx)	0	200	2000	Residual Saturation
Heavy Oils (6)	460	200	2000	Leaching		100 (NWTPH-Dx)	0	200	2000	Residual Saturation
Electrical Insulating Mineral Oil			4000	Leaching		100 (NWTPH-Dx)	0	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 11: 4-Phase Model Results using ARCO #4 (ARCO 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
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
 Computation completed? **Yes!**
 TPH Distribution @ 4-phase in soil pore system:
 Total Mass distributed in Water Phase: 8.90% in Solid: 78.72%
 Total Mass distributed in Air Phase: 12.37% in NAPL: NONE

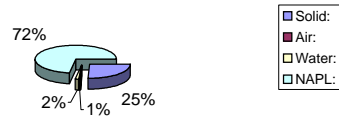
Soil Concentration = 22.00

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%

Soil - Mass Distribution



	Equilibrium Composition %	Protective Soil ppm	Predicted G.W. ug/l
Aliphatics	BP #24		
EC >5-6	0.0000%	0.00	0.0
EC >6-8	0.0601%	0.06	0.2
EC >8-10	10.4590%	10.98	2.8
EC >10-12	31.3676%	32.94	0.6
EC >12-16	0.0000%	0.00	0.0
EC >16-21	0.0000%	0.00	0.0
Aromatics		0.00	
Benzene	0.0000%	0.000	0.0
Toluene	0.0000%	0.00	0.0
Ethylbenzene	0.0012%	0.00	0.1
Xylenes	0.0098%	0.01	0.7
EC >8-10	3.7452%	3.93	70.8
EC >10-12	21.2490%	22.31	205.9
EC >12-16	31.2770%	32.84	88.2
EC >16-21	0.0000%	0.00	0.0
EC >21-35	0.0000%	0.00	0.0
Naphthalene	1.8311%	1.92	30.1
MTBE	0.0000%	0.00	0.0
Total	100.0000%	105.00	399.3

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.