Risk-Based Equations and Calculations for January 11, 2010 Meeting

These figures and tables are designed to illustrate some of the risk assessment/risk management issues that Ecology has identified over the last year.

- Figure 1: MTCA Ground Water Cleanup Equations: This figure includes the current MTCA equations and parameters for establishing ground water cleanup levels.
- Figure 2: Ground Water Cleanup Equation with Age Adjustments in Exposure Parameters: This figure shows how cleanup levels would be calculated if we took into account the differences in exposure between adults and children. The equation and child-specific exposure parameters are based on the methods described in the Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens published by EPA in March 2005.
- Figure 3: Ground Water Cleanup Equations with Early-Life Stage Adjustments: This figure shows how cleanup levels would be calculated if we took into account recent scientific work and regulatory guidance on child susceptibility to chemical carcinogens. As with Figure 2, the equation and child-specific exposure parameters are based on the methods described in the Supplemental Guidance for Assessing Susceptibility from Early-Life Exposure to Carcinogens published by EPA in March 2005. This equation also includes the Age Dependent Adjustment Factors (ADAFs) developed by EPA to account for the differences in child and adult susceptibility to carcinogens. The California Environmental Protection Agency has developed similar procedures. However, the California guidance applies these adjustments to all carcinogens. The EPA guidance focuses on carcinogens that are believed to act through a mutagenic mode of action.
- Table 1: Arsenic: Comparison of Ground Water Cleanup Level Options Using Current Toxicity Data and Risk Assessment Guidance: This Table is designed to illustrate some of the practical implications for cleanup levels associated with the use of new scientific information and regulatory guidance.
- Table 2: Benzene: Comparison of Ground Water Cleanup Level Options Using Current Toxicity Data and Risk Assessment Guidance: This Table is designed to illustrate some of the practical implications for cleanup levels associated with the use of new scientific information and regulatory guidance.
- Table 3: Benzo[a]pyrene: Comparison of Ground Water Cleanup Level Options Using Current Toxicity Data and Risk Assessment Guidance: This Table is designed to illustrate some of the practical implications for cleanup levels associated with the use of new scientific information and regulatory guidance.
- Table 4: Trichloroethylene: Comparison of Ground Water Cleanup Level Options Using Current Toxicity Data and Risk Assessment Guidance: This Table is designed to illustrate some of the practical implications for cleanup levels associated with the use of new scientific information and regulatory guidance.

Figure 1 - MTCA Ground Water Cleanup Level Equations

Ground Water Cleanup Level based on Non-Carcinogen Risks (Equation 720-1)

$$\text{GW Cleanup Level (non-cancer)} = \frac{RfD * ABW * HQ * AT * UCF}{DWIR * ED * INH * DWF}$$

Ground Water Cleanup Level based on Carcinogenic Risks (Equation 720-2)

$$\text{GW Cleanup Level (cancer)} = \frac{Risk * ABW * AT * UCF}{CPF * DWIR * ED * INH * DWF}$$

Parameter	Definition	Value	
		Equation 720-1	Equation 720-2
GW Cleanup Level	Ground water cleanup level, ug/L	Chemical-specific	
Risk	Target cancer risk level, unitless	NA	1.00E-06
AT	Averaging time, years	6	75
ABW	Average body weight, kg	16	70
CPF	Oral Cancer potency factor kg-day/mg	Chemical-specific	
UCF	Unit conversion factor ug/mg	1.E+03	1.E+03
DWIR	Drinking water ingestion rate, L/day	1	2
ED	Exposure duration, years	6	30
INH	Inhalation correction factor, unitless	Chemical-specific	
DWF	Drinking Water Fraction, unitless	1	1
HQ	Hazard quotient, unitless	1	NA
RfD	Oral refernce dose, mg/kg/day	Chemical-specific	

Figure 2 - Ground Water Cleanup Equation with Age-Specific Exposure Adjustments

$$\text{GW Cleanup Level } \mu g/L = \frac{1}{\dfrac{1}{C_{GW\ child\ (0\text{-}6\ years)}} + \dfrac{1}{C_{GW\ adult\ 6\text{-}30\ yr}}}$$

Where

$$\text{GW cleanup level (children - 0-6 years)} = \frac{\mathbf{Risk * ABW_{child} * AT * UCF_1}}{\mathbf{CPF * DWIR_{child} * ED_{child} * INH * DWF}}$$

$$\text{GW cleanup level (Adult 6-30 yr)} = \frac{\mathbf{Risk * ABW_{adult} * AT * UCF_1}}{\mathbf{CPF * DWIR_{adult} * ED_{adult} * INH * DWF}}$$

Parameter	Definition	Value
$C_{GW\text{-}o\text{-}adj}$	Age Adjusted Drinking Water Cleanup Level	
Risk	Target cancer risk level, unitless	1.00E-06
ABW	Average body weight, kg	
	child	16
	adult	70
AT	Averaging time, years	75
CPF	Cancer potency factor kg-day/mg	Chemical-specific
DWIR	Drinking water ingestion rate, L/day	
	child	1
	adult	2
ED	Exposure duration, years	
	child	6
	adult	30
INH	Inhalation correction factor, unitless	Chemical-specific
UCF_1	Unit conversion factor ug/mg	1000
DWF	Drinking Water Fraction, unitless	1

Figure 3 - Ground Water Cleanup Equation with Early Life Stage Adjustments

$$\text{GW Cleanup Level } \mu g/L = \frac{1}{\frac{1}{C_{GW\ 0\text{-}2\ yr}} + \frac{1}{C_{GW\ 2\text{-}6\ yr}} \quad \frac{1}{C_{GW\ 6\text{-}16\ yr}} \quad \frac{1}{C_{GW\ 16\text{-}30\ yr}}}$$

Where

$$\text{GW cleanup level (0-2 yr)} = \frac{Risk * ABW_{0\text{-}2} * AT * UCF_1}{CPF * ADAF_{0\text{-}2} * DWIR_{0\text{-}2} * ED_{0\text{-}2} * INH}$$

$$\text{GW cleanup level (2-6 yr)} = \frac{Risk * ABW_{2\text{-}6} * AT * UCF_1}{CPF * ADAF_{2\text{-}6} * DWIR_{2\text{-}6} * ED_{2=6} * INH}$$

$$\text{GW cleanup level (6-16 yr)} = \frac{Risk * ABW_{6\text{-}16} * AT * UCF_1}{CPF * ADAF_{6\text{-}16} * DWIR_{6\text{-}16} * ED_{6\text{-}16} * INH}$$

$$\text{GW cleanup level (16-30yr)} = \frac{Risk * ABW_{16\text{-}30} * AT * UCF_1}{CPF * ADAF_{16\text{-}30} * DWIR_{16\text{-}30} * ED_{16\text{-}30} * INH}$$

Figure 3 (Continued)

Parameter	Definition	Value
$C_{GW\text{-}o\text{-}adj}$	Age Adjusted Drinking Water Cleanup Level	
Risk	Target cancer risk level, unitless	1.00E-06
ABW	Average body weight, kg	
	0-2 year age interval	16
	2-6 year age interval	16
	6-16 year age interval	70
	16-30 year age interval	70
ADAF	Age Dependent Adjustment Factor, unitless	
	0-2 year age interval	10
	2-6 year age interval	3
	6-16 year age interval	3
	16-30 year age interval	1
AT	Averaging time, years	75
CPF	Cancer potency factor kg-day/mg	Chemical-specific
DWIR	Drinking water ingestion rate, L/day	
	0-2 year age interval	1
	2-6 year age interval	1
	6-16 year age interval	2
	16-30 year age interval	2
ED	Exposure duration, years	
	0-2 year age interval	2
	2-6 year age interval	4
	6-16 year age interval	10
	16-30 year age interval	14
INH	Inhalation correction factor, unitless	Chemical-specific
UCF_1	Unit conversion factor ug/mg	1000
DWF	Drinking Water Fraction, unitless	1

Table 1 - Arsenic

Comparison of Ground Water Cleanup Levels Options Using Current Toxicity Data and Risk Assessment Guidance

		Risk-Based Ground Water Level (one-in-a million cancer risk)	Implications for GW Cleanup Levels
Current Rule Equations and 2001 Toxicological Data	Risk-Based Ground Water Concentration Using 2001 Toxicological Data and Equation 720-2 (Figure 1)	0.06 ug/L	Ground water cleanup levels are established at natural background levels (5 ug/L).
Current Rule Equations with New Toxicity Values	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III and Equation 720-2 (Figure 1)	0.06 ug/L	Ground water cleanup levels would continue to be established at natural background levels (5 ug/L).
Age-Adjusted Equations	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III and Age-Adjusted Version of Equation 720-2 (Figure 2)	0.05 ug/L	Ground water cleanup levels would continue to be established at natural background levels (5 ug/L).
EPA Early Life Cancer Policy	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III, Age-Adjusted Version of Equation 720-2 With EPA Policy on Early-Life Stage Carcinogens (Figure 3)	0.05 ug/L	Ground water cleanup levels would continue to be established at natural background levels (5 ug/L).
CalEPA Early Life Cancer Policy	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III, Age-Adjusted Version of Equation 720-2 With California EPA Policy on Early-Life Stage Carcinogens (Figure 3)	0.02 ug/L	Ground water cleanup levels would continue to be established at natural background levels (5 ug/L).

Table 2 - Benzene

Comparison of Ground Water Cleanup Level Options Using Current Toxicity Data and Risk Assessment Guidance

		Risk-Based Ground Water Level (one-in-a million cancer risk)	Implications for GW Cleanup Levels
Current Rule Equations and 2001 Toxicological Data	Risk-Based Ground Water Concentration Using 2001 Toxicological Data and Equation 720-2 (Figure 1)	1.5 ug/L	Ground water cleanup levels are based on MCL (5 ug/L).
Current Rule Equations with New Toxicity Values	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III and Equation 720-2 (Figure 1)	0.8 ug/L	Ground water cleanup levels would continue to be based on MCL (5 ug/L). [May be impacted by decisions on vapor intrusion.]
Age-Adjusted Equations	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III and Age-Adjusted Version of Equation 720-2 (Figure 2)	0.6 ug/L	Ground water cleanup levels would continue to be based on MCL (5 ug/L). [May be impacted by decisions on vapor intrusion.]
EPA Early Life Cancer Policy	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III, Age-Adjusted Version of Equation 720-2 With EPA Policy on Early-Life Stage Carcinogens (Figure 3)	0.6 ug/L	Ground water cleanup levels would continue to be based on MCL (5 ug/L). [May be impacted by decisions on vapor intrusion.]
CalEPA Early Life Cancer Policy	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III, Age-Adjusted Version of Equation 720-2 With California EPA Policy on Early-Life Stage Carcinogens (Figure 3)	0.3 ug/L	Ground water cleanup levels would be based on MCL (5 ug/L) adjusted for cancer risk (10-5). [May be impacted by decisions on vapor intrusion.]

Table 3 - Benzo[a]pyrene

Comparison of Ground Water Cleanup Level Options Using Current Toxicity Data and Risk Assessment Guidance

		Risk-Based Ground Water Level (one-in-a million cancer risk)	Implications for GW Cleanup Levels
Current Rule Equations and 2001 Toxicological Data	Risk-Based Ground Water Concentration Using 2001 Toxicological Data and Equation 720-2 (Figure 1)	0.01 ug/L	Ground water cleanup levels based on MCL adjusted to 10-5 risk (@ 0.1 ug/L). PQL may be a limiting factor.
Current Rule Equations with New Toxicity Values	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III and Equation 720-2 (Figure 1)	0.01 ug/L	Ground water cleanup levels would continue to be based on MCL adjusted to 10-5 risk (@ 0.1 ug/L). PQL may be a limiting factor.
Age-Adjusted Equations	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III and Age-Adjusted Version of Equation 720-2 (Figure 2)	0.01 ug/L	Ground water cleanup levels would continue to be based on MCL adjusted to 10-5 risk (@ 0.1 ug/L). PQL may be limiting factor.
EPA Early Life Cancer Policy	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III, Age-Adjusted Version of Equation 720-2 With EPA Policy on Early-Life Stage Carcinogens (Figure 3)	0.004 ug/L	Ground water cleanup levels based on MCL would require additional adjustments to 10-5 risk. PQL and natural background may be limiting factors.
CalEPA Early Life Cancer Policy	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III, Age-Adjusted Version of Equation 720-2 With California EPA Policy on Early-Life Stage Carcinogens (Figure 3)	0.004 ug/L	Ground water cleanup levels based on MCL would require additional adjustments to 10-5 risk. PQL and natural background may be limiting factors.

Table 4 - Trichloroethylene

Comparison of Ground Water Cleanup Level Options Using Current Toxicity Data and Risk Assessment Guidance

		Risk-Based Ground Water Level (one-in-a million cancer risk)	Implications for GW Cleanup Levels
Current Rule Equations and 2001 Toxicological Data	Risk-Based Ground Water Concentration Using 2001 Toxicological Data and Equation 720-2 (Figure 1)	4.0 ug/L	Ground water cleanup levels are based on MCL (5 ug/L).
Current Rule Equations with New Toxicity Values	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III and Equation 720-2 (Figure 1)	3.4 ug/L	Ground water cleanup levels would continue to be based on MCL (5 ug/L). [May be impacted by decisions on vapor intrusion.]
Age-Adjusted Equations	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III and Age-Adjusted Version of Equation 720-2 (Figure 2)	2.7 ug/L	Ground water cleanup levels would continue to be based on MCL (5 ug/L). [May be impacted by decisions on vapor intrusion.]
EPA Early Life Cancer Policy	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III, Age-Adjusted Version of Equation 720-2 With EPA Policy on Early-Life Stage Carcinogens (Figure 3)	2.7 ug/L	Ground water cleanup levels would continue to be based on MCL (5 ug/L). [May be impacted by decisions on vapor intrusion.]
CalEPA Early Life Cancer Policy	Risk-Based Ground Water Concentration Using 2009 Toxicological Data Compiled by EPA Region III, Age-Adjusted Version of Equation 720-2 With California EPA Policy on Early-Life Stage Carcinogens (Figure 3)	1.1 ug/L	Ground water cleanup levels would continue to be based on MCL (5 ug/L). [May be impacted by decisions on vapor intrusion.]