DEPARTMENT OF ECOLOGY
State of Washington

Natural Background for Dioxins/Furans in WA Soils[1]

Technical Memorandum #8

To: Interested Persons

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Previously, Ecology recommended that 2.2 ng/kg TEQ dioxins & furans in Washington soils be used as a natural background. Reference to this value, supporting data, and discussion can be found in the following three Ecology publications:

1. April 1999. Screening Survey for Metals and Dioxins in Fertilizer Products and Soils in Washington State. State of Washington, Department of Ecology. Publication Number 99-309.
2. April 1999. Supplemental Appendices - Survey for Metals and Dioxins in Fertilizer Products and Soils in Washington State. State of Washington, Department of Ecology. Publication Number 99-310.
3. October 10, 2007. Concise Explanatory Statement and Responsiveness Summary for the Amendment of Chapter 173-340 WAC, Model Toxics Control Act Cleanup Regulation. State of Washington, Department of Ecology. Publication Number 07-09-108, page 83.

Since calculation of the 2.2 ng/kg TEQ for natural background, the MTCA rule was updated in 2007, requiring the use of different toxicity equivalency factors (TEFs). Changes to TEF values are summarized in Table 1.

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[1] Calculations supporting this memorandum were conducted by Laura Klasner, P.E., Toxics Cleanup Program Peer review was conducted by Connie Groven and Pete Kmet, P.E., Toxics Cleanup Program.

The 1999 natural background calculations assigned a value of zero to non-detects. WAC 173-340-709(5)(a) currently specifies that non-detects be assigned a value equal to one-half of the method detection limit (MDL) when calculating natural background. The 2007 Concise Explanatory Statement, page 80, referenced above, also discusses how to treat undetected congeners in TEQ calculations.

The 1999 open and forested samples data set has one or more detections for all 17 congeners. Therefore, consistent with these references all congeners were assigned a value of one-half of the MDL if they were not detected. Where the laboratory reported a higher sample method detection limit than published for the method, the Method MDL was substituted for the laboratory MDL.

The method detection limits for dioxin congeners in EPA Method 8290 are as follows: [2]

tetra & penta have a MDL of 1 pptr
hexa & hepta have MDLs of 2.5 pptr
octa has a MDL of 5 pptr

Identical data sets were used for both the 1999 and 2010 natural background concentration calculations. This data set included 16 forested and open samples collected in 1998 within the state of Washington (Table 2). Data sets were evaluated and natural background was calculated using statistics appropriate for the distribution pattern (per WAC 173-340-709) (Table 3). Where duplicate samples were analyzed, an average of the two sample results was assigned to the congener values.

The results summarized in Table 2 are consistent with results from other studies.[3] [4] The Toxics Cleanup Program is currently designing a soil sampling study to characterize background soil concentrations for several organic hazardous substances that are frequently found at Washington cleanup sites. These substances include dioxins, furans, polychlorinated biphenyls (PCBs) and polynuclear aromatic hydrocarbons (PAHs). Once that study is completed, we will review and update (as appropriate) the information in this technical memorandum.

Based on these revised calculations (attached), an appropriate background for dioxin and furan mixtures is 5.2 ng/kg TEQ (2,3,7,8 TCDD - Toxic Equivalent Concentration). This can be considered a "natural background" concentration for upland soils for the purposes of cleanups under the Model Toxics Control Act Cleanup Regulation (Chapter 173-340 WAC).

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[2] See Table 1 on Page 47 for EPA Method 8290.
http://www.epa.gov/epawaste/hazard/testmethods/sw846/pdfs/8290a.pdf

[3] Environmental Protection Agency. 2007. Pilot Survey of Levels of Polychlorinated Dibenzo-p-dioxins, Polychlorinated Dibenzofurans, Polychlorinated Biphenyls, and Mercury in Rural Soils in the United States. EPA/600/R-05/048F. National Center for Environmental Assessment, Office of Research and Development. April 2007.

[4] Environmental Protection Agency. 2003. Exposure and Human Health Reassessment of 2,3,7,8 Tetrachlorodibenzo-p-dioxin (TCDD) and Related Compounds. NAS Review Draft. National Center for Environmental Assessment. EPA/600/P-00/001Cb.

Table 1: Differences in TEF Values Used

Congener Name	2010[5] TEFs	1999[6] TEFs
2,3,7,8-TCDD	1	1
1,2,3,7,8-PCDD	1	0.5
1,2,3,4,7,8-HxCDD	0.1	0.1
1,2,3,6,7,8-HxCDD	0.1	0.1
1,2,3,7,8,9-HxCDD	0.1	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.01
OCDD	0.0003	0.001
2,3,7,8-TCDF	0.1	0.1
1,2,3,7,8-PCDF	0.03	0.05
2,3,4,7,8-PCDF	0.3	0.5
1,2,3,4,7,8-HxCDF	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01
1,2,3,4,7,8,9-HpCDF	0.01	0.01
OCDF	0.0003	0.001

[5] The TEF values in the MTCA rule were obtained from the following publication: Van den Berg et al. 2006. The 2005 World Health Organization Re-evaluation of Human and Mammalian Toxic Equivalency Factors for Dioxins and Dioxin-like Compounds. Toxicological Sciences 93(2): 223-241. These TEF values are included in WAC 173-340-900 (Table 708-1).

[6] The TEF values used in the 1999 analysis were obtained from the following publication: Van den Berg et al. 1998. Toxic equivalency factors (TEFs) for PCB, PCDDs and PCDFs for humans and wildlife. Environ. Health Perspect 106; 775-792.

Table 2: Data from Ecology Publication 99-310, Sorted by Category:

Sample Number	Sample Name	2007 TEQ (ND=1/2) (ng/kg)*	1999 TEQ (ND=0) ng/kg
98328332	Forest west commercial	2.6166	2.0338
98318243	Forested east commercial	2.4316	0.9140
98338330	Forested east commercial	1.1212	0.0330
98328341	Forested east non-commercial	6.5511	5.0985
98338331	Forested east non-commercial	1.3826	0.4490
98338333	Forested west commercial	2.7310	2.4213
98308000	Forested west non-commercial	6.1746	4.9288
98318241	Forested west non-commercial	3.5223	2.5690
98328335	Open east non-grazed	0.6533	0.0460
98328340	Open east non-grazed	1.3881	0.0834
98328336	Open east rangeland grazed	1.3252	0.0400
98338332	Open rangeland grazed	0.9596	0.0431
98318242	Open west non-grazed	1.1720	0.3360
98328330	Open west non-grazed	2.8599	2.3950
98308004	Open west rangeland grazed	1.2207	0.6190
98328331	Open west rangeland grazed	4.5294	4.5810
98328339	Urban Kennewick	1.6081	1.0840
98328337 & 98328338 avg	Urban Richland	4.4260	4.6252
98318230	Urban Seattle 1	0.7338	0.3120
98318238	Urban Seattle 2	5.6909	5.1490
98318236	Urban Seattle 3	1.3301	4.7250
98318231	Urban Seattle 4	0.7416	0.1300
98318235	Urban Seattle 5	1.3301	0.8212
98318232	Urban Seattle 6	2.5401	2.0970
98318233	Urban Seattle 7	1.4009	0.7365
98318234	Urban Seattle 8	6.1189	5.9740
98318237	Urban Seattle 9	1.7828	1.3640
98328333 & 98328334 avg	Urban Spokane	2.1531	0.6547
98318239	Urban Tacoma 1	21.0208	19.4890
98318240	Urban Tacoma 2	8.5060	9.4730

* 1/2 EPA Method 8290 method detection limit substituted for lab detection limit, if lab detection limit was greater than Method 8290 method detection limit.

Table 3: Sample Statistics by Category of Land Use

Forested Samples Statistics		
	2007 TEQ ng/kg	**1999 TEQ ng/kg**
Distribution	Lognormal	Normal
mean =	3.3160	2.3060
median =	2.6738	2.2276
50th percentile =	2.8100	2.3100
4 X 50th =	11.2200	9.2200
90th percentile =	6.8100	4.1000
min	1.1212	0.0330
max	6.5511	5.0985

Open Areas Samples Statistics		
	2007 TEQ ng/kg	**1999 TEQ ng/kg**
Distribution	Lognormal	Lognormal
mean =	1.7640	1.0180
median =	1.2729	0.2097
50th percentile =	1.4700	0.2500
4 X 50th =	5.8700	1.0000
90th percentile =	3.5800	3.8900
min	0.6533	0.0400
max	4.5294	4.5810

Forested and Open Areas Samples Statistics		
	2007 TEQ ng/kg	**1999 TEQ ng/kg**
Distribution	Lognormal	Lognormal
mean =	2.5400	1.6620
median =	1.9098	0.7665
50th percentile =	2.0300	0.5500
4 X 50th =	8.1100	2.1900
90th percentile =	5.2100 **	8.0700
min	.6533	0.0330
max	6.5511	5.0985

Urban Samples Statistics		
	2007 TEQ ng/kg	**1999 TEQ ng/kg**
Distribution	Lognormal	Lognormal
mean =	4.2420	4.0450
median =	1.9679	1.7305
50th percentile =	2.5800	1.8700
4 X 50th =	10.3200	7.4600
90th percentile =	9.9300	12.5700
min	0.7338	0.1300
max	21.0208	19.4890

Forested, Open & Urban Samples Statistics		
	2007 TEQ ng/kg	**1999 TEQ ng/kg**
Distribution	Lognormal	Lognormal
mean =	3.3340	2.3530
median =	1.9679	0.6369
50th percentile =	2.2700	0.5600
4 X 50th =	9.0800	2.2500
90th percentile =	6.9400	5.3800
min	0.6533	0.0330
max	21.0208	19.4890

Highlighted values are the lower of 90th percentile and 4 X 50 percentile (per WAC 173-340-709).

** Basis for MTCA natural background.