UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
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M E M O R A N D U M

Subject: **Compilation and discussion of sediment quality values for dioxin, and their relevance to potential removal of dams on the Klamath River**

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In the attached tables we have compiled a number of sediment quality values (SQVs) that have been developed for dioxin.[1] Because some older dioxin values have been updated by more recent work, and because in some cases erroneous values continue to be cited, we present two separate tables. Table 1, "Dioxin Sediment Quality Values Currently Proposed or In Use", lists current values that have not been superceded or corrected by later work. Table 2, "Dioxin Sediment Quality Values No Longer In Use", lists values that have been superceded or corrected by later work and are no longer appropriate to use. Both tables are annotated and include references. The following discussion focuses on values currently proposed or in use (Table 1).

1 There are a number of structurally related congeners (chemical forms) of dioxin and furan compounds that may be present in sediments. They are typically evaluated collectively by normalizing the potencies of the individual congeners to that of the most toxic congener, 2,3,7,8-TCDD, termed a "TEQ" value. The values presented in the attached tables are all TEQs in parts per trillion (pptr) dry weight.

Categories of SQVs

The tables include three types of sediment quality values: risk assessment-based, effects-based, and background-based. Risk assessment-based values are calculated for human populations or ecological receptors based on specific exposure scenarios. The intent of a risk assessment-based value is to estimate a "safe" exposure level for a given population. In contrast, effects-based values represent concentrations associated with specific effects, usually to individuals of a particular indicator species, identified from bioassay testing. Effects-based values often are used as input for modeling in risk assessments. Background-based values are different in that they are empirical measurements of ambient sediment dioxin concentrations (and therefore exposure levels) in areas not influenced by specific local sources of dioxin contamination.

When background levels exceed risk-based or effects-based values, the concern for potential effects due to the contaminant are highlighted. However, in such cases options to manage the sediment in a manner that reduces exposure (so as to reduce the existing background risk or effect) can be significantly limited. As Table 1 shows, background concentrations do in fact exceed a number of effects-based or risk-based values.

Background Concentrations of Dioxin in Sediments

Table 1 lists four different surveys that have evaluated background concentrations of dioxin in sediments. In each case the samples were taken at locations felt to be unaffected by any known specific dioxin source, and therefore to be representative of ambient sediment concentrations in the area studied. Two of the studies were national in scope (one for the U.S. one for Canada) while two of the studies were regional, focused west coast water bodies (Puget Sound and San Francisco Bay). The regional surveys were the most intensive in terms of number of samples. All four of these studies found similar "background" concentrations of dioxin in sediments. The national surveys identified background as being 3.9 pptr TEQ (Canada) and 5.3 pptr TEQ (U.S.). The regional survey conducted in Puget Sound identified 4 pptr TEQ as background in non-urban embayments. The regional survey conducted in San Francisco Bay identified 2-5 pptr TEQ as background in areas selected to be unaffected by any known specific dioxin source.

Of course, future surveys may modify our current assessment of background in general, or identify different background concentrations for specific areas of the country. But at this time, dioxin concentrations in the range of 2-5 pptr TEQ appear to represent a reasonable estimate of what could be expected as background in non-source-impacted sediments anywhere in the country, specifically including the west.

Sediment Management Implications

In our dredging regulatory programs under the Clean Water Act and the Marine Protection, Research and Sanctuaries Act, EPA Regions 9 and 10 each follow a background-based approach for managing

dioxin in sediment from routine navigation dredging projects.[2] Sediment testing is utilized as necessary to establish whether dioxin concentrations are effectively at background levels for individual dredging projects. If concentrations are not elevated relative to background, and if none of the sediment management alternatives would effectively reduce exposure to or risk from the background dioxin levels already present, special restrictions on management of the sediment (relative to dioxin) are generally not required.

When considering potential sediment contaminant effects that might be associated with removal of Klamath River dams, similar considerations seem reasonable. Data collected to date on sediment quality behind the Klamath River dams, while limited, indicate that dioxin appears to be at background concentrations. The Sampling and Analysis Plan developed (with EPA involvement) for the project is designed to more comprehensively assess the sediment dioxin levels that are present. If this additional sampling shows that dioxin is present within the background range of 2-5 pptr TEQ, EPA would likely conclude that the special restrictions on management of the sediment (relative to dioxin) should not be required. Of course, if dioxin levels are found to be elevated above background we would have to consider the need for more detailed evaluation. That could include additional sampling and analysis to identify whether there may be any sediment "hot spots" amenable to separate management alternatives that could reduce dioxin exposure and risk.

2 Note that this is only true when regulating projects where sediment dioxin is effectively at background concentrations. When sediment dioxin concentrations are significantly elevated above background due to local sources, or in the case of sediment remediation projects (for example, at a Superfund site) EPA typically applies effects- or risk-based approaches to identify appropriate site-specific cleanup levels.

Table 1. Dioxin Sediment Quality Values Currently Proposed or In Use

12/9/2009

Source	Basis	Intent	Sediment Guideline pg/g dw TEQ	Comments	Reference
DMMP/EPA Region 10	Non-urban background in Puget Sound	Management of CWA 404 open water disposal sites in Puget Sound.	10 / 4	Sediments with dioxin concentrations up to 10 pptr TEQ will be allowed for open-water disposal as long as the volume-weighted average concentration of dioxins in material from the entire dredging project does not exceed 4 pptr TEQ. 4 pptr is based on an upper bound estimate of the distribution of dioxin in sediments from non-urban areas of Puget Sound (n=97).	DMMP (2009)
EPA (Region 9)	Area background in SF Bay	Component of reason-to-believe guidelines used for management of CWA 404 disposal sites in San Francisco Bay	2 - 5	Median and mean TEQ observed in a one-time sampling (n=56) designed to provide area background in San Francisco Bay.	EPA Region 9 Fact Sheet (2000)
US EPA	Background	Represents avg. in US sediments (n=11) from non-impacted lakes	5.3	No data were included that were collected from uncommon point sources (pulp and paper mills, POTWs). No distinction made between urban and rural sites.	EPA (2003) - draft dioxin reassessment
Ministry of Environment in British Columbia	Background	Mean (n=12) ambient level in the environment	3.9	Mean represents an I-TEQ calculated using international toxicity equivalency factors (rather than WHO values).	BC Environment (1995)
PSDDA	Risk-based	Protection of recreational fishers. Applied to Grays Harbor/Willapa projects only.	5 pg/g 2378-TCDD 15 pg/g TEQ	Bioaccumulation triggers based on a 1991 human risk evaluation for Grays Harbor conducted by the Corps of Engineers. 5/15 are the dioxin guidelines previously applied to Puget Sound projects.	DMMP (2009)

Table 1. Dioxin Sediment Quality Values Currently Proposed or In Use

12/9/2009

Source	Basis	Intent	Sediment Guideline pg/g dw TEQ	Comments	Reference
WA DOE	Risk-based	Residential Soil Clean-up level Industrial Soil Clean-up level	11 1460	Method B Standard reflects 2007 rule amendments. Calculated assuming 60% soil bioavailability. Old value was 6.6 pptr.	Chapter 173-340 WAC/Pers. Comm P. Kmet.
EPA (OSWER)	Risk-based	Current PRGs Proposed Draft Interim PRGs	1,000 / 5,000-20,000 72 / 950	Preliminary remediation goals (PRGs) in residential soil / commercial or industrial soil Proposed draft interim PRGs in residential soil / commercial or industrial soil	US EPA (2009)
Oregon DEQ	Risk-based	Protection of human consumers. Screening level value to determine need for bioaccumulation testing/modeling	0.0011 – 1.1	Low value represents threshold for potential risk to subsistence human consumers; high value represents threshold for potential risk to the general population of human consumers.	ODEQ (2007)
EPA (ORD-Duluth)	Effects-based	Protection of ecological receptors	60 - 100 (fish) 2.5 - 25 (mammals) 21 - 210 (birds)	Low value represents threshold for low risk; high value represents threshold for high level risk.	US EPA (1993)
Oregon DEQ	Effects-based	Protection of wildlife consumers: Mammals Birds	 0.052 - 1.4 0.7 – 3.5	Low/High values represent chemical concentrations in sediment at and below which chemicals are not expected to accumulate in the tissues of prey items (e.g., fish) above NOAEL/LOAEL-based acceptable levels.	ODEQ (2007)

Table 1. Dioxin Sediment Quality Values Currently Proposed or In Use

12/9/2009

Source	Basis	Intent	Sediment Guideline pg/g dw TEQ	Comments	Reference
Oregon DEQ	Effects-based	Protection of fish	0.56	For marine and freshwater. Represent chemical concentrations in sediment at and below which chemicals would not be expected to accumulate in tissues of fish or other aquatic organisms above levels acceptable to the organisms.	ODEQ (2007)
Environment Canada	Effects-based	Protection of benthos	0.85 / 21.5	Threshold effect/Probable effect levels based on benthic sediment toxicity data (with a safety factor of 10 applied). For fresh water and marine. Canadian SQGs not intended to address bioaccumulation. Also adopted by State of WI as Interim Consensus-based SQGs (Dec 2003) and by EPA Region III BTAG as Screening Benchmarks for the evaluation of sampling data at Superfund sites.	Environment Canada (2002)

Notes:
Federal and State specific (< 1990) values based on analytical detection limits were not included in this table (e.g., citations from Table 2 in Iannuzzi et al., 1995).

All TEQs based on Van den Berg *et al.*, (2006) except where noted.

Table 1. Dioxin Sediment Quality Values Currently Proposed or In Use
12/9/2009

References:

BC Environment, 1995. Dioxins and furans in the British Columbia environment. Report prepared for the Environmental Protection Department, British Columbia Environment, Victoria, British Columbia.

Dredged Material Management Program (DMMP), 2009. Proposal to Revise the Open-water Disposal Guidelines for Dioxins in dredged material. Draft issue paper presented at 2009 SMARM, May 2009. (http://www.nws.usace.army.mil/PublicMenu/documents/DMMO/Dioxin_Issue_Paper-May_1_2009.pdf)

Environment Canada, 2002. Canadian Sediment Quality Guidelines for the Protection of Aquatic Life, Summary Table Update 2002. http://www.ccme.ca/publications/cegg_rcqe.html.

Iannuzzi, T.J., N.L Bonnevie, R.J. Wenning, 1995. An Evaluation of Current Methods for Developing Sediment Quality Guidelines for 2,3,7,8-Tetrachlorodibenzo-p-Dioxin. Arch. Environ. Contam. Toxicol. (28) pg 366-377.

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US EPA (2009). Draft Recommended Interim Preliminary Remediation Goals for Dioxin in Soil at CERCLA and RCRA sites. Public Review Draft, Office of Superfund Remediation and Technology Innovation. December 2009. http://www.epa.gov/superfund/policy/remedy/pdfs/Interim_Soil_Dioxin_PRG_Guidance_12-30-09.pdf

US EPA (2003). Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-*p*-Dioxin (TCDD) and Related Compounds, National Academy Sciences (NAS) Review Draft.

Table 1. Dioxin Sediment Quality Values Currently Proposed or In Use

12/9/2009

US EPA - Region 9 (2000) Fact Sheet: Analysis of Dioxin in Sediments of San Francisco Bay. http://www.epa.gov/region09/water/dioxin/sediment.pdf.

US EPA (1993) Interim Report on Data and Methods for Assessment of 2,3,7,8-Tetrachlorodibenzo-p-dioxin Risks to Aquatic Life and Associated Wildlife. Environmental Research Laboratory, Office of Research and Development, US EPA, Duluth, MN. EPA/600/R-93/055. March 1993.

Van den Berg, M., L.S. Birnbaum, M. Denison, M. De Vito, W. Farland, M. Feeley, H. Fiedler, H. Hakansson, A. Hanberg, L. Haws, M. Rose, S. Safe, D. Schrenk, C. Tohyama, A. Tritscher, J. Tuomisto, M. Tysklind, N. Walker and R.E. Peterson (2006). The 2005 World Health Organization re-evaluation of human and mammalian toxic equivalency factors for dioxins and dioxin-like compounds, Tox. Sci. **93**, pp. 223–241.

Table 2. Dioxin Sediment Quality Values No Longer In Use

12/9/2009

Source	Basis	Intent	Sediment Guideline pg/g dw TEQ	Comments	Reference
WA DOE	Apparent Effects Threshold	Protection of benthos	8.8	1997 AETs were developed using a small *Hyallela* toxicity data set and older data and were therefore not intended for regulatory use and never adopted into rule. In 2002/3 new draft freshwater guidelines were developed which supercede the 1997 values and do not include dioxin. Also cited in NOAA SQuiRT tables as a freshwater upper effects threshold (UET).	Cubbage (1997)
WA DOE	Apparent Effects Threshold	Protection of benthos	3.6 pg/g (expressed as 2378-TCDD)	Value never used. Calculated by Gries/Waldow but not included in 1996 AET reevaluation report because there was too little data. Erroneously included in NOAA SQuiRT tables.	Buchman (2008)
WA DOE	Human Risk	Clean-up soil criterion	6.67	This is the old WA state residential soil clean-up value. Value has since been revised based on 2007 MTCA rule amendments.	Blakley and Norton (2005)
US EPA	Miscellaneous risk assessment and bioaccumulation studies	Protection of human and eco receptors associated with dredged material disposal	4	Reference attributes value to EPA R10 pers. comm. Believed to be John Malek. Basis of this value is unknown. It was never used in the dredging program.	Iannuzzi et al., (1995)

Notes:
Federal and State specific (<1990) values based on analytical detection limits were not included in this table (e.g., most of Table 2 from Iannuzzi et al., 1995).

All TEQs based on Van den Berg *et al.*, (2006).

Table 2. Dioxin Sediment Quality Values No Longer In Use
12/9/2009

References:

Blakley, N., and D. Norton. 2005. Spatial Extent of Dioxin/Furan Contaminated Sediments in Dillenbaugh Creek. WA Dept of Ecology, Environmental Assessment Program, Olympia, WA. Waterbody No. WA-23-1027, Pub. No. 05-03-008. April 2005.

Buchman, M.F., 2008. NOAA Screening Quick Reference Tables, NOAA ORR&R Report 08-1, Seattle WA, Office of Response and Restoration Division, National Oceanic and Atmospheric Administration, 34 pages.

Cubbage, J., D. Batts, S. Breidenbach, 1997. Creation and Analysis of Freshwater Sediment Quality Values in Washington State. Washington State Dept. of Ecology. Pu No. 97-323a. July 1997.

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