PROTOCOL

AQUATIC TOXICITY REFERENCE VALUES (TRVs)

Introduction

Toxicity reference values (TRVs) are used in the ecological risk assessment (ERA) process as part of the *Ecological Constituent of Potential Concern (COPC) Selection Process* (WSRC 1999b). The evaluation conducted using TRVs is performed in Step F of the Ecological COPC Selection Process. Step E of the Ecological COPC Selection Process requires selection of appropriate assessment endpoint(s), and selection of representative receptors with which to perform TRV-based calculations for exposure dose estimates. The dose estimates, which are based on maximum and average concentrations, are then compared to the lowest recorded median lethal concentration (LC_{50}, the concentration at which 50% of the test population dies) or median effects concentration (EC_{50}, the concentration at which 50% of the test population exhibits an effect) showing reproductive effects, in order to calculate a hazard quotient (HQ) for each constituent.

For aquatic receptors, the preferred source of aquatic surface water TRVs is *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision* (Suter and Tsao 1996). This document provides a compilation of aquatic toxicity values, including Federal Ambient Water Quality Criteria (AWQC), derived Tier II values (secondary chronic and acute values), and chronic values from a variety of other governmental sources. Uncertainty factors (other than use for use of a surrogate chemical) are not applied to TRVs from the above sources because the methods of their derivation already account for uncertainties. AWQC values based on SCDHEC water quality criteria (EPA 1992) are applicable or relevant and appropriate requirements (ARARs) and are the preferred value for the surface water TRVs. If no AWQCs are available, the lowest (most conservative) value from the other sources is used as the surface water TRV. In the absence of TRVs for a constituent of potential concern (COPC) from the above sources, aquatic toxicity data from the Aquatic Information Retrieval System (AQUIRE) or Hazardous Substances Data Bank (HSBD) databases or other sources are used. The databases are searched for the lowest recorded LC_{50} or EC_{50} for reproductive effects. Taxonomic preference for the lowest value occurs in the following order: (1) native species potentially present at the unit; (2) proxy species commonly studied in the laboratory, such as fathead minnow (*Pimephales promelas);* or (3) other species most similar taxonomically and physiologically to native species. The lowest (most conservative) appropriate value from the preferred data is used as the TRV for each of the surface water COPCs.

Sediment is also evaluated for potential toxicity to aquatic receptors. The preferred source of sediment TRVs is *Toxicological Benchmarks for Screening Contaminants of Potential Concern*

for Effects on Sediment Associated Biota (Jones et al. 1997). This document compiles the following:

- Sediment toxicity values, including EPA Sediment Quality Criteria for Protection of Benthic Organisms
- Derived Sediment quality benchmarks for nonionic organic chemicals based on equilibrium partitioning
- Washington State sediment quality standards for some ionic organic compounds
- National Oceanic and Atmospheric Administration (NOAA) values from Long and Morgan (1991) and Long et al. (1995)
- Values from other governmental sources

The lists of TRVs (surface water TRVs for aquatic receptors are presented in Table 1; sediment TRVs for aquatic receptors are presented in Table 2) are not comprehensive lists of TRVs, but will be needed for constituent evaluation at the SRS. Additional TRVs will be compiled and incorporated into the lists presented below, on a periodic basis, as required based on project-specific needs. The additional TRVs will be obtained for constituents that exceed the ecological screening value (ESV) comparisons conducted in Step B of the Ecological COPC Selection Process. Further revisions of this protocol will focus on TRVs specific to SRS biota, beginning with the aquatic fauna. This is contingent upon the selection of receptor species indigenous to SRS based on the draft protocol for *Assessment and Measurement Endpoint Selection Process* WSRC 1999a).

Table 1. Surface Water Toxicity Reference Values

Constituent	TRV (ug/L)	Source
Inorganics		
Aluminum [a]	87	1
Antimony	160	2
Arsenic [b]	190	1
Barium	4.0	3
Beryllium	0.53	2
Boron	750	1
Cadmium [c]	0.66	1
Calcium	116000	4
Chloride	230000	1
Chlorine	11	1
Chromium [b]	117.32	1
Cobalt	23	3
Copper [c]	6.54	1
Cyanide	5.2	6
Iron	1000	1
Lead [c]	1.32	1
Lithium	14	3
Magnesium	82000	4
Manganese	120	3
Mercury	0.012	1
Molybdenum	370	4
Nickel [c]	87.71	1
Potassium	53000	4
Selenium	5	1
Silver	0.012	5
Sodium	680000	4
Strontium	1500	3
Thallium	12	3
Tin	73	3
Uranium	2.6	3
Vanadium	20	3
Zinc [c]	120	6
Zirconium	17	3
Organics		

Table 1. Surface Water Toxicity Reference Values

Constituent	TRV (ug/L)	Source
Acenaphthene	17	5
Acetone	1500	3
Organics (continued)		
Acrolein	2.1	5
Acrylonitrile	75.5	3
Anthracene	0.73	3
Aldrin	0.3	5
Benzene	0.73	3
Benzidine	3.9	3
Benzo(a)anthracene	0.027	3
Benzo(a)pyrene	0.014	3
Benzoic acid	42	3
Benzyl alcohol	8.6	3
α-BHC	500	5
β-BHC	5000	5
γ-BHC (Lindane)	0.08	1,5
Biphenyl	14	3
Bis(2-chloroethyl)ether	2380	5
Bis(2-ethylhexyl)phthalate	3.0	3
Bromoform	293	5
4-Bromophenyl phenyl ether	1.5	3
Butylbenzyl phthalate	19	3
2-Butanone	14000	3
Carbon disulfide	0.92	3
Carbon tetrachloride	9.8	3
Chlordane	0.0043	1
Chlorobenzene	64	3
2-Chloroethylvinyl ether	3540	5
Chloroform	28	3
2-Chlorophenol	43.8	5
Chlorpyrifos	0.041	1
DDD	0.001	6
DDE	10.5	5
DDT	0.001	1
Decane	49	3
Demeton	0.1	1
Di-n-butyl phthalate	35	3

Table 1. Surface Water Toxicity Reference Values

Constituent	TRV (ug/L)	Source
Diazinon	0.043	3
Dibenzofuran	3.7	3
1,2-Dichlorobenzene	14	3
1,3-Dichlorobenzene	50.2	5
Organics (continued)		
1,4-Dichlorobenzene	11.2	5
1,1-Dichloroethane	47	3
1,2-Dichloroethane	910	3
1,1-Dichloroethene	25	3
1,2-Dichloroethene	590	3
2,4-Dichlorophenol	36.5	5
1,2-Dichloropropane	525	5
Dichloropropylene	24.4	5
Dieldrin	0.0019	1
Diethyl phthalate	210	3
2,4-Dimethylphenol	21.2	5
2,4-Dinitrophenol	6.2	5
Di-n-octyl phthalate	708	4
2,4-Dinitrotoluene	310	5
Dioxin	0.00001	5
1,2-Diphenylhydrazine	2.7	5
Endosulfan I	0.056	1
Endosulfan II	0.056	1
Endrin	0.0023	1
Ethylbenzene	7.3	3
Fluoranthene	39.8	5
Fluorene	3.9	3
Guthion	0.01	1
Heptachlor	0.0036	1
Heptachlor epoxide	0.0036	1
Hexane	0.58	3
2-Hexanone	99	3
Hexachlorobutadiene	0.93	5
Hexachlorocyclopentadiene	0.07	5
Hexachloroethane	9.8	5
Isophorone	1170	5
Malathion	0.1	1

Table 1. Surface Water Toxicity Reference Values

Constituent	TRV (ug/L)	Source
Methoxychlor	0.03	6
Methyl bromide	110	5
Methyl chloride	5500	5
1-Methylnaphthalene	2.1	3
2-Methyl-4,6-dinitrophenol	2.3	5
3-Methyl-4-chlorophenol	0.3	5
Organics (continued)		
4-Methyl-2-pentanone	170	3
2-Methylphenol	13	3
Methylene chloride	1930	5
Methoxychlor	0.03	1
Mirex	0.001	1
Naphthalene	12	3
2-Nitrophenol	3500	5
4-Nitrophenol	82.8	5
N-Nitrosodiphenylamine	58.5	5
2-Octanone	8.3	3
Parathion	0.013	1
PCBs (total)	0.14	3
Aroclor 1016	0.014	1
Aroclor 1221	0.014	1
Aroclor 1232	0.014	1
Aroclor 1242	0.014	1
Aroclor 1248	0.014	1
Aroclor 1254	0.014	1
Aroclor 1260	0.014	1
Pentachlorobenzene	0.47	3
Pentachlorophenol [d]	13	1
1-Pentanol	110	3
2-Propanol	7.5	3
1,2,4,5-Tetrachlorobenzene	50	5
1,1,2,2-Tetrachloroethane	240	5
Tetrachloroethene	98	3
Tetrachloromethane	240	3
Toluene	9.8	3
Toxaphene	0.0002	1
Tribromomethane	320	3

Table 1. Surface Water Toxicity Reference Values

Constituent	TRV (ug/L)	Source
Tributyltin	0.026	5
1,2,4-Trichlorobenzene	44.9	5
1,1,1-Trichloroethane	11	3
1,1,2-Trichloroethane	1200	3
Trichloroethene	47	3
2,4,6-Trichlorophenol	3.2	5
Vinyl acetate	16	3
Xylene	13	3
Organics (continued)		
m-Xylene	1.8	3

TRV = toxicity reference value
1 – SCDHEC AWQC (EPA 1992)
2 – Ecotox Threshold (Tier II) Values (EPA 1996)
3 – Secondary Chronic Value (Suter and Tsao 1996)
4 – Lowest Chronic Value for Daphids (Suter and Tsao 1996)
5 - EPA Region IV Chronic Screening Values (EPA 1995)
6 – National AWQC (EPA 1998)
a- pH 6.5-9.0.
b- Values are for Arsenic III and Chromium III.
c- Hardness Dependent Based on the following equations:

Compound	Acute Screening Value	Chronic Screening Value
Cadmium	$e^{(1.128(\ln H)-3.828)}$	$e^{(0.7825(\ln H)-3.49)}$
Chromium III	$e^{(0.819(\ln H)+3.688)}$	$e^{(0.819(\ln H)+1.561)}$
Copper	$e^{(0.9422(\ln H)-1.464)}$	$e^{(0.8545(\ln H)-1.465)}$
Lead	$e^{(1.273(\ln H)-1.46)}$	$e^{(1.273(\ln H)-4.705)}$
Nickel	$e^{(0.846(\ln H)+3.3612}$	$e^{(0.846(\ln H)+1.1645)}$
Silver	$e^{(1.72(\ln H)-6.52)}$	
Zinc	$e^{(0.8473(\ln H)+0.8604)}$	$e^{(0.8473(\ln H)+0.7614)}$

d- pH dependent based on the following equation:

Compound	Acute Screening Value	Chronic Screening Value
Pentachlorophenol	$e^{(1.005pH-4.869)}$	$e^{(1.005pH-5.134)}$

Table 2. Sediment Toxicity Reference Values

Constituent	TRV (mg/kg)	Ref.
Inorganics		
Antimony	2	1
Arsenic	8.2	1
Cadmium	1.2	1
Chromium	81	1
Copper	34	1
Lead	46.7	1
Mercury	0.15	1
Nickel	20.9	1
Silver	1	1
Zinc	150	1
Organics		
Acenaphthene	0.016	1
Acenaphthylene	0.044	1
Anthracene	0.085	1
Benzo(a)anthracene	0.261	1
Benzo(a)pyrene	0.430	1
Benzoic acid	0.650	2
Benzyl alcohol	0.057	2
Chlordane	0.0005	1
Chrysene	0.384	1
DDD	0.002	1
DDE	0.0022	1
DDT	0.0016	1
Dibenzo(a,h)anthracene	0.063	1
Dieldrin	0.00002	1
2,4-Dimethyl phenol	0.029	2
Endrin	0.00002	1
Fluoranthene	0.600	1
Fluorene	0.019	1
2-Methylnaphthalene	0.070	1
2-Methyl phenol	0.063	2
4-Methyl phenol	0.670	2
PAHs (Total Low Molecular Weight)	0.552	1
PAHs (Total High Molecular Weight)	1.700	1
PAHs (Total)	4.022	1
PCBs (Total)	0.023	1
Pentachlorophenol	0.360	2

Table 2. Sediment Toxicity Reference Values

Constituent	TRV (mg/kg)	Ref.
Phenanthrene	0.240	1
Phenol	0.420	2
Organics (continued)		
Pyrene	0.665	1

TRV = toxicity reference value.
1 – Effects Range – Low (Jones et al. 1997).
2 – Washington state sediment quality standards for ionizable organic compounds (Jones et al. 1997).

References

(1) EPA. 1992. *National Recommended Water Quality Criteria.* Federal Register 57-60848. (December 22, 1992).

(2) EPA. 1995. *Supplemental Guidance to RAGS: Region 4 Bulletins Ecological Risk Assessment. (*http://www.epa.gov/region4/wastepgs/oftecser/otsguid.htm)

(3) EPA. 1996. "Ecotox Thresholds". *ECO Update*, Office of Solid Waste and Emergency Response, Intermittent Bulletin Vol. 3, No. 2. EPA 540/F-95-038 PB95-963324. January 1996. *(*http://www.epa.gov/superfund/oerr/r19/ecotox).

(4) EPA. 1998. *National Recommended Water Quality Criteria.* Federal Register 90-30272. Volume 63, No 237 (December 10, 1998).

(5) Jones, D.S., G.W. Suter, and R.N. Hull. 1997. *Toxicological Benchmarks for Screening Contaminants of Potential Concern for Effects on Sediment-Associated Biota: 1997 Revision*. Oak Ridge National Laboratory. ES/ER/TM-95/R4, Oak Ridge National Laboratory, Oak Ridge, TN.

(6) Suter, G.W, II, and C.L.Tsao. 1996. *Toxicological Benchmarks for Screening Potential Contaminants of Concern for Effects on Aquatic Biota: 1996 Revision.* Oak Ridge National Laboratory, ES/ER/TM-96/R2, Oak Ridge National Laboratory, Oak Ridge, TN.

(7) WSRC. 1999a. *Assessment and Measurement Endpoint Selection Process*. April 1999, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC.

(8) WSRC. 1999b. *Ecological Constituents of Potential Concern Selection Process*. April 1999, Westinghouse Savannah River Company, Savannah River Site, Aiken, SC.