State of Oregon
Department of
Environmental
Quality

Toxic Compounds Criteria

1999 – 2003 Water Quality Standards Review

ISSUE PAPER

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Chapter 1 Standards Review and Status of Water Quality Criteria for Toxic Pollutants

Section 1.1 Triennial Water Quality Standards Review for Toxic Pollutants

1.1.1 Introduction

Why is a review needed?

The federal Environmental Protection Agency (EPA) authorized the Oregon Department of Environmental Quality (DEQ) to administer sections of the Clean Water Act. Section 303 of the Act requires that DEQ review Oregon's water quality standards regularly in order to use the latest scientific information and consider the state's latest needs.

The State of Oregon's water quality standards last underwent periodic review from 1992 to 1996; however, criteria for toxic pollutants were not part of that process. Oregon's criteria for toxic pollutants were last revised in 1991 and are based on the EPA Gold Book (EPA 1986). Since Oregon adopted these criteria in 1991, EPA has published updates of individual as well as whole lists of compounds (EPA 1992; EPA 1995a; EPA 1999; EPA 2000a; EPA 2002a; EPA 2002b). Therefore, the existing rule in Oregon is not based on the latest scientific information and needs to be updated.

Purpose of this Issue Paper

This issue paper addresses the technical and policy concerns that were raised during the review of Oregon's water quality criteria for toxic pollutants. It also presents the recommendations for those criteria made by the various advisory committees as well as the agency recommendation to the Environmental Quality Commission.

1.1.2 Overview of Standards Review Process

Framework

The interim goal of the federal Clean Water Act (CWA) is to achieve "fishable and swimmable" waters which provides the policy framework that

drives water quality standards review. Oregon's policy has been to protect designated beneficial uses—this does not mean that there is protection from the detrimental effects of pollution at all times because criteria that are derived for protecting designated beneficial uses include consideration of a certain level of risk to either the aquatic environment or human health. This policy formed the premise for the technical and policy discussions that took place during this review.

Current Water Quality Standards Review Process

Water quality standards are established using the best available scientific information within a public policy framework. DEQ initiated the current Water Quality Standards Review (triennial review) in 1999 and completed the review in 2003. For this review, DEQ consulted a Technical Advisory Committee (TAC) made up of external experts for each topic (e.g. toxic pollutants, temperature) and a Policy Advisory Committee (PAC) made up of external stakeholders for the overall process. This review process was devised to maintain independence between the technical and policy review discussions, while simultaneously providing sufficient interaction between the two groups. This enabled policy makers to understand both the technical and policy ramifications of their decisions in order to make the best informed choices.

Scope & Depth

The sheer number of criteria in need of updating presented a challenge for DEQ to accomplish within the resource and time limits of the current triennial review of water quality standards. Initially, DEQ considered only reviewing those compounds for which the new EPA criteria would be more stringent than Oregon's current criteria. However, comments from both the PAC and TAC led DEQ to give all compounds the same review process in order to ensure that Oregon's water quality criteria would be based on the best available science. Due to the broad scope of the review, the depth of the technical review was necessarily limited. DEQ used the following general process:

1) review EPA methodology for deriving criteria for all compounds used in the 1999 EPA criteria update; if acceptable, move to (2); if EPA methodology unacceptable or criteria are unavailable, move to (3).
2) approve EPA's latest criteria unless there is a compelling reason to maintain Oregon's current criteria.
3) if another methodology for deriving criteria is scientifically credible, propose new criteria based on that methodology; if no other methodology is scientifically credible, maintain Oregon's current criteria.

1.1.3 Advisory Committee Members

Technical Advisory Committee Members

In 2000, DEQ established a TAC, drawn from academia and government, to assist in reviewing the water quality criteria for toxic pollutants. Members of the TAC were experts in the field of toxicology (see Table 1.1).

Table 1.1: Toxics Technical Advisory Committee membership and Affiliation.

Name	Affiliation
Ken Kauffman, Reg. Sanitarian	Oregon Department of Human Services
Rick Johnson, PhD	Oregon Graduate Institute
Joan Rothlein, PhD	Center for Research on Occupational and Environmental Toxicology, Oregon Health and Science University
Jeff Jenkins, PhD	Oregon State University
Deke Gundersen, PhD	Pacific University
Jennifer Orme Zavaleta, MS	EPA
Steve Kolmes, PhD	University of Portland
Gene Foster, PhD	Oregon DEQ
Martin Fitzpatrick, PhD, Chair	Oregon DEQ

Policy Advisory Committee Members

DEQ also established a PAC with members from stakeholder groups, including industry, environmental advocacy groups, and municipal organizations (Table 1.2). Federal and State government officials were included as *ex officio* (non-voting) members. The purpose of the PAC review was to provide candid, critical, and constructive advice on the policy implications of options raised during the water quality standards review.

Table 1.2: Water Quality Standards Review Policy Advisory Committee and Agency Advisors membership and affiliation.

Name	Organization
Pat Amadeo, Chair	unaffiliated
Nina Bell	Northwest Environmental Advocates
Sharon Beck	Oregon Cattlemen's Association
Bill Gaffi/Charles Logue	Association of Clean Water Agencies
Sherri Groh	Confederated Tribes of the Siletz Indian Reservation
Chris Jarmer	Oregon Forest Industries Council
John Ledger	Associated Oregon Industries
Karen Lewotsky	Oregon Environmental Council
Peter Ruffier	League of Oregon Cities
Aubrey Russell	Oregon Trout
Glen Spain	Pacific Coast Federation of Fishermen's Associations
Pete Test/Jean Wilkenson	Oregon Farm Bureau
Kathryn VanNatta	Northwest Pulp and Paper Association
Agency Advisors	
Dru Keenan	EPA
Rick Kepler	Oregon Department of Fish and Wildlife
David Leland	Oregon Health Services
Robert Anderson	National Marine Fisheries Service/NOAA-Fisheries
Elizabeth Materna	US Fish and Wildlife Service

1.1.4 Existing Oregon Administrative Rule (OAR)

Current Review

The current water quality standards review included proposed revision of the following rule language; as well as proposed revision of many of the values for criteria listed in Oregon Administrative Rule (OAR) 340-041-Table 20 (http://www.deq.state.or.us/wq/wqrules/wqrules.htm).

Rule Language

The existing rule governing numeric criteria for toxic pollutants ("toxics") reads as follows in OAR 340-041-(basin)(2)(p)(B) for all basins:

"340-041-<Basin>

Water Quality Standards Not to be Exceeded (To be Adopted Pursuant to ORS 468.735 and Enforceable Pursuant to ORS 468.720, 468.990 and 468.992)

(1) Notwithstanding the water quality standards contained below, the highest and best practicable treatment and/or control of wastes, activities, and flows shall in every case be provided so as to maintain dissolved oxygen and overall

water quality at the highest possible levels and water temperatures, coliform bacteria concentrations, dissolved chemical substances, toxic materials, radioactivity, turbidities, color, odor, and other deleterious factors at the lowest possible levels.

(2) No wastes shall be discharged and no activities shall be conducted which either alone or in combination with other wastes or activities will cause violation of the following standards in the waters of the <Basin>: …

(p) Toxic pollutants:

(A) Toxic pollutants shall not be introduced above natural background levels in the waters of the state in amounts, concentrations, or combinations which may be harmful, may chemically change to harmful forms in the environment, or may accumulate in sediments or bioaccumulate in aquatic life or wildlife to levels that adversely affect public health, safety, or welfare; aquatic life; wildlife; or other designated beneficial uses;

(B) Levels of toxic pollutants shall not exceed the criteria listed in Table 20 which were based on criteria established by EPA and published in Quality Criteria for Water (1986), unless otherwise noted;

(C) The criteria in paragraph (B) of this subsection shall apply unless data from scientifically valid studies demonstrate that the most sensitive designated beneficial uses will not be adversely affected by exceeding a criterion or that a more restrictive criterion is warranted to protect beneficial uses, as accepted by the Department on a site specific basis. Where no published EPA criteria exist for a toxic substance, public health advisories and other published scientific literature may be considered and used, if appropriate, to set guidance values;

(D) Bio-assessment studies such as laboratory bioassays or instream measurements of indigenous biological communities, shall be conducted, as the Department deems necessary, to monitor the toxicity of complex effluents, other suspected discharges or chemical substances without numeric criteria, to aquatic life. These studies, properly conducted in accordance with standard testing procedures, may be considered as scientifically valid data for the purposes of paragraph (C) of this subsection. If toxicity occurs, the Department shall evaluate and implement measures necessary to reduce toxicity on a case-by-case basis.

Section 1.2 What needs to be updated?

1.2.1 EPA Updates

Major EPA criteria revisions

Since 1986, EPA has updated a large number of water quality criteria for toxic pollutants several times. In 1992, EPA promulgated water quality criteria for toxic pollutants for 14 States (EPA 1992). These updated criteria became known as the "National Toxics Rule" and differed substantially from the EPA Gold Book. In 1995, EPA applied the methodology and data used in the Great Lakes Water Quality Initiative to derive new national aquatic life criteria for 15 toxic pollutants in freshwater (EPA 1995a). In 1999, EPA published the next major update of water quality criteria (EPA 1999). In 2000, EPA promulgated criteria for California ("California Toxics Rule"; EPA 2000a) and also published a revised methodology for deriving criteria that would be protective of human health (EPA 2000b; although no summary table of criteria was published). Since 2000, EPA has updated the criteria for some individual compounds as well (e.g. cadmium). In late 2002, EPA published another major update (EPA 2002a) using the EPA (2000b) revised human health methodology and proposed (EPA 2002b) revised criteria for 15 other toxic pollutants.

Number of criteria needing revision

A total of 62 criteria for the protection of aquatic life differ between Oregon's OAR 340-041-Table 20 and the latest EPA criteria as of December 2002 (Table 1.3). These differences included 22 chemical compounds or classes. A total of 219 criteria for the protection of human health differ between Oregon's Table 20 and the latest EPA criteria as of October 2001 (Table 1.4). These differences included 116 chemical compounds or classes.

Table 1.3. Comparison of Oregon's and EPA's Aquatic Life Criteria.
Aquatic Life Protection Criteria Comparison between Oregon Table 20 and the latest EPA (EPA 2002a) criteria. In the "Stringency" column, 'OR < EPA' indicates that the value for Oregon's criterion is less than that of the latest EPA criterion; 'OR > EPA' indicates the value for Oregon's criterion is more than that of latest EPA criterion; 'OR: no criteria' indicates that OR has no criterion for which EPA has a published criterion; 'Varies' indicates that the value for Oregon's criterion shifts between being more than to less than that of the latest EPA criterion; and 'OR = EPA' indicates the value for Oregon's criterion equals that of the latest EPA criterion.

Stringency	Freshwater		Seawater		
	Acute	Chronic	Acute	Chronic	Total Criteria
OR < EPA	4	8	4	5	21
OR > EPA	11	6	3	1	21
OR: no criteria	5	5	4	5	19
Varies	0	1	0	0	1
OR = EPA	13	19	17	21	70
Total Criteria	**33**	**39**	**28**	**32**	**132**
Criteria needing update	**20**	**20**	**11**	**11**	**62**

Table 1.4: Comparison of Oregon's and EPA's Human Health Criteria.
Human Health Protection Criteria Comparison between Oregon Table 20 and the latest EPA criteria. See Table 3 caption for explanation of "Stringency" column.

Stringency	Water + Fish Ingestion	Fish Consumption Only	Total Criteria
OR < EPA	28	18	46
OR > EPA	45	43	88
OR: no criteria	37	48	85
Varies	0	0	0
OR = EPA	12	3	15
Total Criteria	**122**	**112**	**234**
Criteria needing update	**110**	**109**	**219**

1.2.2 EPA Withdrawals

Status of EPA Criteria withdrawn

Since publishing the EPA Gold Book, EPA has changed the values of criteria or added new criteria and also withdrawn criteria. Table 1.5 and Table 1.6 list the compounds for which the latest recommendation for criteria (EPA 2002a) indicates withdrawn criteria.

Table 1.5: EPA-withdrawn Aquatic Life Criteria.
Compounds for which EPA removed Aquatic Life Protection Criteria. The "Criteria" column contains freshwater (FW) or saltwater (SW) values for acute or chronic criteria; the "Year Withdrawn" column contains the year which EPA first published a summary table that did not contain the criteria.

Compound	Criteria	Year Withdrawn
Lindane	FW Chronic	1995
PCBs	FW Acute	1992
	SW Acute	1992
Silver	FW Chronic	1992

Table 1.6: EPA-withdrawn Human Health Criteria.
Compounds for which EPA removed Human Health Protection Criteria. The "Criteria" column contains values for water and fish ingestion (water + fish) or fish consumption only (fish only); the "Year Withdrawn" column contains the year which EPA first published a summary table that did not contain the criteria.

Compound	Criteria	Year Withdrawn
Beryllium	Water + fish	1992
	Fish only	1992
Cadmium	Water + fish	1992
	Fish only	1992
Chromium III	Water + fish	1992
	Fish only	1992
Chromium VI	Water + fish	1992
2,6-Dinitrotoluene	Water + fish	1992
	Fish only	1992
Lead	Water + fish	1992
	Fish only	1992
Mercury	Water + fish	2002
	Fish only	2002
Silver	Water + fish	1992
1,1,1-Trichloroethane	Water + fish	1992
	Fish only	1992

Rationale for criteria withdrawal

In some instances, the withdrawals happened within the context of a formal process. For example, in "Water Quality Standards; Establishment of Numeric Criteria for Priority Pollutants for the State of California" (EPA 2000b; the California Toxics Rule), EPA "reserved" the aquatic life criteria for mercury (freshwater acute and chronic, saltwater acute and chronic) and selenium (freshwater acute only) while these criteria underwent re-evaluation. At the time of the TAC review of Oregon's criteria, EPA evaluation of mercury and selenium was still underway; therefore, the TAC and PAC discussions were based on this 'withdrawn' status. Since EPA (2002a) re-published the EPA (1999) values for mercury and selenium criteria, these criteria became the "latest" EPA recommendation which influenced the Department's own recommendation (see Section 4.2)

1.2.3 Status of EPA Guidance Values and Human Health Criteria

Guidance Values

Oregon's Table 20 contains 130 "guidance values" (from 58 compounds or classes) that the EPA Gold Book (1986) included in the summary table of criteria even though there were insufficient data to derive criteria. Beginning with the 1992 "National Toxics Rule", EPA no longer listed these values when publishing its criteria tables. Therefore, the issue of what to do with Oregon's guidance values needed to be addressed.

Human Health Criteria based on 2000 EPA Methodology

In 2000, EPA published "Methodology for deriving ambient water quality criteria for the protection of human health (2000)" (2000 EPA Methodology). The formulae used to calculate the criteria values in the 2000 EPA Methodology differed from those in the 1980 EPA methodology by:

1) the addition of a new formula to calculate criteria for compounds where the mode of carcinogenicity shows a non-linear relationship between dose and effect;
2) the use of a bioaccumulation factor rather than bioconcentration factor (bioconcentration refers to the uptake and retention of a chemical from the water only; bioaccumulation refers to the uptake and retention of a chemical from all the surrounding environment, e.g. water, food, and sediment); and
3) the use of a new fish consumption rate.

In addition, the 2000 EPA Methodology proposed new options for deriving the factors used in these formulae. The TAC agreed to review the new EPA Methodology to determine whether it should be applied in deriving Oregon's criteria.

2002 EPA Criteria

After the TAC process ended, EPA published recommended water quality criteria (EPA 2002a) that reflected the use of a new fish consumption rate in calculating the values, the use of bioconcentration factors rather than bioaccumulation factors (since national bioaccumulation factors were not available), and newer information on the toxicity of various pollutants. The EPA Gold Book (EPA 1986), Oregon's criteria, and 1999 EPA criteria (EPA 1999) were derived using a fish consumption rate of 6.5 g (0.2 oz)/day; the latest EPA criteria (EPA 2002a, 2002b) were derived using a fish consumption rate of 17.5 g (0.6 oz)/day.

Section 1.3 Water Quality Criteria for Toxic Pollutants

1.3.1 Background

Components of Water Quality Standards

Water quality standards consist of three parts:

1) beneficial uses, which represent the State's goals for a particular waterbody;
2) water quality criteria, which are the numeric values and narrative conditions that are designed to protect the beneficial uses; and
3) an antidegradation policy, which protects existing water quality from needless degradation.

The numeric water quality criteria for toxic pollutants were the components being reviewed during the current Water Quality Standards Review process.

Beneficial Uses

In Oregon, designated beneficial uses include:

- Public Domestic Water Supply
- Private Domestic Water Supply
- Industrial Water Supply
- Irrigation
- Livestock Watering
- Anadromous Fish Passage
- Salmonid Fish Rearing
- Resident Fish & Aquatic Life
- Wildlife & Hunting
- Fishing
- Boating
- Water Contact Recreation
- Aesthetic Quality
- Hydro Power
- Commercial Navigation & Transportation

Purpose of Criteria

The purpose of the toxic pollutants water quality criteria is to protect the most sensitive designated beneficial use for the waters included in the specified basin. Oregon's Table 20 lists up to six surface water criteria for each pollutant based on the following protections: aquatic life (freshwater acute, freshwater chronic, marine acute, and marine chronic) and human health (water and fish ingestion, and fish consumption only). Waters of the State (at the level of Basin) always have multiple designated beneficial uses.

How are the criteria utilized?

In the situation of competing uses, DEQ employs and will employ the criteria that protect the most sensitive beneficial use. Furthermore, one or more criteria may be relevant to a particular waterbody. When determining whether a waterbody should be designated as water quality impaired on the State's 303(d) list, the lowest criteria concentration for the pollutant consistent with an applicable beneficial use will govern which criteria should be applied.

For example, Oregon's current water quality criteria for cadmium have values for 1) freshwater acute, 2) freshwater chronic, 3) marine acute, 4) marine chronic, and 5) water and fish ingestion. In the Clackamas River, Designated Beneficial Uses include the following most sensitive beneficial uses: "Resident Fish & Aquatic Life," "Public Domestic Water Supply," and "Fishing"; therefore, the relevant criteria include 1) freshwater acute, 2) freshwater chronic, and 5) water and fish ingestion. Since the freshwater chronic criterion has the lowest concentration, this criterion would be the one used to determine if the Clackamas River should be listed as water quality impaired. For individual NPDES permits, multiple criteria may be applied (e.g. acute criteria in the zone of initial dilution and chronic criteria at the edge of the mixing zone).

1.3.2 Criteria for Protection of Aquatic Life

Overview of Aquatic Life Criteria

The freshwater and marine criteria for the protection of aquatic life may be presented in two forms: acute and chronic values. The acute value should not be exceeded by the one-hour average concentration of the compound; the chronic value should not be exceeded by the four-day average concentration of the compound (Stephan et al. 1985). Similar to most States, Oregon uses the recommended criteria published by the United States Environmental Protection Agency (EPA) as its own criteria, although it reserves the right to adopt different criteria to protect beneficial uses. Oregon's current water quality criteria for toxic pollutants for the protection of aquatic life are based on the values published in Quality Criteria for Water 1986 (EPA 1986) which is often referred to as the "EPA Gold Book." The EPA Gold Book contains a summary table of values (similar to Table 20) as well as brief narrative descriptions of the criteria which have been excerpted from ambient water quality criteria documents published for individual compounds.

Technical Basis for Aquatic Life Criteria

The process that EPA uses to generate aquatic life criteria is described in "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" (Stephan et al. 1985). EPA

can follow a number of paths to generate values for acute and chronic criteria including gathering information on

1) acute toxicity to aquatic animals;
2) chronic toxicity to aquatic animals;
3) toxicity to plants;
4) bioaccumulative effects; and
5) other effects.

However, the most common path taken involves reviewing data on acute and chronic toxicity to aquatic animals. The level of protection of aquatic organisms is not absolute (i.e. all species at all times and places) because aquatic ecosystems are tolerant of some stress; therefore, the procedure EPA uses is designed to protect at least 95% of the species.

Criteria are derived only if sufficient high quality data exist from aquatic organisms (both vertebrates and invertebrates) that represent a broad range of life history and taxonomic groups. The procedures followed to calculate acute and chronic criteria may be very similar to each other if sufficient data are available. The criteria are primarily based on the toxicity of the compound to the four most sensitive genera (with some influence of data from other available genera). In some cases, if a recreationally or commercially important species is more sensitive to the contaminant than any of the other most sensitive genera, then the criterion is based on the toxicity value from this recreationally or commercially important species. In this way, the procedure can produce numeric values that will be broadly protective, or values that are specifically protective of the single most sensitive species.

If data on chronic toxicity are limited (i.e. too few genera with high quality data), then chronic criteria may be calculated from values that are derived from the relationship between chronic and acute criteria for a few species. For example, if data are available for acute and chronic toxicity of fathead minnows tested under the same conditions, then the ratio of the acute to chronic toxicity can be generated. If sufficient numbers of these acute-chronic ratios are available from a variety of species, then a chronic criterion can be generated using the acute criteria and the acute-chronic ratios.

1.3.3 Criteria for Protection of Human Health

Overview of Human Health Criteria

The criteria for the protection of human health are presented in two forms: values based on the consumption of organisms (usually fish or shellfish) and water, and values based on the consumption of organisms only. Similar to aquatic life criteria, Oregon generally follows EPA's recommended criteria for the protection of human health, although it reserves the right to generate criteria on its own. Oregon's current water quality criteria for toxic pollutants for the protection of human health are based on the values published in the EPA Gold Book in 1986.

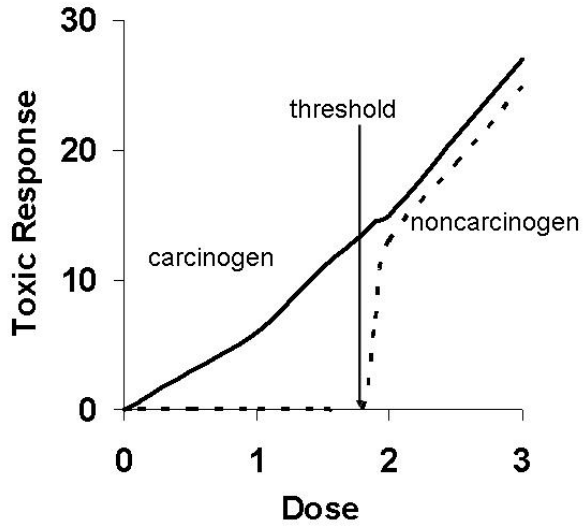
Technical Basis for Human Health Criteria

In 1980, EPA published a methodology for deriving the water quality criteria in the EPA Gold Book which addressed noncancer, cancer, and organoleptic (taste and odor) effects. Oregon did not adopt criteria based on organoleptic effects into Table 20. For noncancer and cancer endpoints, EPA used risk assessment-based procedures to derive human health criteria and these criteria became part of Oregon's Table 20. Noncancer endpoints include neurotoxicity, immunotoxicity, and reproductive/developmental effects.

Depending on the ultimate toxic endpoint, the calculation of criteria differed in type of variables included. Criteria for contaminants which cause cancer were derived assuming that even infinitesimally small doses carry some risk of inducing cancer (linear, nonthreshold assumption for low dose risk); criteria for contaminants which do not cause cancer were derived assuming that there must be some sufficient dose of contaminant to cause an adverse effect (threshold concentration for adverse effects). The major difference in these approaches is that for carcinogens, the relationship between dose of contaminant and incidence of cancer remains linear at very low doses; whereas for noncarcinogens, there is a dose of contaminant (the threshold) below which there is no observable adverse effect (Figure 1.1).

Figure 1.1: Theoretical Dose-Response Curve for Carcinogenic and Noncarcinogenic Compounds.

Theoretical relationship between dose/concentration of a toxic compound and the toxic response to exposure. Note that the response to a carcinogen has a linear relationship through a dose/concentration of 0, but that the response to a noncarcinogen has a threshold below which no adverse effect is observed.



The equation for deriving the criteria for cancer-causing contaminants contains variables for cancer risk level (e.g. 10^{-6} = 1 additional case per 1,000,000 people) and the effectiveness of the contaminant to cause cancer (a carcinogenicity potency slope factor). The equation for noncancer-causing contaminants contains a variable for the threshold dose (reference dose) in water that will not cause a deleterious effect and accounts for exposure by other routes (dietary and inhalation).

Regardless of the toxic endpoint, the remaining variables used for calculating the criteria are similar: body weight of an average adult (70 kg or 154 lbs), water intake of an average adult (2 L/day or 68 ounces/day), daily fish consumption of an average adult, ratio of lipid fraction of fish consumed adjusted to 3%, and a bioconcentration factor. See Section 2.2 for a more detailed discussion.

Chapter 2 Technical Review of Water Quality Criteria for Toxic Pollutants

Section 2.1 Aquatic Life Protection Criteria

2.1.1 Technical Review Process

Review of EPA Aquatic Life Criteria Methodology

One of the initial concerns of the TAC was whether EPA had revised the methodology for deriving ambient water quality criteria for the protection of aquatic life between the publication of the 1986 criteria (the resulting criteria became Oregon's Table 20) and the latest published criteria at the time of the TAC review (EPA 1999). Once it became clear that EPA still used Stephan et al. (1985) to derive its latest criteria, the TAC then reviewed the methodology to make a determination on its scientific credibility. The TAC agreed that the 1985 EPA Methodology was scientifically credible and therefore, could be used as the basis from which it would make recommendations on Oregon's new WQ criteria.

For the 62 aquatic life criteria that differed between Oregon's Table 20 and EPA's latest criteria summary table, the TAC reviewed EPA's rationale for the changes. The TAC then decided whether to recommend that Oregon use the latest EPA criteria, continue to use its current criteria, or propose different criteria altogether. Appendix A lists all such compounds and presents the reasons that EPA changed criteria, which can be summarized as follows:

- new data were used in deriving the criterion
- data were reanalyzed to derive the criterion
- data were subjected to a new analytical approach
- the criterion was never finalized

Review of Other Sources and Considerations

In addition to the EPA Methodology (Stephan et al. 1985), TAC members also reviewed selected scientific literature on particular topics. The TAC reviewed literature to determine if there was sufficient information to derive criteria for compounds EPA has yet to publish criteria. This included a number of scientific papers on sublethal effects of various pesticides and synthetic compounds (PAHs, DDTs, PCBs, fluoride, diazinon, atrazine, hexachlorocyclohexane, carbofuran) on salmonid fishes (Arkoosh et al. 1991; Arkoosh et al. 1994; Moore and Waring 1996; Waring and Moore 1997; Arkoosh et al. 1998a; Arkoosh et al. 1998b; Moore and Waring 1998; Sweet et al. 1998; Scholz et al. 2001), since protection of Endangered Species Act-listed salmonids is of particular concern to the State of Oregon. The TAC

concluded that there was insufficient scientific information to propose criteria for these compounds based on the sublethal effects to salmonids.

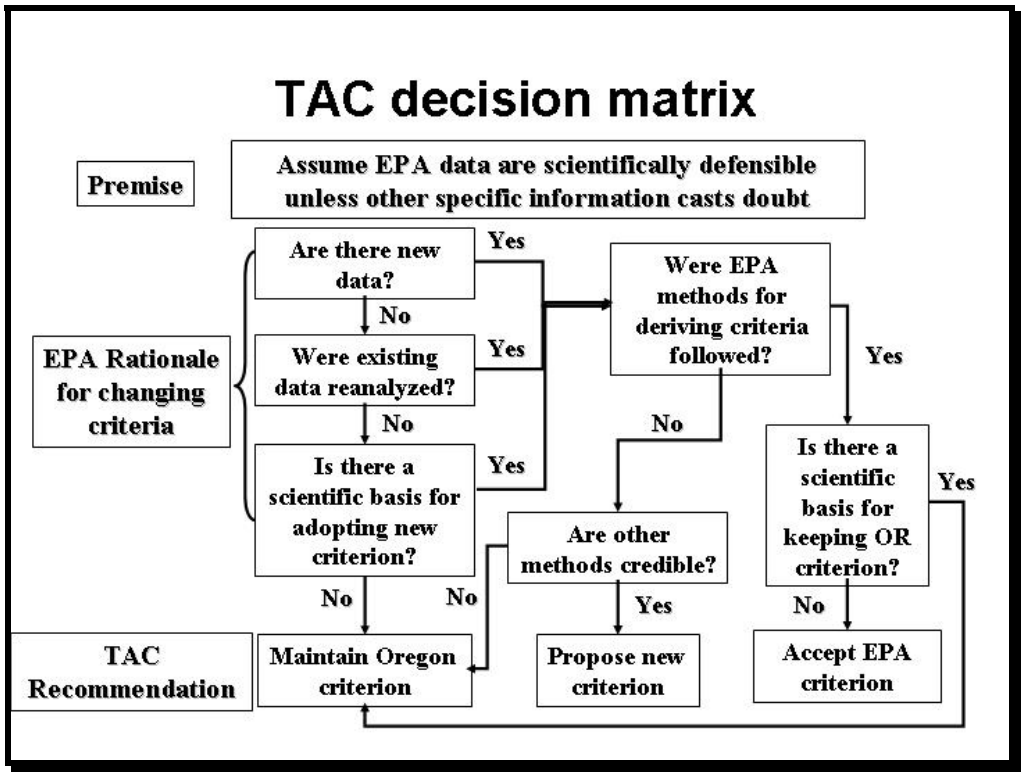
The TAC also examined scientific literature on the Toxic Equivalency Factor approach in its discussion of deriving new criteria for dioxins, furans, and PCBs (Van den Berg et al. 1998; WHO 1998; see Section 2.3). Finally, individual Policy Advisory Committee (PAC) members asked the TAC to review information provided by PAC members on background levels of aluminum and on using total recoverable vs. dissolved metals concentrations for criteria.

Since the TAC was particularly concerned with protecting Endangered Species Act (ESA)-listed salmonids, EPA's revised criteria were also evaluated for whether information on salmonids was used in generating the final values. Although EPA's methodology for deriving ambient water quality criteria uses all acceptable data, the final criteria values are particularly influenced by the toxicity information from the four most sensitive species for a particular compound. EPA's methodology allows for adjustment of criteria due to the presence of a commercially or recreationally important species among the most sensitive species. Therefore, the TAC determined if EPA adjusted any criteria because of the presence of an ESA-listed salmonid. Of the 22 compounds reviewed, the TAC found that EPA followed its methodology and adjusted the criteria of 2 compounds due to the presence of salmonid species that also inhabit the waters of Oregon. Appendix A provides the information on the four most sensitive species that the TAC considered before making its recommendation on criteria, as well as the ranked toxicity of salmonid species (if available).

Framework for making technical recommenda-tions

The TAC recommended criteria based on a framework that presumed that the EPA data included in the criteria documents were scientifically defensible unless other information was more compelling. From that assumption, the TAC considered EPA's rationale for changing the criteria. Once the rationale for change was evaluated, the TAC then considered whether EPA methods were followed, whether other scientifically credible methods were used, or whether technically sound reasons existed for maintaining Oregon's current criteria before making its final recommendation on the criterion that Oregon should adopt. The process is diagrammed in Figure 2.1.

Figure 2.1: TAC Decision Matrix on Aquatic Life Criteria.
Technical Advisory Committee (TAC) decision matrix for recommending ambient water quality criteria for the protection of aquatic life.



If EPA revised a criterion due to the incorporation of new data, the reanalysis of existing data, or the consideration of other scientifically credible reasons, then the TAC considered whether the EPA methodology was followed for deriving the new criteria. If EPA methodology was followed and there was no scientific basis for maintaining current Oregon criterion, then the TAC recommended that Oregon adopt the latest EPA criterion. If, as in the instance of the toxic equivalency factor approach to dioxins, furans, and PCBs, EPA methodology was not applied to derive the new criteria but other scientifically credible methods were employed, then the TAC recommended that Oregon adopt new criteria that differed from both EPA and Oregon's current criteria (see Section 2.3).

Technical Options for Aquatic Life Criteria

The TAC recommendations for criteria that Oregon should adopt fell into four categories:

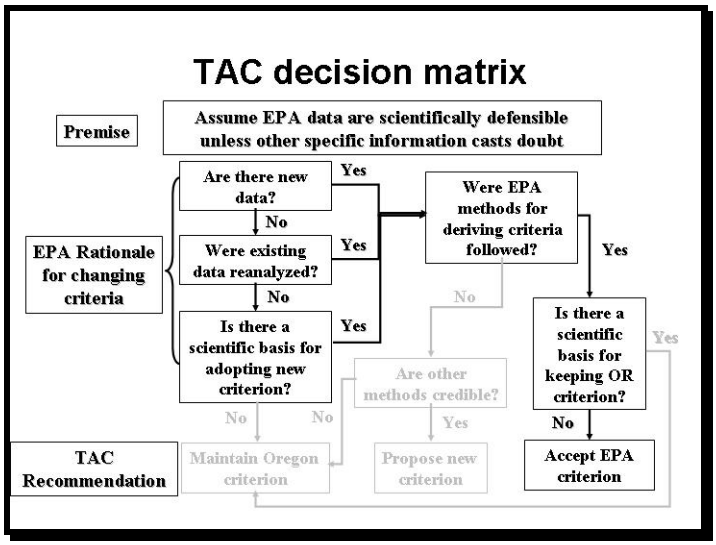
1) adopt latest EPA criteria without modification;
2) adopt latest EPA criteria expressing the values as 'total recoverable' concentrations of metals;
3) maintain Oregon criteria; and
4) maintain Oregon criteria until EPA completes its review.

2.1.2 TAC Recommendation: Adopt EPA Aquatic Life Criteria

Decision Path

The TAC used its decision matrix to review all the aquatic life criteria that differed between Oregon and EPA 1999. As shown in Figure 2.2, if new data were used, existing data reanalyzed, or there was a scientific reason for adopting EPA's latest criteria, then the TAC confirmed that EPA methods were used in deriving the criterion in question. If there was no outstanding technical reason for maintaining Oregon's criterion, then the TAC recommended that Oregon adopt EPA's latest criterion. Table 2.1 contains the compounds and their criteria for which the TAC followed this path to recommend adoption of EPA's latest criteria.

Figure 2.2: Decision path leading to TAC recommendation to adopt EPA criterion.



Adopt EPA Criteria

Table 2.1: Compounds for which the TAC recommended that Oregon adopt the 1999 EPA criteria. Table presents the compound name, the relevant medium (freshwater or saltwater) and exposure (acute or chronic) conditions, Oregon's (OR) and EPA's (EPA) recommended criteria, and the criteria recommended by the TAC.

	Compound	Medium	Exposure	Criteria (in ug/L) OR	Criteria (in ug/L) EPA	TAC Recommen-dation
1	Aluminum [1]	Freshwater	Acute	none	750	**750**
		Freshwater	Chronic	none	87	**87**
2	Ammonia [2,3]	Freshwater	Acute	15000 [4]	13000 [4]	**13000**

Compound		Medium	Exposure	Criteria OR (in ug/L)	Criteria EPA (in ug/L)	TAC Recommen-dation (in ug/L)
		Freshwater	Chronic	2200 [5]	4200 [5]	**4200**
3	Dieldrin	Freshwater	Acute	2.5	0.24	**0.24**
		Freshwater	Chronic	0.0019	0.056	**0.056**
4	alpha-Endosulfan	Freshwater	Acute	none	0.22	**0.22**
		Freshwater	Chronic	none	0.056	**0.056**
		Saltwater	Acute	none	0.034	**0.034**
		Saltwater	Chronic	none	0.0087	**0.0087**
5	beta-Endosulfan	Freshwater	Acute	none	0.22	**0.22**
		Freshwater	Chronic	none	0.056	**0.056**
		Saltwater	Acute	none	0.034	**0.034**
		Saltwater	Chronic	none	0.0087	**0.0087**
6	Endrin	Freshwater	Acute	0.18	0.086	**0.086**
		Freshwater	Chronic	0.0023	0.036	**0.036**
7	Heptachlor Epoxide	Freshwater	Acute	none	0.52	**0.52**
		Freshwater	Chronic	none	0.0038	**0.0038**
		Saltwater	Acute	none	0.053	**0.053**
		Saltwater	Acute	none	0.0036	**0.0036**
8	Lindane	Freshwater	Acute	2	0.95	**0.95**
9	Pentachlorophenol [6]	Freshwater	Acute	20	19	**19**
		Freshwater	Chronic	13	15	**15**
		Saltwater	Chronic	7.9 [7]	7.9	**7.9**
10	Tributyltin	Freshwater	Acute	none	0.46	**0.46**
		Freshwater	Chronic	none	0.063	**0.063**
		Saltwater	Acute	none	0.37	**0.37**
		Saltwater	Chronic	none	0.01	**0.01**

[1]Criteria shown are 'total recoverable' (not 'dissolved') concentrations
[2,3]Ammonia criteria dependent on pH and temperature (see Appendix A for formulae used to calculate OR and EPA criteria).
[4]pH = 7.5; T = 15 C; value converted to 'total ammonia' using table in EPA Ambient Water Quality document (EPA 440/5-85-001).
[5]pH = 7.5; T = 15 C; value is for 'total ammonia'
[6]Pentachlorophenol criteria dependent on pH (see Appendix A for formulae to calculate criteria for pentachlorophenol):
[7]Oregon value is a 'guidance value'; EPA value and TAC recommendation are criteria.

Express concentrations as "total recoverable"

The technical discussion for many of the metals initially followed a similar path as that for the compounds in Table 2.1. However, EPA's latest criteria (EPA 1999, 2002a) for the metals in Table 2.2 were published with the concentrations expressed as 'dissolved' rather than 'total recoverable' because EPA believed (EPA 1995) that 'dissolved' was more appropriate for capturing the bioavailable fraction of metals in the water column. EPA

(1995) developed conversion factors that could be applied to 'total recoverable' concentrations in order to calculate 'dissolved' concentrations.

EPA (1995) acknowledged that part of the scientific community did not agree that the 'dissolved' concentration was a more accurate estimate of bioavailable fraction; therefore, EPA stated that States could adopt metals criteria as either 'dissolved' or 'total recoverable'. Communication with EPA staff at the Duluth laboratory indicated that EPA had found that most of the data used in generating the criteria came from studies in which 'total recoverable' metals concentrations were determined.

TAC members voiced their concern that dissolved concentrations did not take into account the evidence of toxicity resulting from non-dissolved metals suspended in the water column (for example, see Freeman and Everhart 1971; Gundersen et al. 1994). They also pointed out that the criteria were derived mostly from data that had been generated using 'total recoverable' concentrations of metals. Therefore, the TAC recommended that Oregon adopt the latest EPA criteria for metals, but maintain Oregon's current practice of expressing the concentrations as 'total recoverable.'

Table 2.2: Compounds for which the TAC recommended that Oregon adopt EPA criteria for "total recoverable" concentrations (rather than "dissolved").

Compound		Medium	Exposure	Criteria OR (in ug/L)	Criteria EPA (in ug/L)	TAC Recommen-dation
1	Arsenic [1]	Freshwater	Acute	360	340	**340**
		Freshwater	Chronic	190	150	**150**
2	Cadmium [1,2]	Freshwater	Acute	3.9	2.1	**2.1**
		Freshwater	Chronic	1.1	0.27	**0.27**
		Saltwater	Acute	43	40	**40**
		Saltwater	Chronic	9.3	8.8	**8.8**
3	Chromium III [1,2]	Freshwater	Acute	1700	1800	**1800**
		Freshwater	Chronic	210	86	**86**
4	Copper [1,2]	Freshwater	Acute	18	14	**14**
		Freshwater	Chronic	12	9.3	**9.3**
		Saltwater	Acute	2.9	5.8	**5.8**
		Saltwater	Chronic	2.9	3.7	**3.7**
5	Lead [1]	Saltwater	Acute	140	220	**220**
		Saltwater	Chronic	5.6	8.5	**8.5**
6	Nickel [1,2]	Freshwater	Acute	1400	470	**470**
		Freshwater	Chronic	160	52	**52**
7	Selenium [1]	Freshwater	Chronic	35	5	**5**
		Saltwater	Acute	410	290	**290**
		Saltwater	Chronic	54	71	**71**
8	Zinc [1,2]	Freshwater	Chronic	110	120	**120**

[1]criteria shown are "total recoverable" concentrations.

[2]formulae to calculate metals criteria that are hardness-dependent

acute $CMC = e^{(m_a[\ln(hardness)]+b_a)}$

chronic $CCC = e^{(m_c[\ln(hardness)]+b_c)}$

Chemical	*Current Oregon*				*EPA recommended*			
	m_a	b_a	m_c	b_c	m_a	b_a	m_c	b_c
Cadmium	1.128	-3.828	0.7852	-3.490	1.0166	-3.924	0.7409	-4.719
Chromium III	0.8190	3.688	0.8190	1.561	0.8190	3.7256	0.8190	0.6848
Copper	0.9422	-1.4640	0.8545	-1.465	0.9422	-1.700	0.8545	-1.702
Nickel	0.8460	3.3612	0.8460	1.1645	0.8460	2.255	0.8460	0.0584
Silver	1.7200	-6.520	--	--	1.7200	-6.520	--	--
Zinc	0.8473	0.8604	0.8473	0.7614	0.8473	0.884	0.8473	0.884

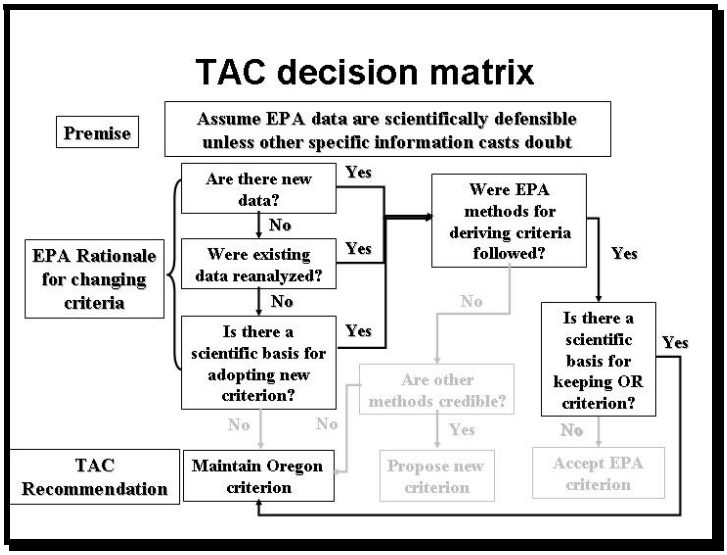
values presented in Table 2.2 are for hardness = 100 mg/L

2.1.3 TAC Recommendation: Maintain Oregon's Current Aquatic Life Criteria

Decision Path

For several compounds, the TAC recommended that Oregon maintain the current criteria using the following decision matrix (Figure 2.3).

Figure 2.3: Decision path leading to TAC recommendation to maintain Oregon's current criterion.



Maintain Oregon's Criteria

Table 2.3 and Table 2.4 list the compounds for which the TAC recommended maintaining Oregon's current criteria. More detailed information is provided in the sections after the tables.

Table 2.3: Compounds for which the TAC recommended maintaining Oregon's current criteria until such time that EPA completes its review resulting from the California Toxics Rule (2000).

Compound		Medium	Exposure	Criteria (in ug/L) OR	Criteria (in ug/L) EPA	Coarse Screening Value	TAC Recommen-dation
1	Mercury[1]	Freshwater	Acute	2.4	1.6	**1.6**	2.4
			Chronic	0.012	0.91	**0.91**	0.012
		Saltwater	Acute	2.1	2.1	**2.1**	2.1
			Chronic	0.025	1.1	**1.1**	1.1
2	Selenium[1]	Freshwater	Acute	260	190/13 [2]	**190/13**	260

[1]All values are presented as "total recoverable" concentrations.
[2]formula to calculate the 1999 EPA acute criterion:

$$CMC = \left(\frac{1}{[(f1/CMC1) + (f2/CMC2)]} \right)$$

where f1 and f2 are the fractions of selenite and selenate; and CMC1= 185.9 and CMC2= 12.83. If the relative fraction of selenite is 1 (making selenate 0), then the CMC is 13 (rounding 12.83 to 2 significant digits); if the relative fraction of selenate is 1 (making selenite 0), then the CMC is 190 (rounding 185.9 to 2 significant digits).

Table 2.4: Compounds for which the TAC recommended maintaining Oregon's current criteria.

Compound		Medium	Exposure	Criteria (in ug/L) OR	Criteria (in ug/L) EPA	TAC Recommen-dation
1	Endosulfan [1]	Freshwater	Acute	0.22	none	**0.22**
		Freshwater	Chronic	0.056	none	**0.056**
		Saltwater	Acute	0.034	none	**0.034**
		Saltwater	Chronic	0.0087	none	**0.0087**
2	Lindane (γ-BHC)	Freshwater	Chronic	0.08	none	**0.08**
3	Silver [2,3]	Freshwater	Chronic	0.12	none	**0.12**

[1]recommended criteria are for the sum of alpha- and beta-endosulfan, each of which has EPA recommended criteria at these concentrations.
[2]criteria based on 'total recoverable' (not 'dissolved') concentrations.
[3]acute criterion has a formula to account for hardness (see Table 2.2 footnotes); however, chronic criterion has no formula.

Mercury & Selenium

For mercury (all criteria) and selenium (freshwater acute criteria), EPA had 'reserved' the criteria in the California Toxics Rule (CTR; EPA 2000a) until reviews of the criteria could be completed to address the concerns raised by

the US Fish and Wildlife Service and the National Marine Fisheries Service in the Biological Opinion on the CTR (USFWS 2000). This meant that those criteria were effectively withdrawn.

The TAC reviewed the information in the 1995 update of criteria (EPA 1995), the CTR (EPA 2000), and the Biological Opinion (USFWS 2000). The TAC recognized that the 1999 EPA criteria for mercury (all) and selenium (freshwater acute) as being scientifically defensible by the process that had been devised for developing national criteria. However, the TAC recommended that DEQ maintain Oregon's current criteria for these compounds until completion of the EPA review. The EPA review is reportedly focused on deriving criteria that will protect threatened and endangered west coast salmonids, which are also found in Oregon. Therefore, in the interim, the TAC recommended maintaining Oregon's current criteria for these compounds (Table 2.3) rather than adopting EPA criteria to which USFWS and NMFS already object. The TAC recommended that once EPA completes the review, then Oregon should consider revising its criteria. The TAC recommendation was made prior to EPA's re-publication of the 1999 criteria in the 2002 recommendation (EPA 2002a).

Endosulfan

EPA had recommended new criteria for alpha-endosulfan and beta-endosulfan and removal of the (total) endosulfan criteria. The new alpha- and beta-endosulfan criteria had the same values as the total endosulfan criteria. However, the 1999 EPA criteria table carried the footnote that these criteria would be "most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan." The TAC was concerned that this crucial information would be missed with table values for only alpha- and beta-endosulfan; thereby resulting in exceeding the current Oregon criteria for total endosulfan while complying individually with the alpha-endosulfan and beta-endosulfan criteria. Therefore, the TAC recommended that DEQ should maintain its current criteria for endosulfan because it captured the intent of EPA (Table 2.4).

Lindane

EPA had withdrawn its recommended freshwater chronic criterion for Lindane (γ-BHC) in 1995 because the removal of data for fathead minnow had resulted in too few species for calculation of the criterion. The TAC discussion included the observation that Lindane was still used in Oregon and had been detected in environmental samples. Therefore, the TAC recommended that DEQ maintain the current freshwater chronic criterion for Lindane (Table 2.4) and undertake a review in order to determine Lindane's current use and environmental detection in Oregon, as well as to ascertain if new data could be used to calculate a criterion.

Silver

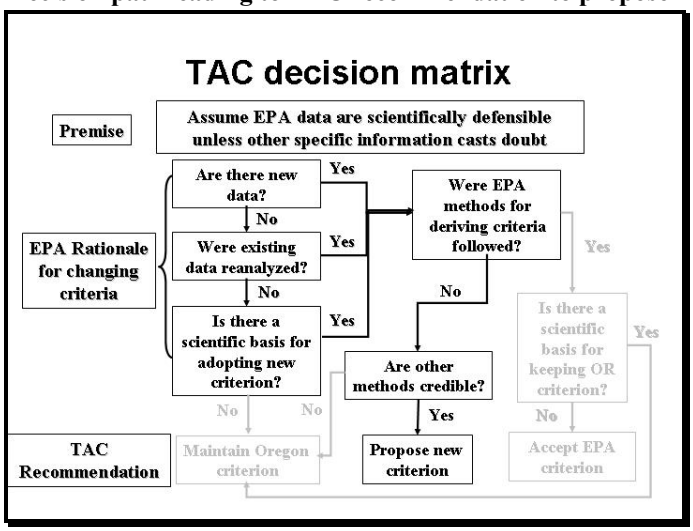
EPA had published a freshwater chronic value for silver in the 1986 EPA Gold Book which was then adopted by Oregon as a criterion in Table 20. However, email correspondence with staff at EPA Headquarters established that EPA considered this value "draft" and never finalized it after it had been challenged during the public comment period. Subsequent publications of EPA criteria did not include the freshwater chronic criterion for silver. The TAC reviewed the draft Silver ambient water quality criteria document (EPA 1987) and found that the data were credible and the calculation of the draft criterion was consistent with EPA methods. Therefore, the TAC recommended that DEQ maintain the current freshwater chronic criterion for silver (Table 2.4).

2.1.4 TAC Recommendation: Propose New Aquatic Life Values for Dioxins, Furans, and PCBs

Decision Path

Oregon's Table 20 contains values for acute (freshwater and saltwater) criteria for polychlorinated biphenyls (PCBs). Since 1992, EPA has published its table of recommended criteria without these criteria. The TAC's discussion of how to address this removal of criteria quickly turned to the opportunity to apply new scientific information (van den Berg et al. 1998) to address the need for taking into account the common mechanism of toxicity of some of the dioxins, furans, and PCBs. Thus, for this group of chemicals, the TAC made recommendations for new criteria for the protection of human health and new guidance values for the protection of aquatic life based on the following decision path (Figure 2.4). This meant that for this group of compounds, the TAC considered aquatic life and human health criteria simultaneously. For more information on these recommendations, see Section 2.3.

Figure 2.4: Decision path leading to TAC recommendation to propose new criteria.



2.1.5 Guidance Values for the Protection of Aquatic Life

Background

Both the EPA Gold Book (EPA 1986) and Oregon's Table 20 contain "guidance values" for the protection of aquatic life. These values are described as resulting from "insufficient data to develop criteria; value presented is the L.O.E.L—Lower Observed Effect Level." The next time EPA published its recommended criteria in the National Toxics Rule (EPA 1992), these values no longer appeared in the criteria table. TAC members reviewed the use of these numbers at DEQ and found that because they were not criteria, "guidance values" were inconsistently used in DEQ's regulatory actions.

TAC Proposal for Guidance Values

The TAC understood EPA's motive to avoid confusion by removing "guidance values" from the table of criteria; however, members felt that in the absence of criteria for these compounds, the "guidance values" were worthwhile for use in the application of Oregon's narrative toxics rule and possibly other regulatory actions. Therefore, the TAC recommended that DEQ remove the guidance values to a separate table (Table 2.5; draft name: "Table 20a") so as to prevent misapplication of the numbers as criteria, but to allow for their use in other contexts. The guidance values were not reviewed to determine if information now existed that would allow for criteria to be calculated. In addition, the TAC recommended that Table 20a include several other compounds/categories so as to provide placeholders for new information. These compounds included polybrominated diphenylethers (PBDE), polybrominated biphenyls (PBB), pharmaceuticals, personal care products, alkyl phenols, pyrethroids, and other chemicals with toxic effects. Even though no values were proposed for these compounds, the TAC felt that identifying them would provide the impetus to take appropriate regulatory action after review of the latest scientific information should they turn up in the waste stream or in ambient monitoring results.

Table 2.5: Guidance Values for inclusion in "Table 20a"
(These numbers represent Lowest Observed Effects Levels and are expressed as µg/L)

Compound or Class	Freshwater		Saltwater	
	Acute	Chronic	Acute	Chronic
Acenaphthene	1,700	520	970	710
Acrolein	68	21	55	
Acrylonitrile	7,550	2,600		
Antimony	9,000	1,600		
Benzene	5,300		5,100	700
Benzidine	2,500			
Beryllium	130	5.3		
BHC	100		0.34	
Carbon tetrachloride	35,200		50,000	
Chlorinated benzenes	250	50	160	129
Chlorinated naphthalenes	1,600		7.5	
Chloroalkyl ethers	238,000			
Chloroform	28,900	1,240		
Chlorophenol 2	4,380	2,000		
Chlorophenol 4			29,700	
Chloro-4 Methyl-3 Phenol	30			
Chromium (II)			10,300	
DDT Metabolite (DDE)	1,050		14	
DDT Metabolite (TDE)	0.06		3.6	

Compound or Class	Freshwater		Saltwater	
	Acute	Chronic	Acute	Chronic
Dichlorobenezenes	1,120	763	1,970	
Dichloroethane	118,000	20,000	113,000	
Dichloroethylenes	11,600		224,000	
Dichlorophenol	2,020	365		
Dichloropropane	23,000	5,700	10,300	3,040
Dichloropropene	6,060	244	790	
Dimethyl Phenol	2,120			
Dinitrotoluene	330	230	590	370
Dioxin (2,3,7,8-TCDD)	0.01	0.000038		
Diphenylhydrazine	270			
Ethylbenzene	32,000		430	
Fluoranthese	3,980		40	16
Haloethers	360	122		
Halomethanes	11,000		12,000	6,400
Hexachloroethane	980	540	940	
Hexachlorobutadiene	90	9.3	32	
Hexachlorocyclopentadiene	7	5.2	7	
Isophorone	117,000		12,900	
Naphthalene	2,300	620	2,350	
Nitrobenezene	27,000		6,680	
Nitrophenols	230	150	4,850	
Nitrosamines	5,850		3,300,000	
Pentachlorinated Ethanes	7,240	1,100	390	281
Pentachlorophenol				7.9
Phenol	10,200	2,560	5,800	
Phthalate Esters	940	3	2,944	3.4
Polynuclear Aromatic Hydrocarbons			300	
Tetrachlroinated Ethanes	9,320			
Tetrachloroethane 1,1,2,2-		2,400	9,020	
Tetrachloroethanes	9,320			
Tetrachloroethylene	5,280	840	10,200	450
Tetrachlorophenol 2,3,5,6-				440
Thallium	1,400	40	2,130	
Toluene	17,500		6,300	5,000
Trichlorinated Ethanes	18,000			
Trichloroethane 1,1,1-			31,200	
Trichloroethane 1,1,2-		9,400		
Trichloroethylene	45,000	21,900	2,000	
Trichlorophenol 2,4,6-		970		
Dioxins, furans, PCBs (TEF approach)	.01	.000038		
Polybrominated diphenyl ethers (PBDE)				
Polybrominated biphenyls (PBB)				
Pharmaceuticals				

Compound or Class	Freshwater		Saltwater	
	Acute	Chronic	Acute	Chronic
Personal care products				
Alkyl Phenols				
Pyrethroids				
Diazinon	0.08	0.05		
Other chemicals with Toxic effects				

Recommended Use of "Guidance Values"

TAC members advised that "guidance values" should be used in conjunction with evidence of beneficial use impairment and best professional judgment in order to apply the narrative toxics criterion (Oregon Administrative Rules 340-041-<Specified Basin>(2)(p)(A)). Best professional judgment may include information from scientific literature (such information should be of the nature of having been corroborated by others in the scientific community) and beneficial use impairment may include effects such as lethality, neurotoxicity, reproductive impairment, or immunosuppression.

Section 2.2 Human Health Protection Criteria

2.2.1 Technical Review Process

Framework for making technical choices

The TAC struggled with the magnitude of the task of reviewing the large number of new and different (between EPA and Oregon) criteria for the protection of human health. A decision matrix similar to that used to evaluate aquatic life criteria could not be used because information on why criteria had been changed or newly recommended did not exist in a readily accessible form. Since the human health criteria were developed with broader participation from various EPA offices and received more scrutiny by many more interested parties, the TAC accepted the data published by EPA in the Integrated Risk Information System (IRIS) database as the basis for developing human health criteria, and decided to focus on whether to recommend the 2000 EPA Methodology for deriving ambient water quality criteria for the protection of human health.

TAC Approach

In comparing the 2000 EPA Methodology with the old EPA methodology for deriving human health criteria, the TAC concluded that the 2000 EPA Methodology was a superior approach, but that some of the data required to develop criteria based on the 2000 EPA Methodology was not yet available. Therefore, the TAC focused its efforts on determining the availability of data on bioaccumulation factors so that the 2000 EPA Methodology could be applied for deriving Oregon's water quality criteria and on deriving a fish consumption rate appropriate for the protection of Oregon's population. The TAC review took place prior to publication of the 2002 EPA recommended criteria (EPA 2002a).

2.2.2 EPA Methodology

Major Factors in Calculating Criteria

The methodology for calculating the 1999 EPA Criteria and the 2000 EPA Methodology both derive ambient water quality criteria through the consideration of three major factors: risk assessment, exposure, and biomagnification. Risk assessment includes the potency of the compound to cause a toxic effect that is either cancerous or noncancerous, and for cancer-causing compounds, the level of risk that is acceptable for society (e.g. one additional cancer per million people). Exposure includes consideration of body weight, water intake, and fish intake. Biomagnification encompasses the degree of increase in concentration of a compound as it makes its way

through the food chain prior to being eaten by humans.

TAC Focus on Fish Consumption and Bioaccumulation

The TAC accepted EPA's data as being authoritative for setting the toxic potency of the compounds, the average body weight of US citizens, and the average water intake. The TAC felt that setting the relative risk of increasing the incidence of cancer was a policy decision, not a technical decision. Therefore, the TAC focused its efforts on a more in-depth evaluation of the two remaining variables used in developing criteria: fish consumption rates and bioaccumulation factors.

Review of EPA Human Health Criteria Methodology

The TAC evaluated EPA's methodology for deriving the 1999 EPA Criteria (EPA 1980) and the 2000 EPA Methodology (EPA 2000a). EPA published recommended criteria (EPA 2002a) using the 2000 EPA Methodology after the TAC process ended. The TAC reviewed the EPA documents and had discussions (conference call and email) with the EPA Headquarters staff responsible for authoring the new methodology. The major differences between the 'old' EPA Methodology and the 2000 EPA Methodology are:

1) use of Bioaccumulation Factors (BAFs) in place of Bioconcentration Factors (BCFs),
2) use of new fish consumption rates, and
3) use of a new formula for calculating criteria for carcinogenic compounds that exhibit a threshold effect.

The 2000 EPA Methodology provided suggestions for the type of information that should be used to formulate the variables used for deriving human health criteria. EPA outlined a hierarchy of approaches that States should consult in deriving the criteria. The spectrum of possibilities begins with States relying on locally relevant information (on fish species for calculating bioaccumulation factor levels and on human populations for setting fish consumption rates) to states relying on national numbers for these factors provided by EPA. The TAC focused its efforts on determining the availability of data on bioaccumulation factors and on deriving a fish consumption rate appropriate for the protection of Oregon's population.

2.2.3 Bioconcentration factors (BCFs) vs. Bioaccumulation factors (BAFs)

Overview

Water quality criteria for the protection of human health are derived, in part, by considering human exposure to pollutants that have been stored within fish

after that fish has been exposed. A bioconcentration factor (BCF) accounts for the uptake by a fish of pollutant from the surrounding water; a bioaccumulation factor (BAF) accounts for the uptake by a fish of pollutant from all sources (including the surrounding water, food, and sediment). In the 2000 EPA Methodology, the use of BAFs was singled out as a major improvement in setting criteria. The 1999 EPA Criteria formula did address bioaccumulation in theory by including the product of BCF and a foodchain multiplier; however, in practice, the foodchain multiplier for each pollutant was set to 1, making a theoretical BAF equal to a BCF. The 2000 EPA Methodology proposed a more sophisticated approach to calculating bioaccumulation by including fish consumption and the bioaccumulation at several trophic levels in order to account for possible biomagnification of contaminants within foodwebs.

Latest BAF Information

The TAC made several requests to EPA for the latest information on BAFs for compounds with human health criteria. However, EPA responded that a list of national BAFs for compounds had not yet been developed and that EPA only had plans to release information on BAFs for a limited number of compounds sometime in the near future. Since resource limitations precluded DEQ from deriving Oregon-specific BAFs, the TAC discussed how best to proceed with its recommendation on human health criteria given the unavailability of this critical information.

2.2.4 Fish Consumption

Discussion on Relevant, Defensible Fish Consumption Rates

The TAC discussion on fish consumption rates centered on the availability of technically defensible values for Oregon's general population and for subpopulations within Oregon that are known to be high fish consumers. The TAC reviewed fish consumption rates published in a variety of surveys (see OEHHA 2001). The TAC agreed that there were no quantitative studies that would provide the necessary information on fish consumption by the general Oregon population; however, the 1994 Columbia River Inter-Tribal Fish Commission (CRITFC) Fish Consumption Study did contain good information on fish consumption in a subpopulation with a high fish consumption rate. Issues that were considered included whether the fish consumption rate used in deriving criteria should protect the average or some higher percentage of Oregonians, and whether it should protect subpopulations of Oregonians that consume large amounts of fish.

Both the 1999 EPA criteria and the 2000 EPA Methodology used USDA survey data in setting the fish consumption rate to be used in calculating

criteria. The 2000 EPA Methodology offered 17.5 g/day (0.6 oz/day) as its default fish consumption rate, which is the national 90th percentile for consumers and non-consumers of fish. It also offered the 99th percentile rate, 142.4 g/day (5.0 oz/day), as a value that can be used if states desire to protect subsistence anglers. These rates are higher than the 6.5 g/day (0.2 oz/day) used in calculating the 1999 EPA Criteria, which was the national 50th percentile. The CRITFC Study mean and 99th percentile rates, 63.5 and 389.0 g/day (2.2 and 13.7 oz/day, respectively), are also higher than the rate used to calculate the 1999 EPA criteria.

TAC Recommended Fish Consumption Rates

The TAC concluded that 17.5, 142.4, 63.5, and 389.0 g/day were technically defensible fish consumption rates. Initially, the TAC indicated that the choice of which rate to employ was a policy decision to be made based on which population or subpopulation Oregon wished to protect. Members of the PAC were reluctant to choose a single fish consumption rate in the face of incomplete information; therefore, the TAC responded by proposing an approach to apply different fish consumption rates depending on the intensity of consumption of fish from specific waters of the State.

TAC Proposal to Apply Different Fish Consumption Rates to Different Waters of Oregon

The TAC proposed that one of three fish consumption rates

17.5 g/day (0.6 oz/day)	low intensity fish consumption
142.4 g/day (5.0 oz/day)	medium intensity fish consumption
389.0 g/day (13.7 oz/day)	high intensity fish consumption

be used for deriving criteria that would be specific to waters within Oregon's designated subbasins (see Table 2.6). Waters where fish are actively harvested by members of Oregon subpopulations with high fish consumption (e.g. Native American, Asian) would be assigned the high intensity value, waters where fish are harvested by sport fishers but not members of the previous subpopulations would be assigned the medium intensity, and the remaining waters of the State in which fishing is a beneficial use would be assigned the low intensity fish consumption value. The TAC used professional judgment in assigning the fish consumption rates and indicated that these numbers could be modified once a more in-depth study was conducted on fishing intensity in the waters of Oregon.

2.2.5 Carcinogens

Non-linear low dose extrapolation model for some carcinogens

The early methods for calculating water quality criteria for cancer-causing compounds assumed that there was some risk of cancer from exposure to these compounds at any dose (i.e. the dose-response curve was linear even at very low doses; see Figure 1.1). Some carcinogenic compounds do not conform to this linear dose-response assumption at low doses; therefore, the

2000 EPA Methodology included a formula for calculating water quality criteria which employs the point of departure from linearity and an uncertainty factor. A variable to account for exposure from non-water sources is also included in the non-linear low dose extrapolation model. Since the model no longer includes linear extrapolation to low doses for a particular cancer risk level, the latter has been dropped from the formula. The TAC endorsed this approach as being technically sound and discussed how it could be implemented in the face of limited information on the compounds that would be covered under this approach.

2.2.6 TAC Recommendations for Human Health Criteria

Human Health Criteria Technical Options

The TAC approached the revision of the criteria for the protection of Human Health differently than that for criteria for the protection of Aquatic Life because there were many more criteria to consider and the reasons for changes in criteria were not readily accessible from EPA publications. After reviewing the 2000 EPA Methodology, the TAC considered the following options for recommending revisions to Oregon's human health criteria:

1) Adopt the 1999 EPA Human Health Criteria
2) Adopt the 2000 EPA Methodology
3) Adopt the 2000 EPA Methodology with modifications

Option 1 and 2 Rejected

The TAC rejected option 1 to adopt the 1999 EPA criteria because of the inadequacy of the fish consumption rate used in deriving the criteria and availability of the superior 2000 EPA Methodology.

Although the TAC endorsed the 2000 EPA Methodology, its members acknowledged that Oregon did not have the resources to obtain the information needed to fully implement this methodology so option 2 was rejected.

Option 3 Recommended: Adopt the 2000 EPA Methodology with modifications

TAC members felt it was important that DEQ use the 2000 EPA Methodology as soon as sufficient information became available. Therefore, the TAC recommended that:

1) DEQ should use the 2000 EPA Methodology if sufficient information was available.
2) If sufficient information was not available, DEQ should derive criteria by using bioconcentration factors (BCFs) in place of bioaccumulation factors (BAFs).
3) DEQ should derive criteria by using one of three fish consumption rates which would be assigned to particular waters of the State based on the level of consumption of fish from those waters: low, moderate, or high (Table 2.6). The low fish consumption rate would be 17.5 g/day (0.6 oz/day); the moderate would be 142.4 g/day (5.0 oz/day); and the high would be 389.0 g/day (13.7 oz/day).

Table 2.6. Proposed Fish Consumption Rates for Waters of Oregon. The TAC assigned one of three fish consumption rates to each waterbody listed in OAR 340-041 based on the level of fishing intensity that occurs in those waters (17.5 g/day = low intensity; 142.4 g/day = medium intensity; 389.0 g/day = high intensity).

Basin	Specified Waters	Fish Consumption Rate (g/day)
North Coast – Lower Columbia Basin	Estuaries and Adjacent Marine Waters	389.0
	Columbia River: Mouth to RM 86	389.0
	All Other Streams & Tributaries Thereto	17.5
Mid Coast Basin	Estuaries and Adjacent Marine Waters	389.0
	Fresh Waters	17.5
Umpqua Basin	Umpqua R. Estuary to Head of Tidewater and Adjacent Marine Waters	389.0
	Umpqua R. Main Stem from Head of Tidewater to Confluence of N. & S. Umpqua Rivers	142.4
	North Umpqua River Main Stem	142.4
	South Umpqua River Main Stem	142.4
	All Other Tributaries to Umpqua, North & South Umpqua Rivers	17.5
South Coast Basin	Estuaries and Adjacent Marine Waters	389.0
	All Streams & Tributaries Thereto	17.5
Rogue Basin	Rogue River Estuary and Adjacent Marine Waters	389.0
	Rogue River Main Stem from Estuary to Lost Creek Dam	142.4

Basin	Specified Waters	Fish Consumption Rate (g/day)
	Rogue River Main Stem above Lost Dam & Tributaries	142.4
	Bear Creek Main Stem	17.5
	All Other Tributaries to Rogue River & Bear Creek	17.5
Willamette Basin	Clackamas River	142.4
	Molalla River	142.4
	Santiam River	142.4
	McKenzie River	142.4
	Tualatin River	142.4
	All Other Streams & Tributaries	17.5
	Mouth of Willamette Falls, Including Multnomah Channel	389.0
	Willamette Falls to Newberg	142.4
	Newberg to Salem	142.4
	Salem to Coast Fork	142.4
	Main Stem Columbia River (RM 86 to 120)	389.0
Sandy Basin	Streams Forming Waterfalls Near Columbia River Highway	17.5
	Sandy River	142.4
	Bull Run River and All Tributaries	
	All Other Tributaries to Sandy River	17.5
	Columbia River (RM 120 to 147)	389.0
Hood Basin	Columbia River (RM 147 to 203)	389.0
	Other Hood River Basin Streams	142.4
Deschutes Basin	Columbia River (RM 203 to 218)	389.0
	Deschutes River Main Stem from Mouth to Pelton Regulating Dam	389.0
	Deschutes River Main Stem from Pelton Regulating Dam to Ben Diversion Dam and for the Crooked River Main Stem	142.4
	Deschutes River Main Stem above Bend Diversion Dam & for the Metolius River Main Stem	142.4
	All Other Basin Streams	142.4
John Day Basin	Columbia River (RM 218 to 247)	389.0
	John Day River & All Tributaries	142.4
Umatilla Basin	Umatilla Subbasin	142.4
	Willow Creek Subbasin	17.5
	Columbia River (RM 247 to 309)	389.0

Basin	Specified Waters	Fish Consumption Rate (g/day)
Walla Walla Basin	Walla Walla River Main Stem from Confluence of North and South Forks to State Line	142.4
	All Other Basin Streams	142.4
Grande Ronde Basin	Main Stem Snake River (RM 176 to 260)	389.0
	Main Stem Grande Ronde River (RM 39 to 165)	142.4
	All Other Basin Waters	142.4
Powder Basin	Main Stem Snake River (RM 260 to 335)	389.0
	All Other Basin Waters	142.4
Malheur River Basin	Snake River Main Stem (RM 335 to 395)	389.0
	Malheur River (Namorf to Mouth) Willow Creek (Brogan to Mouth) Bully Creek (Reservoir to Mouth)	142.4
	Willow Creek (Malheur Reservoir to Brogan) Malheur R. (Beulah Dam & Warm Springs Dam to Namorf)	142.4
	Reservoirs: Malheur, Bully Creek, Beulah, Warm Springs	142.4
	Malheur River & Tributaries Upstream from Reservoirs	17.5
Owyhee Basin	Snake River (Rm 295 – 409)	389.0
	Owyhee River (RM 0 – 18)	142.4
	Owyhee River (RM 18 – Dam)	142.4
	Reservoirs: Antelope, Cow Creek, Owyhee	142.4
	Owyhee River & Tributaries Upstream from Owyhee Reservoir	142.4
	Designated Scenic Waterway	142.4
Malheur Lake Basin	Natural Lakes	17.5
	All Rivers & Tributaries	17.5
Goose and Summer Lakes Basin	Goose Lake	142.4
	Fresh Water Lakes & Reservoirs	142.4
	Highly Alkaline & Saline Lakes	17.5
	Freshwater Streams	17.5
Klamath Basin	Klamath River from Klamath Lake to Keno Dam (RM 255 to 232.5)	142.4
	Lost River (RM 5 to 65) & Lost River	142.4

Basin	Specified Waters	Fish Consumption Rate (g/day)
	Diversion Channel	
	All Other Basin Waters	142.4

Section 2.3 Dioxins, Furans and PCBs

2.3.1 Overview

What are these chemicals?

Polychlorinated dibenzo-*p*-dioxins (dioxins), polychlorinated dibenzofurans (furans), and polychlorinated biphenyls (PCBs) are classes of human-made chemicals that persist in the environment. There are more than 70 dioxins and more than 130 furans, which are produced as by-products of industrial processes such as chemical manufacturing, bleaching at pulp and paper mills, and chlorination during water treatment. More than 200 PCBs were produced in the US until 1977 for use as insulators and lubricants in electrical equipment such as transformers.

Mechanisms of Toxicity

A number of dioxins, furans, and PCBs have been found to cause toxic responses--including dermal toxicity, immunotoxicity, carcinogenicity, and adverse effects on reproduction, development, and endocrine functions (Van den Berg et al. 1998)--similar to those caused by one particularly toxic dioxin called 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (2,3,7,8-TCDD).

At the cellular level, 2,3,7,8-TCDD exerts its the toxic effects through a multistep process. Once 2,3,7,8-TCDD reaches the tissue (e.g. liver) on which it will act, it binds to a specific intracellular receptor molecule (the aryl-hydrocarbon or *Ah* receptor) that attaches itself to the cell's DNA to then affect gene expression to cause a toxic effect. Other dioxins, furans, and PCBs act through this same Ah receptor mechanism to cause toxicity, although individual chemicals have different potencies. Furthermore, the latest scientific information indicates that the toxicity to an organism resulting from exposure to a mixture of these compounds is additive rather than synergistic.

This mechanism of action is sometimes explained as “one lock, many keys” with the receptor molecule being the “lock” and the similarly acting dioxins, furans, and PCBs acting as the “keys”—all of which fit into the lock with some fitting better than others. Thus, the receptor can affect gene function through the binding of any single type of molecule (e.g. 2,3,7,8-TCDD) or through the binding of a mixture of compounds from any of the classes. This is important because these compounds often exist in the environment as complex mixtures, and therefore the magnitude of the toxic response cannot be completely explained by the toxicity of any one chemical. This also raises an important policy issue because numeric water quality criteria have been set for some of these compounds, but not for others.

Current Oregon & EPA criteria

Oregon currently has numeric water quality criteria for 2,3,7,8-TCDD for the protection of human health, guidance values for 2,3,7,8-TCDD for the protection of freshwater aquatic life, and numeric water quality criteria for PCBs (as a group) for the protection of aquatic life and the protection of human health (Table 2.7). EPA has published numeric water quality criteria for 2,3,7,8-TCDD for the protection of human health and for PCBs (as a group) for the protection of aquatic life and protection of human health (Table 2.7).

Neither Oregon nor EPA has numeric water quality criteria for any of the furans. The current Table 20 values for the 2,3,7,8-TCDD criteria to protect human health for Oregon are less strict than those for EPA; EPA no longer publishes its guidance values for 2,3,7,8-TCDD for aquatic life.

EPA and Oregon have the same chronic criteria for PCBs for the protection of aquatic life. Both EPA's and Oregon's criteria are set for the concentration of all PCBs; thereby including some PCBs that do not act through the *Ah* receptor.

Table 2.7: Water Quality Criteria for 2,3,7,8-TCDD and PCBs (Oregon's current and EPA's latest) in µg/L.

Guidance values are not shown.

	Freshwater		Seawater			
	Acute	Chronic	Acute	Chronic	Water + Fish Ingestion	Fish Consumption Only
Oregon						
2,3,7,8-TCDD					1.3×10^{-8}	1.4×10^{-8}
PCBs	2.0	0.014	10	0.03	7.9×10^{-5}	7.9×10^{-5}
EPA						
2,3,7,8-TCDD					5.0×10^{-9}	5.1×10^{-9}
PCBs		0.014		0.03	6.4×10^{-5}	6.4×10^{-5}

Summing Individual Toxicities: Toxic Equivalency Factor Approach

The scientific evidence indicates that the toxicity of a mixture of pollutants that act through the Ah receptor can be viewed as the sum of all the individual toxicities. Therefore, scientists have developed methods for expressing the toxicity of these individual chemicals relative to that of 2,3,7,8-TCDD (World Health Organization 1998; Van den Berg et al. 1998). Each individual chemical is assigned a value called the "toxic equivalency factor" (TEF) based on its potency in comparison to 2,3,7,8-TCDD. The toxicity associated with a mixture of these chemicals can be calculated by adding the product of the concentration of each individual chemical and its toxic equivalency factor

for all the compounds present in the mixture. Similarly, water quality criteria can be expressed as "2,3,7,8-TCDD-equivalents" for mixtures by using the toxic equivalency factors to calculate the relative contribution of each chemical towards limits established by the criteria. Table 2.8 depicts the human health toxic equivalency factors for those 29 compounds considered to function through the *Ah* receptor.

In the TEF approach, the toxicity should not exceed the criteria for 2,3,7,8-TCDD, since this is considered the most toxic pollutant. This can be expressed in the following equation:

$$(Concentration_1 \times TEF_1) + (Concentration_2 \times TEF_2) \ldots + (Concentration_n \times TEF_n) \leq \text{2,3,7,8-TCDD criterion}$$

where 1) $Concentration_1$ through $Concentration_n$ are the concentrations of each *Ah* receptor-acting chemical present and 2) TEF_1 through TEF_n are the Toxic Equivalency Factors for the *Ah* receptor-acting chemicals.

Table 2.8: Toxic Equivalency Factors (TEF) for human risk assessment.

Congener	TEF value	Congener	TEF value
Dioxins		**Non-ortho PCBs**	
2,3,7,8-tetraCDD (2,3,7,8-TCDD)	1	PCB 77	0.0001
1,2,3,7,8-pentaCDD	1	PCB 81	0.0001
1,2,3,4,7,8-hexaCDD	0.1	PCB 126	0.1
1,2,3,6,7,8-hexaCDD	0.1	PCB 169	0.01
1,2,3,7,8,9-hexaCDD	0.1		
1,2,3,4,6,7,8-heptaCDD	0.01		
OctaCDD	0.0001		
Furans		**Mono-ortho PCBs**	
2,3,7,8-tetraCDF	0.1	PCB 105	0.0001
1,2,3,7,8-pentaCDF	0.05	PCB 114	0.0005
2,3,4,7,8-pentaCDF	0.5	PCB 118	0.0001
1,2,3,4,7,8-hexaCDF	0.1	PCB 123	0.0001
1,2,3,6,7,8-hexaCDF	0.1	PCB 156	0.0005
1,2,3,7,8,9-hexaCDF	0.1	PCB 157	0.0005
2,3,4,6,7,8-hexaCDF	0.1	PCB 167	0.00001
1,2,3,4,6,7,8-heptaCDF	0.01	PCB 189	0.0001
1,2,3,4,7,8,9-heptaCDF	0.01		
OctaCDF	0.0001		

2.3.2 TAC Recommendation

Toxic Equivalency Factor (TEF) Approach

The TAC recommended that Oregon adopt the TEF approach for setting water quality criteria protective of human health for those dioxins, furans, and PCBs that act through the Ah receptor (see Table 2.8) and for setting water quality guidance values protective of aquatic life (see Table 2.9). The TAC acknowledged that this would be a new approach; however, members believed the TEF approach was justified because it used the latest scientific information that was broadly accepted within the scientific community. Furthermore, the TAC felt that use of the TEF approach in water quality criteria was most appropriate for protecting beneficial uses from the toxic effects of the number of pollutants that exert their toxicity through the *Ah* receptor.

Table 2.9: Toxic Equivalency Factors (TEF) for aquatic life risk assessment

Congener	TEF value	Congener	TEF value
Dioxins		**Non-ortho PCBs**	
2,3,7,8-tetraCDD (2,3,7,8-TCDD)	1	PCB 77	0.0005
1,2,3,7,8-pentaCDD	1	PCB 81	0.0001
1,2,3,4,7,8-hexaCDD	0.5	PCB 126	0.005
1,2,3,6,7,8-hexaCDD	0.01	PCB 169	0.00005
1,2,3,7,8,9-hexaCDD	0.01		
1,2,3,4,6,7,8-heptaCDD	0.001		
OctaCDD	<0.0001		
Furans		**Mono-ortho PCBs**	
2,3,7,8-tetraCDF	0.05	PCB 105	<0.00005
1,2,3,7,8-pentaCDF	0.05	PCB 114	<0.00005
2,3,4,7,8-pentaCDF	0.5	PCB 118	<0.00005
1,2,3,4,7,8-hexaCDF	0.1	PCB 123	<0.00005
1,2,3,6,7,8-hexaCDF	0.1	PCB 156	<0.00005
1,2,3,7,8,9-hexaCDF	0.1	PCB 157	<0.00005
2,3,4,6,7,8-hexaCDF	0.1	PCB 167	<0.00005
1,2,3,4,6,7,8-heptaCDF	0.01	PCB 189	<0.00005
1,2,3,4,7,8,9-heptaCDF	0.01		
OctaCDF	<0.0001		

Example of TEF calculation

The following example is presented to aid understanding of how the TEF approach might be applied as a water quality criterion. For the example, an analysis of a sample revealed the following compounds at the following concentrations:

Compound	*Concentration*	*TEF*	*Ah-receptor acting?*
2,3,7,8-TCDD	0.4×10^{-8} μg/L	1	Yes
1,2,3,4,7,8-hexaCDD	1.5×10^{-8} μg/L	0.1	Yes
1,2,3,7,8-pentaCDF	2.3×10^{-7} μg/L	0.05	Yes
PCB 81	6.5×10^{-8} μg/L	0.0001	Yes
PCB 101	1.9×10^{-7} μg/L	--	No

$$(0.4 \times 10^{-8}\ \mu g/L \times 1) + (1.5 \times 10^{-8}\ \mu g/L \times 0.1) + (2.3 \times 10^{-7}\ \mu g/L \times 0.05) + (6.5 \times 10^{-8}\ \mu g/L \times 0.0001) =$$

$$1.70 \times 10^{-8}\ \mu g/L$$

Since the proposed criterion concentration for 2,3,7,8-TCDD is 5.0×10^{-9} μg/L (see Table 2.7), then the concentration from the sample exceeds the criterion.

Chapter 3 Policy Analysis of Potential Options

Section 3.1 Policy Advisory Committee Process

PAC Membership & Mandate

The Policy Advisory Committee (PAC) was convened to provide DEQ with diverse stakeholder input on the policy implications of decisions made with regard to water quality standards. The PAC membership is shown in Table 1.2. The PAC discussed issues regarding the toxic pollutants criteria beginning in January 2001 and lasting through November 2003. Discussions of issues related to toxics criteria often occupied the balance of time at PAC meetings in 2001 and 2002. PAC members agreed that its recommendations should come from a consensus of members in order that DEQ should have a clear mandate in moving forward with its water quality standards review. Interested parties, numbering more than 500 names, received notices of PAC meetings in advance. Meetings were open to the public and a public comment period was provided at every meeting.

Section 3.2 Policy Issues Considered

EPA Inspector General's audit underestimates criteria review needs

In 1999, an audit from the EPA Inspector General indicated that Oregon did not have water quality criteria for 8 out of 99 priority pollutants for which EPA had published criteria. DEQ's review revealed that over 250 of Oregon's criteria differed from those of the latest EPA recommendation (see Table 1.3 and Table 1.4); therefore, DEQ decided to broaden the scope of criteria review from the 8 compounds that the Inspector General's audit had identified. One of the first issues that the PAC discussed was the extent of the review of toxic compounds and the scope of the technical committee's (TAC) responsibilities.

Continued on next page

Initial Proposed Scope of Technical Review	DEQ's initial proposal was to limit its technical review to those compounds for which Oregon's criteria were either absent or less strict than those of EPA (1999). The rationale for this proposed approach stemmed from the reality that EPA can (and has for other States) promulgate criteria if a State does not adopt EPA's recommended criteria, criteria more strict than EPA's recommendations, or provide acceptable scientific justification for why the State's criteria should be less stringent than EPA's recommended criteria. DEQ's initial proposal was to adopt only those criteria susceptible to potential promulgation, and then to undertake a more in-depth technical review of those EPA criteria that were less stringent than Oregon's current criteria in order to ensure that EPA's criteria would be protective of local species.
PAC Response to Initial Proposal	Some PAC members disagreed with limiting the review to only those EPA criteria more stringent than Oregon's criteria. A review of all criteria was suggested because it was more equitable and consistent since DEQ would be generally deferring to EPA as the authority on the best science regardless of the stringency of the criteria. Other PAC members wanted DEQ to broaden the scope of the technical review to include consideration of toxic effects on wildlife as well as aquatic life and human health. The PAC did not endorse a PAC member-initiated proposal to accept EPA's criteria by reference. Subsequently, a PAC subcommittee was unable to propose an alternate approach for the technical review.
DEQ Decision on Approach	DEQ responded by proposing a broader review that encompassed all criteria as one option for the PAC to consider. A majority of PAC members endorsed this approach (vote: 6 for, 0 against, 3 abstained), but there was not consensus. DEQ moved forward with a review of all criteria that differed between Oregon and EPA without a formal PAC recommendation.

Section 3.3 Aquatic Life Criteria

Aquatic Life Criteria and Beneficial Uses

As explained in Section 1.3.2, water quality criteria for the protection of aquatic life have four possible forms: freshwater acute, freshwater chronic, marine (saltwater) acute, or marine (saltwater) chronic criteria. Oregon's designated beneficial uses for which these criteria are designed to protect include anadromous fish passage, salmonid fish rearing, salmonid fish spawning, and resident fish and aquatic life. During the course of discussions on the aquatic life criteria, one PAC member suggested including wildlife dependent on aquatic life (e.g. bald eagles) as a beneficial use that should be considered when evaluating the numeric value of a specific criterion. The majority of the PAC did not concur. EPA has not recommended national water quality criteria for the protection of wildlife, although the US Fish and Wildlife Service has recommended such criteria in the Biological Opinion to the California Toxics Rule (http://pacific.fws.gov/caltoxics/). For this review, DEQ took the position of considering aquatic life criteria to protect the designated beneficial uses of anadromous fish passage, salmonid fish rearing, salmonid fish spawning, and resident fish and aquatic life.

Process of PAC Evaluation of Aquatic Life Criteria

DEQ brought the TAC recommendations on Aquatic Life criteria (see Chapter 2) to the PAC and presented them as one of several options to consider for PAC endorsement. DEQ hoped that this approach would allow the PAC to discuss the policy implications with sufficient technical context such that the PAC could make a consensus recommendation on which aquatic life criteria DEQ should adopt. The PAC was also afforded the opportunity to forward questions or issues that fit within the scope of the technical review to the TAC for consideration and response. The TAC recommendations for aquatic life criteria were presented to the PAC in one of four categories depending on the chemicals or compounds under consideration:

- adopt 1999 EPA criteria (Table 2.1);
- adopt 1999 EPA criteria and express value as "total recoverable concentration" (Table 2.2);
- maintain Oregon's current criteria (Table 2.3 and Table 2.4);
- adopt criteria that differ from 1999 EPA and Oregon (Table 2.8).

Compounds for which TAC recommended adopting 1999 EPA criteria

For a large number of compounds (shown in Table 2.1), the TAC concluded that the scientific information supported the adoption of the latest EPA criteria. For these compounds, the PAC considered four options:

1. the TAC recommendation to adopt the 1999 EPA criteria
2. maintenance of all of Oregon's current criteria. The latter option could result in EPA promulgating Oregon's criteria for those compounds for which Oregon's current criteria are not as protective as the latest EPA criteria.
3. the adoption of only those 1999 EPA criteria which were more stringent than Oregon's current criteria.
4. Option 3 and the footnoting of all values in the final criteria table for which information on bioaccumulation had yet to be taken into account. The presence of such compounds in the waste stream or in ambient monitoring samples would trigger the use of the narrative criteria for toxic substances.

Options 3 and 4 were offered during the course of PAC discussion, stemming from one PAC member's belief that sufficient information was not available to indicate whether the 1999 EPA criteria were truly protective of aquatic life. Other members of the PAC did not support these two options because they believed the premise of these options was not supported by the evidence.

PAC decision on compounds in Table 2.1

PAC members entertained a motion to endorse Option 1, i.e. follow the TAC's recommendation to adopt EPA's recommended criteria for the compounds in Table 2.1. A majority of PAC members voted in favor of this recommendation (vote: 7 for; 2 against); however, the resolution had insufficient votes to pass as a consensus recommendation.

Metals criteria: TAC recommends adopting 1999 EPA criteria as "total recoverable concentrations" (Table 2.2)

For metals, the 1999 EPA criteria document expresses the criteria as either individual values or a formula that takes into account the hardness of the water. Therefore, identifying a EPA 1999 criterion for a metal can be viewed as a two-step process. First, a criterion is based on "total recoverable" concentration of the metal, or if water hardness needs to be considered, then the formula is used to calculate the criterion as "total recoverable concentration" of the metal. Second, conversion factors are provided so that the "total recoverable concentration" can be converted to "dissolved concentration." In 1995, EPA recommended that States use the "dissolved concentrations" for metals criteria because these were the most appropriate values for representing the fraction of metal that was available for exposure to biological organisms ("bioavailable fraction"). At the same time, EPA indicated it would approve States to use "total recoverable concentrations" as criteria for metals if States elected not to use "dissolved concentrations." Oregon's current metals criteria are expressed in "total recoverable concentrations."

The TAC recommendation was to adopt the 1999 EPA criteria as calculated for "total recoverable concentrations" rather than "dissolved concentrations" (Table 2.2) because the TAC concluded that some toxicity to metals resulted from exposure to the nondissolved fraction. DEQ outlined 3 options for the PAC:

- adopt the TAC recommendation to use EPA metals criteria for "total recoverable" concentrations;
- use EPA metals criteria for "dissolved" concentrations;
- maintain Oregon's current criteria.

Policy concerns with metals criteria

The PAC had the opportunity to discuss the policy implications of metals criteria over several meetings. The option of maintaining Oregon's current criteria was not deemed viable since EPA could promulgate Oregon's criteria for those compounds which have less stringent criteria than EPA's recommended criteria. In addition, the TAC reviewed a "white paper" from one PAC member's group that supported the use of "dissolved" concentrations for the criteria; however, the TAC reiterated its recommendation that the criteria should be expressed in "total recoverable" concentrations. Some PAC members noted that the US Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) had also supported criteria as "total recoverable" concentrations; thus, Oregon's adoption of such an approach would likely expedite consent from the Services on EPA's approval of Oregon's water quality standards during the Endangered Species Act consultation process.

PAC decision on metals criteria in Table 2.2.

The PAC focused on the technical validity of the TAC's recommendation for metals criteria. Some members of the PAC challenged the TAC recommendation on technical grounds, mainly citing EPA (1995) as indicating that "dissolved" metals concentrations were the most reflective of bioavailability, and therefore, toxicity, of metals. Other members agreed with the TAC recommendation, pointing to NMFS and USFWS expected challenge of the use of "dissolved" metals concentrations for criteria in Idaho as a rationale to adopt "total recoverable" concentrations as more conservative criteria likely to meet with agency approval. A motion to endorse the TAC recommendation did not pass (vote: 2 for; 6 against) and a motion to endorse use of EPA metals criteria for "dissolved" concentrations received a majority of votes (vote: 6 for; 2 against), but did not receive sufficient support to be a consensus recommendation from the PAC on metals criteria.

Federal actions on Mercury and Selenium criteria

In 1999, EPA published revised aquatic life criteria for mercury (freshwater acute, freshwater chronic, saltwater acute, saltwater chronic) and selenium (freshwater acute). However, when EPA proposed these same values in the California Toxics Rule (CTR; EPA 2000), USFWS and NMFS challenged these values during consultation for compliance with the Endangered Species Act (USFWS 2000; http://pacific.fws.gov/caltoxics). EPA responded by "reserving" (i.e. not publishing) values for mercury (freshwater acute, freshwater chronic, saltwater acute, saltwater chronic) and selenium (freshwater acute), and undertaking a review in order to determine if different criteria should be recommended. Therefore, the TAC was faced with a choice of

- adopting the 1999 EPA criteria which would likely be challenged during USFWS and NMFS consultation on compliance of water quality standards with the Endangered Species Act,
- maintaining Oregon's current criteria until the EPA review was complete
- deriving new criteria based on the latest scientific information.

The last choice was not considered viable because of the limited scope of and resources available to the TAC to compile and review the latest scientific information.

PAC discussion of options on Mercury and Selenium criteria

The TAC recommended that DEQ maintain Oregon's current criteria for mercury (all criteria) and selenium (freshwater acute) (Table 2.3). In addition, the TAC recommended that once EPA completes the review of the criteria for these compounds, DEQ should reevaluate the criteria. DEQ offered for PAC discussion a second option of adopting the more stringent of Oregon's current and EPA's latest criteria. The PAC focused most of its discussion on mercury. PAC members expressed general concern about the necessity of limiting the technical review because of the large number of criteria in need of updating. One PAC member suggested that DEQ should adopt aquatic life criteria based on a value put forward by NMFS and USFWS in the CTR Biological Opinion; however, no formal motion was entertained. A motion to endorse the TAC recommendation and amend it to include the requirement of a more in depth technical review of mercury criteria never came to a vote.

Removal of criteria for endosulfan, lindane, and silver?

The 1999 EPA recommendation does not contain criteria for endosulfan (freshwater acute, freshwater chronic, marine acute, marine chronic), lindane (freshwater chronic), or silver (freshwater chronic). EPA had substituted alpha- and beta-endosulfan criteria for the endosulfan criteria. EPA had not published the lindane criterion because of failure to meet the minimum data requirements after data on fathead minnows had been removed. The silver criterion in the Oregon Administrative Rules was based on a draft criterion that was never finalized by EPA. Thus, DEQ sought input on what to do about criteria that EPA had removed from its latest recommendations.

PAC discusses TAC position to maintain Oregon's criteria for endosulfan, lindane, and silver (Table 2.4)

The TAC recommended maintaining Oregon's water quality criteria for endosulfan (all aquatic life criteria), lindane (freshwater chronic), and silver (freshwater chronic). The TAC believed that the endosulfan criteria would be useful in fulfilling EPA's intent with the criteria for alpha- and beta-endosulfan; that lindane use in Oregon warranted maintaining the old EPA criterion until such time that a more in-depth review could be undertaken; and that the silver criterion was based on sound science even if EPA never finalized it (see Section 2.1.3). DEQ presented two options to the PAC:

1. adopt the TAC recommendation to maintain Oregon's current criteria for these compounds
2. adopt EPA's recommendation to remove the criteria from Oregon's list of compounds.

The PAC discussion on these options centered on understanding the TAC rationale for its recommendation. The major policy implication identified concerned the lindane criterion because this pollutant is generally not controlled at the point of disposal; instead, it might be found in the waste stream of the municipal sewage treatment plant which makes application of the criteria to a source a challenge. In general, PAC members acknowledged the rationale of the TAC recommendation and a motion to endorse the TAC recommendation passed unanimously (vote: 8 for; 0 against).

Section 3.4 Human Health Criteria

Background on Human Health Criteria

The large number of human health criteria in need of review and the nature of the information available on those criteria made the TAC review of the human health criteria different from that on the aquatic life criteria. EPA's publication of "Methods for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000)" complicated the TAC review because it did not contain a summary table of recommended criteria based on that methodology. Rather than reviewing the scientific literature on the human toxicity of individual compounds, the TAC focused its efforts on evaluating the new EPA methodology, including an assessment of the availability of information necessary to apply that methodology, and then determining an approach that would apply to deriving all the criteria. In addition, the TAC reviewed an approach for deriving human health criteria for those dioxins, furans, and polychlorinated biphenyls (PCBs) that share a common mechanism of action which was based on relating the cumulative toxicity of these compounds to the existing criteria for 2,3,7,8-TCDD (dioxin).

TEF Approach for Dioxins, Furans, and PCBs

The TAC recommended that DEQ adopt a toxic equivalency factor (TEF) approach for criteria for those dioxins, furans, and PCBs that act through the Ah receptor (see Section 2.3.2). The PAC discussed how this approach would be implemented after DEQ presented an example using USGS data. The major issue raised by some PAC members was whether it would be equitable to include consideration of some PCBs in these criteria because contamination from these compounds results from historical deposition. Thus, these members believed that it would be unfair to include 'legacy' pollution in the calculation of the final criteria. A straw poll indicated that the TAC recommendation would not gain PAC endorsement, so the PAC formed a subcommittee to determine whether it could put forward a consensus recommendation.

PAC subcommittee on TEF discussion

The PAC subcommittee was created to examine this issue in more detail. The subcommittee asked the TAC for clarification on technical aspects of the TEF approach; specifically, 1) whether sufficient information existed on bioavailability, bioaccumulation, depuration rates and other physiological mechanisms of the compounds included in the TEF approach, 2) whether the PCBs should be split off from the TEF approach, 3) whether cost and methodological problems made the TEF approach too difficult to implement, and 4) whether the Arochlor PCBs should be included in the TEF approach. The TAC responded that 1) although more information would always be better, sufficient information existed on the behavior of the TEF compounds to include them in this approach, 2) since the TEF PCBs act through the same mechanism of action, it was appropriate to include them in the TEF approach, 3) analytical techniques were continually improving the detection limits and costs were not prohibitive for the analysis of the TEF compounds, and 4) some PCBs in Arochlor mixtures would be counted in the TEF approach. The subcommittee also reviewed documents from New York State on its limited TEF approach and the rationale for why EPA did not propose a TEF approach when promulgating the California Toxics Rule. Based on these considerations, the subcommittee proposed that Oregon adopt a TEF approach for dioxins and furans but not include PCBs, and that bioconcentration equivalency factors (BEF) as developed by EPA Region 5 be included in application of the TEF approach. This approach is currently used by the State of New York and several other Great Lakes states. The full PAC did not reach consensus on this subcommittee proposal.

Human Health Criteria using 2000 EPA Methodology

The TAC recommended that DEQ use the 2000 EPA Methodology to derive criteria protective of human health when sufficient information was available. In the interim, the TAC recommended that DEQ modify the EPA methodology used to derive the 1999 EPA criteria by incorporating higher fish consumption rates reflective of the information presented in the 2000 EPA Methodology and the 1994 Columbia River Inter-Tribal Fish Commission (CRITFC) Study. The TAC indicated that four published fish consumption rates were scientifically defensible and regionally relevant:

- 17.5 g/day (0.6 oz/day)(national 90th percentile)
- 63.5 g/day (2.2 oz/day)(average for Columbia River tribal members)
- 142.4 g/day (5.0 oz/day)(national 99th percentile)
- 389.0 g/day (13.7 oz/day)(99th percentile for Columbia River tribal members)

Finally, the TAC recommended that DEQ use 10^{-6} as the cancer risk level when deriving criteria for carcinogenic compounds.

Policy issues concerning human health criteria

One major policy issue revolved around whether the criteria should be adopted based on protecting a high fish-consuming subpopulation in Oregon or on protecting the general population of Oregon. This issue was complicated because high quality data were not available on the fish consumption level of the general Oregon population, which was the rationale for the TAC's inclusion of the national numbers in the options to be considered. Another issue arose concerning the proportion of the population that should be targeted for protection. In the past, EPA used mean level of fish consumption in its formulae for calculating criteria; however, the data used to calculate the mean included non-consumers of fish; therefore, the 2000 EPA Methodology recommended that the fish consumption rate be set at a higher percentile in order to provide better protection for fish consumers. A third issue was raised concerning the criteria for carcinogens. Since current EPA criteria for carcinogens are based on the assumption that exposure at any dose would result in some increase in the risk of contracting cancer--and this risk level is a variable used in calculating the criteria--EPA recommends that States use 10^{-5}, 10^{-6}, or 10^{-7} as possible risk levels. Oregon's current criteria are based on a risk level of 10^{-6}.

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Questions on human health criteria considered by PAC

In summary, the PAC faced the following policy decisions that needed to be made concerning human health criteria:

1. which population should the criteria target to protect (i.e. fish consumption rates from which populations)?
2. which percentage of the population should be protected?
3. which level of risk of increased incidence of cancer should the criteria for carcinogens be set?

TAC response to PAC dilemma on selecting a fish consumption rate

The PAC discussed the methods for determining fish consumption rates, acknowledging the difficulty in determining a rate appropriate for Oregon in the face of limited information and the challenge of settling on a particular rate that would provide the appropriate and prudent amount of protection. The TAC responded to this discussion by suggesting three different fish consumption rates that could be applied to different waters of the State depending on the intensity of consumption of fish from those waters.

PAC decision on fish consumption rate

PAC members questioned the TAC's three consumption rate approach for setting human health criteria as possibly leading to inequities because there would be different criteria for the same toxic compound on the same river, leading to situations where a source might have to comply with a criterion more strict than designated for its location in order for the water to meet a more strict criterion downstream. One PAC member offered an alternative approach of using a lower fish consumption rate statewide except for those areas where it was known that highly contaminated fish were being caught and consumed by at least some sector of Oregon's population. Another PAC member offered another alternative of using a higher fish consumption rate statewide except for those areas where it was known that fish are not contaminated or fish are not caught and consumed. In the end, there was no consensus from the PAC regarding whether a single or multiple fish consumption rates should be used, nor was there consensus on the level that that (or those) fish consumption rate(s) should be.

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PAC discussion of population percentile to use for setting fish consumption rate	The PAC discussed the difficulty of deciding on the appropriate population percentile to target in order to derive a protective fish consumption rate. EPA has offered justification for the use of several different percentiles and PAC members struggled with the necessity of making a qualitative judgment on a quantitative variable. A straw poll of PAC members indicated that there was no consensus on the percentile of a population that should be targeted when setting the fish consumption rate to be used in calculating the human health criteria.
PAC decision on cancer risk rate	In considering the three possible cancer risk rates (10^{-5}, 10^{-6}, or 10^{-7}), the PAC discussed the large influence that this factor had on calculating the criteria. EPA had recommended any of these levels as being acceptable for setting human health criteria, and the TAC had recommended that DEQ continue to use 10^{-6}. The PAC acknowledged that there was no strong sentiment to support one risk level over another; therefore, they voted unanimously to accept the TAC recommendation to maintain the value for the cancer risk level variable at 10^{-6} for deriving human health criteria (vote: 8 for; 0 against).

Chapter 4 DEQ Recommendations

Section 4.1 Introduction

Background

Initially, the recommendations for the toxic compounds ambient water quality criteria from the Department of Environmental Quality were developed from the information contained in preceding sections of this issue paper, and the Technical and Policy Advisory Committees' discussions. In addition, these recommendation also considered public comment obtained during the 88-day Public Comment period.

Advisory Committees

All the recommendations from the Technical Advisory Committee (TAC) were made by consensus. Although few PAC recommendations were made by consensus, the PAC frequently agreed by strong majority vote. DEQ has factored this majority approach into its deliberations in lieu of full consensus.

Section 4.2 Criteria for the Protection of Aquatic Life

Compounds for which DEQ recommends 2002 EPA criteria

DEQ recommends adoption of the aquatic life criteria for compounds shown in Table 4.1, which were recommended by the TAC (Table 2.1) and received a majority endorsement from the PAC. DEQ believes that these criteria are the result of the latest science as suggested by the TAC recommendation, and that these criteria represent the best policy choice as suggested by the PAC majority opinion. Adoption of these criteria will bring Oregon into agreement with the latest EPA criteria.

Table 4.1 Compounds for which DEQ recommends acceptance of the 2002 EPA Aquatic Life Criteria. For each compound, medium, and exposure conditions, values are presented for current Oregon criteria, the Technical Advisory Committee (TAC) recommendation, the Policy Advisory Committee (PAC) recommendation or majority opinion, and the Department's recommendation (DEQ). All values are expressed as µg/L.

Compound	Medium	Exposure	Current OR Criteria [1]	Criteria [1] Recommendations		
				TAC	PAC	DEQ
Aluminum	Freshwater	Acute	none	750	750	**750**
	Freshwater	Chronic	none	87	87	**87**
Ammonia	Freshwater	Acute	15000 [2]	13000 [3]	13000 [3]	**13000 [3]**
	Freshwater	Chronic	2200 [2]	4200 [3]	4200 [3]	**4200 [3]**
Dieldrin	Freshwater	Acute	2.5	0.24	0.24	**0.24**
	Freshwater	Chronic	0.0019	0.056	0.056	**0.056**
alpha-Endosulfan	Freshwater	Acute	none	0.22	0.22	**0.22**
	Freshwater	Chronic	none	0.056	0.056	**0.056**
	Saltwater	Acute	none	0.034	0.034	**0.034**
	Saltwater	Chronic	none	0.0087	0.0087	**0.0087**
beta-Endosulfan	Freshwater	Acute	none	0.22	0.22	**0.22**
	Freshwater	Chronic	none	0.056	0.056	**0.056**
	Saltwater	Acute	none	0.034	0.034	**0.034**
	Saltwater	Chronic	none	0.0087	0.0087	**0.0087**
Endrin	Freshwater	Acute	0.18	0.086	0.086	**0.086**
	Freshwater	Chronic	0.0023	0.036	0.036	**0.036**
Heptachlor Epoxide	Freshwater	Acute	none	0.52	0.52	**0.52**
	Freshwater	Chronic	none	0.0038	0.0038	**0.0038**
	Saltwater	Acute	none	0.053	0.053	**0.053**
	Saltwater	Acute	none	0.0036	0.0036	**0.0036**
Lindane (γ-BHC)	Freshwater	Acute	2	0.95	0.95	**0.95**
Pentachlorophenol	Freshwater	Acute	20 [4]	19 [5]	19 [5]	**19 [5]**
	Freshwater	Chronic	13 [4]	15 [5]	15 [5]	**15 [5]**
	Saltwater	Chronic	7.9 [6]	7.9	7.9	**7.9**
Tributyltin	Freshwater	Acute	none	0.46	0.46	**0.46**
	Freshwater	Chronic	none	0.063	0.063	**0.063**
	Saltwater	Acute	none	0.37	0.37	**0.37**
	Saltwater	Chronic	none	0.01	0.01	**0.01**

[1] Criteria are expressed as total recoverable concentrations unless otherwise footnoted.
[2] Criteria depend on pH, temperature, and the presence of salmonids or other cold-water species. Values presented are for total ammonia in waters with pH= 7.5, temperature= 15°C (59°F), and salmonids present using the formula specified in EPA (1986), i.e. the "Gold Book".
[3] Criteria depend on pH, temperature, and the presence of salmonids or other fish with ammonia-sensitive early life stages. Values presented are for total ammonia in waters with pH=7.5, temperature=15°C (59°F), and salmonids or sensitive early life stages present using the formulae

specified in *1999 Update of Ambient Water Quality Criteria for Ammonia* (EPA-822-R-99-014; http://www.epa.gov/ost/standards/ammonia/99update.pdf).
[4] Criteria depend on pH. Values presented are for pentachlorophenol in waters with pH=7.8 using the formula specified in EPA (1986), i.e. the "Gold Book".
[5] Criteria depend on pH. Values presented are for pentachlorophenol in waters with pH=7.8 using the formula specified in *1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water* (EPA-820-96-001).
[6] Value presented is erroneously published in Oregon's Table 20 as a "guidance value" when it should be a criterion. The recommendation will correct this error.

DEQ recommends maintaining Oregon's Endosulfan, Lindane, and Silver criteria

DEQ recommends adoption of the criteria for compounds shown in Table 4.2, which were recommended by the TAC (Table 2.4) and received a consensus endorsement from the PAC. Adoption of these criteria will maintain Oregon's current criteria which are stricter than the latest EPA criteria for these compounds. DEQ believes that there is technical basis for these criteria and that maintaining Oregon's current criteria is the best way to protect beneficial uses.

Table 4.2 Compounds for which DEQ recommends maintaining Oregon's current Aquatic Life Criteria. For each compound, medium, and exposure conditions, values are presented for current Oregon criteria, the Technical Advisory Committee (TAC) recommendation, the Policy Advisory Committee (PAC) recommendation or majority opinion, and the Department's recommendation (DEQ). All values are expressed as µg/L.

Compound	Medium	Exposure	Current OR Criteria [1]	Criteria [1] Recommendations		
				TAC	PAC	DEQ
Endosulfan [2]	Freshwater	Acute	0.22	0.22	0.22	**0.22**
	Freshwater	Chronic	0.056	0.056	0.056	**0.056**
	Saltwater	Acute	0.034	0.034	0.034	**0.034**
	Saltwater	Chronic	0.0087	0.0087	0.0087	**0.0087**
Lindane (γ-BHC)	Freshwater	Chronic	0.08	0.08	0.08	**0.08**
Silver	Freshwater	Chronic	0.12	0.12	0.12	**0.12**

[1] Criteria are expressed as total recoverable concentrations unless otherwise footnoted.
[2] Value is for the sum of alpha- and beta-endosulfan.

DEQ recommends adopting the 2002 EPA Metals Criteria as "dissolved" concentrations

DEQ recommends adoption of the criteria for metals as "dissolved" concentrations as shown in Table 4.3. In its national recommendations to States, EPA recommends States establish water quality criteria for these metals as "dissolved" concentrations although the Agency acknowledges that using "total recoverable" concentrations may be appropriate, too. The TAC had recommended metals criteria be expressed as "total recoverable" concentrations of metals; however, this recommendation did not receive consensus or majority endorsement from the PAC. Although DEQ believes that using a more conservative approach of "total recoverable" concentrations is technically defensible as acknowledged by EPA (1995), the current economic difficulties in the State do not support the adoption of metals criteria more stringent that the federal minimum (which in this case is "dissolved" concentrations).

One might argue that criteria expressed in "total recoverable" concentration represents the best policy choice because they are 1) more protective of beneficial uses than using "dissolved" concentrations and thus, represents protection from metals exposure from all sources, not just dissolved within the water column, 2) consistent with the how the criteria are currently applied, and 3) likely to be approved by both EPA and the Federal Services during consultation on whether the criteria meet the requirements of the Endangered Species Act; however adoption of "total recoverable" would have made Oregon's criteria more stringent that the latest EPA criteria which are expressed as "dissolved" concentrations and thus, might require greater treatment costs by permittees. Therefore, DEQ is recommending that the metals criteria be adopted as "dissolved" concentrations in order to minimize the financial burden to the regulated community during the economic slowdown.

Table 4.3 Compounds for which DEQ recommends acceptance of the 2002 EPA Aquatic Life Criteria as "dissolved" concentrations. For each compound, medium, and exposure conditions, values are presented for current Oregon criteria, the Technical Advisory Committee (TAC) recommendation, the Policy Advisory Committee (PAC) recommendation or majority opinion, and the Department's recommendation (DEQ). All values are expressed as µg/L.

Compound	Medium	Exposure	Current OR Criteria [1]	Criteria [1] Recommendations		
				TAC	PAC	DEQ
Arsenic	Freshwater	Acute	360	340	340 [4]	**340 [4]**
	Freshwater	Chronic	190	150	150 [4]	**150 [4]**
Cadmium	Freshwater	Acute	3.9 [2]	2.1 [3]	2.0 [3,4]	**2.0 [3,4]**
	Freshwater	Chronic	1.1 [2]	0.27 [3]	0.25 [3,4]	**0.25 [3,4]**
	Saltwater	Acute	43	40	40 [4]	**40 [4]**
	Saltwater	Chronic	9.3	8.8	8.8 [4]	**8.8 [4]**
Chromium III	Freshwater	Acute	1700 [2]	1800 [3]	570 [3,4]	**570 [3,4]**

Compound	Medium	Exposure	Current OR Criteria [1]	Criteria [1] Recommendations		
				TAC	PAC	DEQ
	Freshwater	Chronic	210 [2]	86 [3]	74 [3,4]	**74 [3,4]**
Copper	Freshwater	Acute	18 [2]	14 [3]	13 [3,4]	**13 [3,4]**
	Freshwater	Chronic	12 [2]	9.3 [3]	9.0 [3,4]	**9.0 [3,4]**
	Saltwater	Acute	2.9	5.8	4.8 [4]	**4.8 [4]**
	Saltwater	Chronic	2.9	3.7	3.1 [4]	**3.1 [4]**
Lead	Saltwater	Acute	140	220	210 [4]	**210 [4]**
	Saltwater	Chronic	5.6	8.5	8.1 [4]	**8.1 [4]**
Nickel	Freshwater	Acute	1400 [2]	470 [3]	470 [3,4]	**470 [3,4]**
	Freshwater	Chronic	160 [2]	52 [3]	52 [3,4]	**52 [3,4]**
Selenium	Freshwater	Chronic	35	5.0	4.6 [4]	**4.6 [4]**
	Saltwater	Acute	410	290	290 [4]	**290 [4]**
	Saltwater	Chronic	54	71	71 [4]	**71 [4]**
Silver	Freshwater	Acute	4.1	4.1	3.4 [4]	**3.4 [4]**
Zinc	Freshwater	Chronic	110 [2]	120 [3]	120 [3,4]	**120 [3,4]**

[1] Criteria are expressed as total recoverable concentrations unless otherwise footnoted.
[2] Criteria depend on water hardness. Values presented are for metals in waters with water hardness=100 mg/L using the formulae specified in EPA (1986), i.e. the "Gold Book".
[3] Criteria depend on water hardness. Values presented are for metals in waters with water hardness=100 mg/L using the formulae specified in *National Recommended Water Quality Criteria: 2002* (EPA-822-R-02-047; http://www.epa.gov/ost/pc/revcom.pdf) or 2001 Update of Ambient Water Quality Criteria for Cadmium (EPA-822-R-01-001; http://www.epa.gov/waterscience/criteria/aqualife/cadmium/cad2001upd.pdf)
[4] Values presented are for dissolved concentrations of metals.

DEQ recommends adopting EPA's latest Selenium Criterion and Maintaining the current Oregon criteria for Mercury

DEQ recommends that the criteria for selenium be changed to reflect the latest EPA recommendation (Table 4.4). The TAC had recommended maintaining the current Oregon criteria for both compounds, and this recommendation had received no action from the PAC; however, these discussions occurred prior to the 2002 publication of EPA recommended criteria (EPA 2002a). The TAC's recommendation had been to maintain Oregon's current criteria until EPA completed its review and then reevaluate the criteria at that time. EPA (2002a) offered no explanation for why it changed its recommendation from "reserved" in the California Toxics Rule (EPA 2000a) to the values it had previously published in 1999 (EPA 1999). Informal correspondence with EPA Headquarters revealed that EPA considered the "reserved" status for these criteria to only apply to California and therefore, the 1999 EPA criteria were relevant as national recommendations for other States. DEQ believes that changing the selenium criterion to the latest EPA recommendation is prudent until such time that Oregon can review these criteria in depth. DEQ believes that maintaining the current Oregon aquatic life criteria for mercury is prudent because of concerns existing in Oregon over mercury and the protection of threatened and endangered salmonids. These criteria were "reserved" (i.e. withdrawn) from the California Toxics Rule because of the Services' objections to suspected adverse impact of the proposed EPA criteria on Threatened and Endangered salmonids. Since Oregon has the same species as those identified in the Biological Opinion to the California Toxics Rule, DEQ believes this is the most prudent action until such time that the mercury criteria can be reviewed in depth..

Table 4.4 Compounds for which DEQ recommends acceptance of the 2002 EPA Aquatic Life Criteria. For each compound, medium, and exposure conditions, values are presented for current Oregon criteria, the Technical Advisory Committee (TAC) recommendation, the Policy Advisory Committee (PAC) recommendation or majority opinion, and the Department's recommendation (DEQ). All values are expressed as µg/L and as total recoverable concentrations unless specified otherwise.

Compound	Medium	Exposure	Current OR Criteria [1]	Criteria [1] Recommendations		
				TAC	PAC	DEQ
Mercury	Freshwater	Acute	2.4	2.4		**2.4**
	Freshwater	Chronic	0.012	0.012		**0.012**
	Saltwater	Acute	2.1	2.1		**2.1**
	Saltwater	Chronic	0.025	0.025		**0.025**
Selenium	Freshwater	Acute	260	260		**190/13** [2]

[1]Criteria are expressed as total recoverable concentrations.
[2]The CMC = 1/[(f1/CMC1)+(f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 µg/l and 12.82 µg/l, respectively.

Summary Table of Recommended Criteria for the Protection of Aquatic Life

Table 4.5 presents a comparison of the DEQ proposed and current Oregon aquatic life criteria for all compounds, including those that were not reviewed because no differences existed between Oregon and EPA criteria.

Table 4.5 Comparison of Aquatic Life Criteria between DEQ proposed values and current Oregon values. All values are expressed as µg/L. Compounds are listed in alphabetical order with the corresponding EPA (1999) compound number ("N" following a number indicates that the compound is listed by EPA under Non-Priority Pollutants) and the Chemical Abstract Service (CAS) number.

			Freshwater				Saltwater			
			Acute Criteria (CMC)		Chronic Criteria (CCC)		Acute Criteria (CMC)		Chronic Criteria (CCC)	
EPA No.	Compound	CAS	DEQ Proposed	Current OR	DEQ Proposed	Current OR	DEQ Proposed	Current OR	DEQ Proposed	Current OR
56	Acenaphthene	83329								
57	Acenaphthylene	208968								
17	Acrolein	107028								
18	Acrylonitrile	107131								
102	Aldrin	309002	3.0	3.0			1.3	1.3		
2 N	Aluminum (pH 6.5 - 9.0)	7429905	750 C		87 C					
3 N	Ammonia (@18 C & pH=7.5)	7664417	20 A	13 A	5.6 B	3.7 B				

EPA No.	Compound	CAS	Freshwater				Saltwater			
			Acute Criteria (CMC)		Chronic Criteria (CCC)		Acute Criteria (CMC)		Chronic Criteria (CCC)	
			DEQ Proposed	Current OR	DEQ Proposed	Current OR	DEQ Proposed	Current OR	DEQ Proposed	Current OR
58	Anthracene	120127								
1	Antimony	7440360								
2	Arsenic	7440382	340 H	360 C	150 H	190 C	69 H	69 C	36 H	36 C
15	Asbestos	1332214								
6 N	Barium	7440393								
19	Benzene	71432								
59	Benzidine	92875								
60	Benzo(a)Anthracene	56553								
61	Benzo(a)Pyrene	50328								
62	Benzo(b)Fluoranthene	205992								
63	Benzo(ghi)Perylene	191242								
64	Benzo(k)Fluoranthene	207089								
3	Beryllium	7440417								
103	BHC, alpha-	319846								
104	BHC, beta-	319857								
106	BHC, delta	319868								
105	BHC, gamma- (Lindane)	58899	0.95	2.0	0.08	0.08	0.16	0.16		
7 N	Boron	7440428								
20	Bromoform	75252								
69	Bromophenyl Phenyl Ether 4-	101553								
70	Butylbenzyl Phthalate	85687								
4	Cadmium	7440439	2.0 H,D	3.9 C,D	0.25 H,D	1.13 C,D	40 H	43 C	8.8 H	9.3 C
21	Carbon Tetrachloride	56235								
107	Chlordane	57749	2.4	2.4	0.0043	0.0043	0.09	0.09	0.004	0.004
8 N	Chloride	16887006	860000	860000	230000	230000				
9 N	Chlorine	7782505	19	19	11	11	13	13	7.5	7.5
22	Chlorobenzene	108907								
23	Chlorodibromomethane	124481								
24	Chloroethane	75003								
65	ChloroethoxyMethane, Bis2-	111911								
66	ChloroethylEther, Bis2-	111444								
25	Chloroethylvinyl Ether 2-	110758								
26	Chloroform	67663								
67	ChloroisopropylEther, Bis2-	108601								
71	Chloronaphthalene 2-	91587								
45	Chlorophenol 2-	95578								
10 N	Chlorophenoxy Herbicide 2,4,5,-TP	93721								

EPA No.	Compound	CAS	Freshwater				Saltwater			
			Acute Criteria (CMC)		Chronic Criteria (CCC)		Acute Criteria (CMC)		Chronic Criteria (CCC)	
			DEQ Proposed	Current OR	DEQ Proposed	Current OR	DEQ Proposed	Current OR	DEQ Proposed	Current OR
11 N	Chlorophenoxy Herbicide 2,4-D	94757								
72	Chlorophenyl Phenyl Ether 4-	7005723								
12 N	Chloropyrifos	2921882	0.083	0.083	0.041	0.041	0.011	0.011	0.0056	0.0056
5a	Chromium III	16065831	570 H,D	1700 C,D	74 H,D	210 C,D				
5b	Chromium VI	18540299	16	16	11	11	1100	1100	50	50
73	Chrysene	218019								
6	Copper	7440508	13 H,D	18 C,D	9.0 H,D	12 C,D	4.8 H	2.9 C	3.1 H	2.9 C
14	Cyanide	57125	22	22	5.2	5.2	1	1	1	1
110	DDD 4,4'-	72548								
109	DDE 4,4'-	72559								
108	DDT 4,4'-	50293	1.1	1.1	0.001	0.001	0.13	0.13	0.001	0.001
14 N	Demeton	8065483			0.1	0.1			0.1	0.1
74	Dibenzo(a,h)Anthracene	53703								
75	Dichlorobenzene 1,2-	95501								
76	Dichlorobenzene 1,3-	541731								
77	Dichlorobenzene 1,4-	106467								
78	Dichlorobenzidine 3,3'-	91941								
27	Dichlorobromomethane	75274								
28	Dichloroethane 1,1-	75343								
29	Dichloroethane 1,2-	107062								
30	Dichloroethylene 1,1-	75354								
40	Dichloroethylene 1,2-Trans-	156605								
46	Dichlorophenol 2,4-	120832								
31	Dichloropropane 1,2-	78875								
32	Dichloropropene 1,3-	542756								
111	Dieldrin	60571	0.24	2.5	0.056	0.0019	0.71	0.71	0.0019	0.0019
79	DiethylPhthalate	84662								
80	Dimethyl Phthalate	131113								
47	Dimethylphenol 2,4-	105679								
81	Di-n-Butyl Phthalate	84742								
49	Dinitrophenol 2,4-	51285								
27 N	Dinitrophenols	25550587								
82	Dinitrotoluene 2,4-	121142								
83	Dinitrotoluene 2,6-	606202								
84	Di-n-Octyl Phthalate	117840								
16	Dioxin (2,3,7,8-TCDD)	1746016								
85	Diphenylhydrazine 1,2-	122667								
	Endosulfan	7439976	0.22 E	0.22 E	0.056 E	0.056 E	0.034 E	0.034 E	0.0087 E	0.0087 E

EPA No.	Compound	CAS	Freshwater				Saltwater			
			Acute Criteria (CMC)		Chronic Criteria (CCC)		Acute Criteria (CMC)		Chronic Criteria (CCC)	
			DEQ Proposed	Current OR	DEQ Proposed	Current OR	DEQ Proposed	Current OR	DEQ Proposed	Current OR
114	Endosulfan Sulfate	1031078								
112	Endosulfan, alpha-	959988	0.22		0.056		0.034		0.0087	
113	Endosulfan, beta-	33213659	0.22		0.056		0.034		0.0087	
115	Endrin	72208	0.086	0.18	0.036	0.0023	0.037	0.037	0.0023	0.0023
116	Endrin Aldehyde	7421934								
15 N	Ether, Bis Chloromethyl	542881								
33	Ethylbenzene	100414								
68	EthylhexylPhthalate, Bis2-	117817								
86	Fluoranthene	206440								
87	Fluorene	86737								
17 N	Guthion	86500			0.01	0.01			0.01	0.01
117	Heptachlor	76448	0.52	0.52	0.0038	0.0038	0.053	0.053	0.0036	0.0036
118	Heptachlor Epoxide	1024573	0.52		0.0038		0.053		0.0036	
88	Hexachlorobenzene	118741								
89	Hexachlorobutadiene	87683								
19 N	Hexachlorocyclo-hexane-Technical	319868								
90	Hexachlorocyclopentadiene	77474								
91	Hexachloroethane	67721								
92	Ideno1,2,3-cdPyrene	193395								
20 N	Iron	7439896			1000	1000				
93	Isophorone	78591								
7	Lead	7439921	65 H,D	82 C,D	2.5 H,D	3.2 C,D	210 H	140 C	8.1 H	5.6 C
21 N	Malathion	121755			0.1	0.1			0.1	0.1
22 N	Manganese	7439965								
8a	Mercury	7439976	2.4 C	2.4 C	0.012 C	0.012 C	2.1 C	2.1 C	0.025 C	0.025 C
23 N	Methoxychlor	72435			0.03	0.03			0.03	0.03
34	Methyl Bromide	74839								
35	Methyl Chloride	74873								
48	Methyl-4,6-Dinitrophenol 2-	534521								
52	Methyl-4-Chlorophenol 3-	59507								
36	Methylene Chloride	75092								
8b	Methylmercury	22967926								
24 N	Mirex	2385855			0.001	0.001			0.001	0.001
94	Naphthalene	91203								
9	Nickel	7440020	470 H,D	1400 C,D	52 H,D	160 C,D	74 H	75 C	8.2 H	8.3 C
25 N	Nitrates	14797558								
95	Nitrobenzene	98953								
50	Nitrophenol 2-	88755								

EPA No.	Compound	CAS	Freshwater				Saltwater			
			Acute Criteria (CMC)		Chronic Criteria (CCC)		Acute Criteria (CMC)		Chronic Criteria (CCC)	
			DEQ Proposed	Current OR	DEQ Proposed	Current OR	DEQ Proposed	Current OR	DEQ Proposed	Current OR
51	Nitrophenol 4-	100027								
26 N	Nitrosamines	35576911								
28 N	Nitrosodibutylamine,N	924163								
29N	Nitrosodiethylamine,N	55185								
96	Nitrosodimethylamine, N-	62759								
97	Nitrosodi-n-Propylamine, N-	621647								
98	Nitrosodiphenylamine, N-	86306								
30 N	Nitrosopyrrolidine,N	930552								
32 N	Parathion	56382	0.065	0.065	0.013	0.013				
33 N	Pentachlorobenzene	608935								
53	Pentachlorophenol	87865	19 F	20 F	15 F	13 F	13	13	7.9	
99	Phenanthrene	85018								
54	Phenol	108952								
34 N	Phosphorus Elemental	7723140							0.1	0.1
119	Polychlorinated biphenyls PCBs:	1336363	2.0	2	0.014	0.014	10	10	0.03	0.03
100	Pyrene	129000								
10	Selenium	7782492	190/13 G	260	5	35	290	410	71	54
11	Silver	7440224	3.2 H,D	4.1 C,D	0.12 H	0.12 C	1.9 H	2.3 C		
36 N	Sulfide-Hydrogen Sulfide	7783064			2	2			2	2
40 N	Tetrachlorobenzene,1,2,4,5	95943								
37	Tetrachloroethane 1,1,2,2-	79345								
38	Tetrachloroethylene	127184								
12	Thallium	7440280								
39	Toluene	108883								
120	Toxaphene	8001352	0.73	0.73	0.0002	0.0002	0.21	0.21	0.0002	0.0002
43 N	Tributyltin TBT	688733	0.46		0.063		0.37		0.01	
101	Trichlorobenzene 1,2,4-	120821								
41	Trichloroethane 1,1,1-	71556								
42	Trichloroethane 1,1,2-	79005								
43	Trichloroethylene	79016								
44 N	Trichlorophenol 2,4,5	95954								
55	Trichlorophenol 2,4,6-	88062								
44	Vinyl Chloride	75014								
13	Zinc	7440666	120 H,D	120 C,D	120 H,D	110 C,D	90 H	95 C	81 H	86 C

A Ammonia criteria for freshwater may depend on pH, temperature, and the presence of salmonids or other fish with ammonia-sensitive early life stages. Values for freshwater criteria (for total ammonia nitrogen in mg N/L) can be calculated using the formulae specified in *1999 Update of Ambient Water*

Quality Criteria for Ammonia (EPA-822-R-99-014; http://www.epa.gov/ost/standards/ammonia/99update.pdf):

Freshwater Acute:

salmonids present….CMC = $\frac{0.275}{1+10^{7.204-pH}} + \frac{39.0}{1+10^{pH-7.204}}$

salmonids not present…CMC= $\frac{0.411}{1+10^{7.204-pH}} + \frac{58.4}{1+10^{pH-7.204}}$

Freshwater Chronic:

fish early life stages present

$$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}}\right) * MIN(2.85, 1.45*10^{0.028*(25-T)})$$

fish early life stages not present

$$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}}\right) * 1.45*10^{0.028*(25-MAX(T,7))}$$

Note: these formulae would be applied to calculate the 30-day average concentration limit; in addition, the highest 4-day average within the 30-day period should not exceed 2.5 times the CCC.

B Ammonia criteria for saltwater may depend on pH and temperature. Values for saltwater criteria (total ammonia) can be calculated from the tables specified in *Ambient Water Quality Criteria for Ammonia (Saltwater)--1989* (EPA 440/5-88-004; http://www.epa.gov/ost/pc/ambientwqc/ammoniasalt1989.pdf).

C Freshwater and saltwater criteria for metals are expressed in terms of "total recoverable" concentrations in the water column, except where otherwise noted (e.g. iron and manganese).

D The freshwater criterion for this metal is expressed as a function of hardness (mg/L) in the water column. The value shown is for hardness = 100 mg/L. Criteria values for hardness may be calculated from the following formulae:

$$CMC = \exp(m_A*[\ln(hardness) + b_A)$$
$$CCC = \exp(m_C*[\ln(hardness) + b_C)$$

Chemical	m_A	b_A	m_C	b_C
Cadmium	1.0166	-3.924	0.7409	-4.719
Chromium III	0.8190	3.7256	0.8190	0.6848
Copper	0.9422	-1.700	0.8545	-1.702
Lead	1.273	-1.460	1.273	-4.705
Nickel	0.8460	2.255	0.8460	0.0584
Silver	1.72	-6.59		
Zinc	0.8473	0.884	0.8473	0.884

E This value is based on the criterion published in Ambient Water Quality Criteria for Endosulfan (EPA 440/5-80-046) and should be applied as the sum of alpha- and beta-endosulfan.

F Freshwater aquatic life values for pentachlorophenol are expressed as a function of pH, and are calculated as follows: CMC=(exp(1.005(pH)-4.869); CCC=exp(1.005(pH)-5.134).

G The CMC = 1/[(f1/CMC1)+(f2/CMC2)] where f1 and f2 are the fractions of total selenium that are treated as selenite and selenate, respectively, and CMC1 and CMC2 are 185.9 µg/l and 12.82 µg/l, respectively.

H Freshwater and saltwater criteria for metals are expressed in terms of "dissolved" concentrations in the water column, except where otherwise noted (e.g. aluminum).

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Section 4.3 Guidance Values for the Protection of Aquatic Life

Separation of Guidance Values from Criteria

DEQ recommends removing the guidance values in Table 20 to a separate table (shown in Table 4.6) within Division 41 of the Oregon Administrative Rules, as recommended by the TAC. The PAC did not discuss this recommendation. DEQ agrees with the TAC recommendation that Guidance Values can be used in setting effluent limits, especially in the absence of other scientific information on the toxicity of these compounds. DEQ believes that separation of the guidance values from the criteria is technically justified since sufficient information was not available to generate actual criteria for these compounds. EPA removed the guidance values from their latest criteria table and has not yet published a table of guidance values. However, DEQ agrees with the TAC that the guidance values constitute valuable information on this group of compounds that otherwise do not have criteria. Therefore, DEQ believes that the guidance values should be used for reference purposes in setting effluent limits preferably in conjunction with other scientific information. However, violation of the guidance values should not result in the listing of a waterbody as impaired because these values were derived without meeting the data requirements for criteria development.

Table 4.6 Guidance Values for the protection of Aquatic Life. All values are expressed as µg/L. Compounds are listed in alphabetical order with the corresponding EPA (1999) compound number ("N" following a number indicates that the compound is listed by EPA under Non-Priority Pollutants) and the Chemical Abstract Service (CAS) number.

EPA No.	Compound	CAS Number	Freshwater		Saltwater	
			Acute	Chronic	Acute	Chronic
56	Acenaphthene	83329	1,700	520	970	710
17	Acrolein	107028	68	21	55	
18	Acrylonitrile	107131	7,550	2,600		
1	Antimony	7440360	9,000	1,600		
2	Arsenic	7440382	850	48	2,319	13
19	Benzene	71432	5,300		5,100	700
59	Benzidine	92875	2,500			
3	Beryllium	7440417	130	5.3		
19 N	BHC (Hexachlorocyclohexane-Technical)	319868	100		0.34	
21	Carbon Tetrachloride	56235	35,200		50,000	
	Chlorinated Benzenes		250	50	160	129
	Chlorinated naphthalenes		1,600		7.5	
	Chloroalkyl Ethers		238,000			
26	Chloroform	67663	28,900	1,240		
45	Chlorophenol 2-	95578	4,380	2,000		
	Chlorophenol 4-	106489			29,700	
52	Methyl-4-chlorophenol 3-	59507	30			
5a	Chromium (III)	16065831			10,300	
109	DDE 4,4'-	72559	1,050		14	
110	DDD 4,4'-	72548	0.06		3.6	
	Diazinon	333415	0.08	0.05		
	Dichlorobenzenes		1,120	763	1,970	

EPA No.	Compound	CAS Number	Freshwater		Saltwater	
			Acute	Chronic	Acute	Chronic
29	Dichloroethane 1,2-	107062	118,000	20,000	113,000	
	Dichloroethylenes		11,600		224.000	
46	Dichlorophenol 2,4-	120832	2,020	365		
31	Dichloropropane 1,2-	78875	23,000	5,700	10,300	3,040
32	Dichloropropene 1,3-	542756	6,060	244	790	
47	Dimethylphenol 2,4-	105679	2,120			
	Dinitrotoluene		330	230	590	370
16	Dioxin (2,3,7,8-TCDD)	1746016	0.01	0.000038		
85	Diphenylhydrazine 1,2-	122667	270			
33	Ethylbenzene	100414	32,000		430	
86	Fluoranthene	206440	3,980		40	16
	Haloethers		360	122		
	Halomethanes		11,000		12,000	6,400
89	Hexachlorobutadiene	87683	90	9.3	32	
90	Hexachlorocyclopentadiene	77474	7	5.2	7	
91	Hexachloroethane	67721	980	540	940	
93	Isophorone	78591	117,000		12,900	
94	Naphthalene	91203	2,300	620	2,350	
95	Nitrobenzene	98953	27,000		6,680	
	Nitrophenols		230	150	4,850	
26 C	Nitrosamines	35576911	5,850		3,300,000	
	Pentachlorinated ethanes		7,240	1,100	390	281
54	Phenol	108952	10,200	2,560	5,800	
	Phthalate esters		940	3	2,944	3.4
	Polynuclear Aromatic Hydrocarbons				300	
	Tetrachlorinated Ethanes		9,320			
37	Tetrachloroethane 1,1,2,2-	79345		2,400	9,020	
	Tetrachloroethanes		9,320			
38	Tetrachloroethylene	127184	5,280	840	10,200	450
	Tetrachlorophenol 2,3,5,6					440
12	Thallium	7440280	1,400	40	2,130	
39	Toluene	108883	17,500		6,300	5,000
	Trichlorinated ethanes		18,000			
41	Trichloroethane 1,1,1-	71556			31,200	
42	Trichloroethane 1,1,2-	79005		9,400		
43	Trichloroethylene	79016	45,000	21,900	2,000	
55	Trichlorophenol 2,4,6-	88062		970		

The following chemicals/compounds/classes are of concern due to the potential for toxic effects to aquatic organisms; however, no guidance values are designated. If these compounds are identified in the waste stream, then a review of the scientific literature may be appropriate for deriving guidance values.
Polybrominated diphenyl ethers (PBDE)
Polybrominated biphenyls (PBB)
Pharmaceuticals
Personal care products
Alkyl Phenols
Other chemicals with Toxic effects

Section 4.4 Criteria for the Protection of Human Health

TEF Approach for Dioxins, Furans, and PCBs

DEQ recommends adoption of criteria for 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) as shown in Table 4.7. This revision satisfies the federal minimum recommendation for regulating dioxins and furans. The TAC had recommended that DEQ use a dioxin toxic equivalency approach for the dioxins, furans, and PCBs shown in Table 2.8. This approach was not endorsed by the PAC. Instead, a PAC subcommittee that was created to examine this issue in more detail proposed that Oregon adopt a TEF approach for dioxins and furans but not include PCBs, and that bioconcentration equivalency factors (BEF) as developed by EPA Region 5 be included in application of the TEF approach. This approach is currently used by the State of New York and several other Great Lakes states. The full PAC did not reach consensus on this subcommittee proposal. DEQ is recommending criteria for 2,3,7,8-TCDD only be adopted at this time.

TAC and PAC choices for Human Health Criteria

For all human health criteria, the TAC recommended that DEQ use EPA's "Methodology for Deriving Ambient Water Quality Criteria for the Protection of Human Health (2000)" as soon as sufficient information becomes available for deriving bioaccumulation factors and for application of the two models for cancer-causing chemicals. In the interim, the TAC recommended that DEQ modify the approach used to derive the 1999 EPA criteria by 1) substituting one of three values for the intensity of fish consumption for 6.5 g/day (0.2 oz/day) as the value of the fish consumption variable, 2) using the 1999 EPA values for risk level or relative source contribution, cancer potency factor or reference dose, body weight, and water intake, and 3) maintaining EPA's practice of setting the ratio of lipid fraction of fish consumed and the foodchain multiplier both to 1. EPA's national minimum recommendation for fish consumption is 17.5 g/day. The values for fish consumption recommended by the TAC were 17.5 g/day (low; 0.6 oz/day), 142.4 g/day (moderate; 5.0 oz/day), or 389.0 g/day (high; 13.7 oz/day), and these values were designated to apply in the waters of the specific basins identified in the Oregon Administrative Rules. These values are based on the national 90th (17.5 g/day) and 99th (142.4 g/day) percentile fish consumption rates published in EPA (2000), and the 1994 Columbia River Inter-Tribal Fish Commission (CRITFC) Study 99th (389.0 g/day) percentile fish consumption rate. The TAC also recommended that for carcinogens, DEQ should keep the risk level at 10^{-6} (i.e. 1 additional incidence of cancer per 1 million people) in deriving the criteria. In addition, the TAC recommended that DEQ use the values for bioconcentration factors from the 1999 EPA criteria until such time that either national or locally relevant bioaccumulation factors are known. The PAC could not reach a majority agreement on the value for the fish consumption variable.

DEQ choice for Human Health Criteria

DEQ recommends that the criteria for human health be as shown in Table 4.7, which were calculated using the same approach as used for deriving the 2002 EPA criteria (EPA 2002a, 2002b) employing a fish consumption rate of 17.5 g/day (0.6 oz/day). This rate is the national 90th percentile fish consumption rate published by EPA (2000). DEQ believes that this is the best technical and policy approach until such time that sufficient information is available to completely apply the 2000 EPA Methodology in deriving criteria. This approach is consistent with the lowest fish consumption rate recommendation of both EPA and the TAC. Although the PAC did not formulate a recommendation on human health criteria, the recommended approach is a logical policy choice as it will likely be approved by EPA, it avoids the equity issues raised by some PAC members over the use of TAC-recommended multiple fish consumption levels, and it provides greater protection to subsistence fisher subpopulations within the State than currently exists. Ideally, an Oregon-specific survey of fish consumption will be available for similar calculations in the future.

Table 4.7 Comparison of current and recommended criteria for the protection of human health. For each compound and exposure conditions, values are presented for current Oregon criteria, the Technical Advisory Committee (TAC) recommendation, the Policy Advisory Committee (PAC) recommendation or majority opinion, and the Department's recommendation (DEQ). All values are expressed as µg/L.

Compound	Exposure	Current OR Criteria	TAC			PAC	DEQ
			low	medium	high		
Acenaphthene	water and fish ingestion		670	120	44		670
	fish consumption only		990	120	45		990
Acenaphthylene	water and fish ingestion						
	fish consumption only						
Acrolein	water and fish ingestion	320	190	33	13		190
	fish consumption only	780	290	36	13		290
Acrylonitrile	water and fish ingestion	0.058	0.051	0.021	0.0095		0.051
	fish consumption only	0.65	0.25	0.030	0.011		0.25
Aldrin	water and fish ingestion	0.000074	0.00005	0.0000062	0.0000023		0.000049
	fish consumption only	0.000079	0.00005	0.0000062	0.0000023		0.000050

Compound	Exposure	Current OR Criteria	TAC low	TAC medium	TAC high	PAC	DEQ
Aluminum (pH 6.5 - 9.0)	water and fish ingestion						
	fish consumption only						
Ammonia (@18 C & pH=7.5)	water and fish ingestion						
	fish consumption only						
Anthracene	water and fish ingestion		8300	3300	1500		8300
	fish consumption only		40000	4900	1800		40000
Antimony	water and fish ingestion	146	14	13	12		5.6 [4]
	fish consumption only	45000	1600	200	72		640 [4]
Arsenic	water and fish ingestion	0.0022	0.014	0.0048	0.0021		0.018 [4]
	fish consumption only	0.0175	0.052	0.0064	0.0023		0.140 [4]
Asbestos	water and fish ingestion	3.0E+04	7.0E+06	7.0E+06	7.0E+06		7.0E+06 fibers/liter
	fish consumption only						
Barium	water and fish ingestion	1000	1000	1000	1000		1000
	fish consumption only						
Benzene	water and fish ingestion	0.66	1.2	0.88	0.60		2.2 [4]
	fish consumption only	40	27	3.3	1.2		51 [4]
Benzidine	water and fish ingestion	0.00012	0.000090	0.000021	0.000010		0.000086
	fish consumption only	0.00053	0.00020	0.000024	0.000010		0.00020
Benzo(a)Anthracene	water and fish ingestion		0.0038	0.0015	0.00070		0.0038
	fish consumption only		0.018	0.0022	0.00082		0.018
Benzo(a)Pyrene	water and fish ingestion		0.0038	0.0015	0.00070		0.0038
	fish consumption only		0.018	0.0022	0.00082		0.018
Benzo(b)Fluoranthene	water and fish ingestion		0.0038	0.0015	0.00070		0.0038

Compound	Exposure	Current OR Criteria	TAC low	TAC medium	TAC high	PAC	DEQ
	fish consumption only		0.018	0.0022	0.00082		0.018
Benzo(g,h,i)Perylene	water and fish ingestion						
	fish consumption only						
Benzo(k)Fluoranthene	water and fish ingestion		0.0038	0.0015	0.00070		0.0038
	fish consumption only		0.018	0.0022	0.00082		0.018
Beryllium	water and fish ingestion	0.0068					
	fish consumption only	0.117					
BHC, alpha-	water and fish ingestion	0.0092	0.0026	0.00054	0.00021		0.0026
	fish consumption only	0.031	0.0049	0.00060	0.00022		0.0049
BHC, beta-	water and fish ingestion	0.0163	0.0091	0.0019	0.00074		0.0091
	fish consumption only	0.0547	0.017	0.0021	0.00077		0.017
BHC, delta	water and fish ingestion						
	fish consumption only						
BHC, gamma- (Lindane)	water and fish ingestion	0.0186	0.013	0.0026	0.0010		0.98 [3]
	fish consumption only	0.0625	0.024	0.0029	0.0011		1.8 [3]
Boron	water and fish ingestion						
	fish consumption only						
Bromoform	water and fish ingestion		4.3	3.5	2.6		4.3
	fish consumption only		140	17	6.1		140
Bromophenyl Phenyl Ether 4-	water and fish ingestion						
	fish consumption only						
Butylbenzyl Phthalate	water and fish ingestion		1500	230	86		1500
	fish consumption only		1900	240	87		1900

Compound	Exposure	Current OR Criteria	TAC			PAC	DEQ
			low	medium	high		
Cadmium	water and fish ingestion	10					
	fish consumption only	10					
Carbon Tetrachloride	water and fish ingestion	0.40	0.23	0.12	0.058		0.23
	fish consumption only	6.94	1.6	0.20	0.074		1.6
Chlordane	water and fish ingestion	0.00046	0.00080	0.00010	0.000040		0.00080
	fish consumption only	0.00048	0.00081	0.00010	0.000040		0.00081
Chloride	water and fish ingestion						
	fish consumption only						
Chlorine	water and fish ingestion						
	fish consumption only						
Chlorobenzene	water and fish ingestion		640	400	230		130 [3]
	fish consumption only		7800	950	350		1600 [3]
Chlorodibromomethane	water and fish ingestion		0.40	0.33	0.24		0.40
	fish consumption only		13	1.6	0.57		13
Chloroethane	water and fish ingestion						
	fish consumption only						
ChloroethoxyMethane, Bis2-	water and fish ingestion						
	fish consumption only						
ChloroethylEther, Bis2-	water and fish ingestion	0.030	0.030	0.021	0.014		0.030
	fish consumption only	1.360	0.53	0.065	0.024		0.53
Chloroethylvinyl Ether 2-	water and fish ingestion						
	fish consumption only						
Chloroform	water and fish ingestion	0.19	5.7	4.5	3.3		5.7

Compound	Exposure	Current OR Criteria	TAC low	TAC medium	TAC high	PAC	DEQ
	fish consumption only	15.7	470	21	7.9		470
ChloroisopropylEther, Bis2-	water and fish ingestion	34.7	1400	1200	950		1400
	fish consumption only	4360	65000	8000	2900		65000
Chloronaphthalene 2-	water and fish ingestion		1000	180	69		1000
	fish consumption only		1600	190	71		1600
Chlorophenol 2-	water and fish ingestion		81	17	7		81
	fish consumption only		150	18	7		150
Chlorophenoxy Herbicide 2,4,5,-TP	water and fish ingestion	10	10	10	10		10
	fish consumption only						
Chlorophenoxy Herbicide 2,4-D	water and fish ingestion	100	100	100	100		100
	fish consumption only						
Chlorophenyl Phenyl Ether 4-	water and fish ingestion						
	fish consumption only						
Chloropyrifos	water and fish ingestion						
	fish consumption only						
Chromium III	water and fish ingestion	170000					
	fish consumption only	3433000					
Chromium VI	water and fish ingestion	50					
	fish consumption only						
Chrysene	water and fish ingestion		0.0038	0.0015	0.00070		0.0038
	fish consumption only		0.018	0.0022	0.00082		0.018
Copper	water and fish ingestion		1300	1300	1300		1300
	fish consumption only						

Compound	Exposure	Current OR Criteria	TAC low	TAC medium	TAC high	PAC	DEQ
Cyanide	water and fish ingestion	200	690	650	590		140 [3]
	fish consumption only		80000	9800	3600		16000 [3]
DDD 4,4'-	water and fish ingestion		0.00031	0.000030	0.000010		0.00031
	fish consumption only		0.00031	0.000038	0.000010		0.00031
DDE 4,4'-	water and fish ingestion		0.00022	0.000027	0.000010		0.00022
	fish consumption only		0.00022	0.000027	0.000010		0.00022
DDT 4,4'-	water and fish ingestion	0.000024	0.00022	0.000027	0.000010		0.00022
	fish consumption only	0.000024	0.00022	0.000027	0.000010		0.00022
Demeton	water and fish ingestion						
	fish consumption only						
Dibenzo(a,h)Anthracene	water and fish ingestion		0.0038	0.0015	0.00070		0.0038
	fish consumption only		0.0180	0.0022	0.00082		0.0180
Dichlorobenzene 1,2-	water and fish ingestion	400	2100	640	270		420 [3]
	fish consumption only		6500	800	290		1300 [3]
Dichlorobenzene 1,3-	water and fish ingestion		320	95	40		320
	fish consumption only		960	120	43		960
Dichlorobenzene 1,4-	water and fish ingestion		320	95	40		63 [3]
	fish consumption only		970	120	43		190 [3]
Dichlorobenzidine 3,3'-	water and fish ingestion	0.010	0.021	0.0034	0.0013		0.021
	fish consumption only	0.020	0.028	0.0035	0.0013		0.028
Dichlorobromomethane	water and fish ingestion		0.55	0.45	0.33		0.55
	fish consumption only		17	2.1	0.77		17
Dichloroethane 1,1-	water and fish ingestion						

Compound	Exposure	Current OR Criteria	TAC low	TAC medium	TAC high	PAC	DEQ
	fish consumption only						
Dichloroethane 1,2-	water and fish ingestion	0.94	0.38	0.35	0.31		0.38
	fish consumption only	243	37	4.5	1.6		37
Dichloroethylene 1,1-	water and fish ingestion	0.033	0.056	0.042	0.028		330 [3]
	fish consumption only	1.85	1.2	0.15	0.054		1700 [3]
Dichloroethylene 1,2-Trans-	water and fish ingestion		690	630	540		140 [3]
	fish consumption only	1.85	51000	6200	2300		10000 [3]
Dichlorophenol 2,4-	water and fish ingestion	3090	77	27	12		77
	fish consumption only		290	36	13		290
Dichloropropane 1,2-	water and fish ingestion		0.50	0.40	0.29		0.50
	fish consumption only		15	1.8	0.66		15
Dichloropropene 1,3-	water and fish ingestion	87	10	9.2	7.7		0.34 [3]
	fish consumption only	14100	630	78	28		21 [3]
Dieldrin	water and fish ingestion	0.000071	0.00005	0.0000066	0.0000024		0.000052
	fish consumption only	0.000076	0.00005	0.0000066	0.0000024		0.000054
DiethylPhthalate	water and fish ingestion	350000	17000	4500	1800		17000
	fish consumption only	1800000	44000	5400	2000		44000
Dimethyl Phthalate	water and fish ingestion		270000	98000	44000		270000
	fish consumption only		1100000	140000	50000		1100000
Dimethylphenol 2,4-	water and fish ingestion		380	91	36		380
	fish consumption only		850	100	38		850
Di-n-Butyl Phthalate	water and fish ingestion	35000	2000	480	190		2000
	fish consumption only	154000	4500	550	200		4500

Compound	Exposure	Current OR Criteria	TAC low	TAC medium	TAC high	PAC	DEQ
Dinitrophenol 2,4-	water and fish ingestion		69	63	54		69
	fish consumption only		5300	660	240		5300
Dinitrophenols	water and fish ingestion						69 [4]
	fish consumption only						5300 [4]
Dinitrotoluene 2,4-	water and fish ingestion	0.11	0.11	0.11	0.11		0.11
	fish consumption only	9.1	9.1	9.1	9.1		3.4 [4]
Dinitrotoluene 2,6-	water and fish ingestion						
	fish consumption only						
Di-n-Octyl Phthalate	water and fish ingestion						
	fish consumption only						
Dioxin (2,3,7,8-TCDD)	water and fish ingestion	1.3E-08	5.0E-09[1]	6.3E-10[1]	2.3E-10[1]		5.0E-09[2]
	fish consumption only	1.4E-08	5.1E-09[1]	6.3E-10[1]	2.3E-10[1]		5.1E-09[2]
Diphenylhydrazine 1,2-	water and fish ingestion		0.036	0.016	0.0075		0.036
	fish consumption only		0.20	0.025	0.0090		0.20
Endosulfan Sulfate	water and fish ingestion		62	10	3.9		62
	fish consumption only		89	11	4.0		89
Endosulfan, alpha-	water and fish ingestion		62	10	3.9		62
	fish consumption only		89	11	4.0		89
Endosulfan, beta-	water and fish ingestion		62	10	3.9		62
	fish consumption only		89	11	4.0		89
Endrin	water and fish ingestion	1.0	0.29	0.037	0.014		0.059 [3]
	fish consumption only		0.30	0.037	0.014		0.060 [3]
Endrin Aldehyde	water and fish ingestion		0.29	0.037	0.014		0.29

Compound	Exposure	Current OR Criteria	TAC			PAC	DEQ
			low	medium	high		
	fish consumption only		0.30	0.037	0.014		0.30
Ether, Bis Chloromethyl	water and fish ingestion	3.76E-09	0.00010	0.000029	0.000012		0.00010
	fish consumption only	0.00184	0.000290	0.000035	0.000013		0.00029
Ethylbenzene	water and fish ingestion	1400	2600	950	420		530 [3]
	fish consumption only	3280	11000	1300	480		2100 [3]
EthylhexylPhthalate, Bis2-	water and fish ingestion	15000	1.2	0.24	0.10		1.2
	fish consumption only	50000	2.2	0.27	0.10		2.2
Fluoranthene	water and fish ingestion	42	130	17	6		130
	fish consumption only	54	140	17	6		140
Fluorene	water and fish ingestion		1100	450	200		1100
	fish consumption only		5300	660	240		5300
Guthion	water and fish ingestion						
	fish consumption only						
Heptachlor	water and fish ingestion	0.00028	0.000079	0.000010	0.0000036		0.000079
	fish consumption only	0.00029	0.000079	0.000010	0.0000036		0.000079
Heptachlor Epoxide	water and fish ingestion		0.000039	0.0000048	0.0000018		0.000039
	fish consumption only		0.000039	0.0000048	0.0000018		0.000039
Hexachlorobenzene	water and fish ingestion	0.00072	0.00028	0.000035	0.000010		0.00028
	fish consumption only	0.00074	0.00029	0.000035	0.000010		0.00029
Hexachlorobutadiene	water and fish ingestion	0.45	0.44	0.37	0.29		0.44
	fish consumption only	50	18	2.3	0.83		18
Hexachlorocyclo-hexane-Technical	water and fish ingestion	0.0123	0.012	0.012	0.012		0.0123
	fish consumption only	0.0414	0.041	0.041	0.041		0.0414

Compound	Exposure	Current OR Criteria	TAC low	TAC medium	TAC high	PAC	DEQ
Hexachlorocyclopentadiene	water and fish ingestion		240	190	130		40 [3]
	fish consumption only		6500	790	290		1100 [3]
Hexachloroethane	water and fish ingestion	1.9	1.4	0.35	0.14		1.4
	fish consumption only	8.74	3.3	0.40	0.15		3.3
Ideno1,2,3-(c,d)Pyrene	water and fish ingestion		0.0038	0.0015	0.00070		0.0038
	fish consumption only		0.018	0.0022	0.00082		0.018
Iron	water and fish ingestion	300	300	300	300		300
	fish consumption only						
Isophorone	water and fish ingestion	5200	35	28	20		35
	fish consumption only	520000	960	120	43		960
Lead	water and fish ingestion						
	fish consumption only						
Malathion	water and fish ingestion						
	fish consumption only						
Manganese	water and fish ingestion	50	50	50	50		50
	fish consumption only	100	100	100	100		100
Mercury	water and fish ingestion	0.14	0.054	0.0067	0.0024		[4]
	fish consumption only	0.15	0.054	0.0067	0.0025		[4]
Methoxychlor	water and fish ingestion	100	100	100	100		100
	fish consumption only						
Methyl Bromide	water and fish ingestion		47	39	28		47
	fish consumption only		1500	180	67		1500
Methyl Chloride	water and fish ingestion						

Compound	Exposure	Current OR Criteria	TAC			PAC	DEQ
			low	medium	high		
	fish consumption only						
Methyl-4,6-Dinitrophenol 2-	water and fish ingestion	13400000	13	13	13		13
	fish consumption only	765	770	770	770		280 [4]
Methyl-4-Chlorophenol 3-	water and fish ingestion						
	fish consumption only						
Methylene Chloride	water and fish ingestion		4.6	4.4	4.0		4.6
	fish consumption only		590	73	27		590
Methylmercury	water and fish ingestion						
	fish consumption only		300	36	13		300
Mirex	water and fish ingestion						
	fish consumption only						
Naphthalene	water and fish ingestion						
	fish consumption only						
Nickel	water and fish ingestion	13	610	160	69		610
	fish consumption only	100	4600	210	77		4600
Nitrates	water and fish ingestion	10000	10000	10000	10000		10000
	fish consumption only						
Nitrobenzene	water and fish ingestion	19800	17	15	11		17
	fish consumption only		690	85	31		690
Nitrophenol 2-	water and fish ingestion						
	fish consumption only						
Nitrophenol 4-	water and fish ingestion						
	fish consumption only						

Compound	Exposure	Current OR Criteria	TAC			PAC	DEQ
			low	medium	high		
Nitrosamines	water and fish ingestion	0.0008	0.00080	0.00080	0.00080		0.00080
	fish consumption only	1.24	1.2	1.2	1.2		1.24
Nitrosodibutylamine,N	water and fish ingestion	0.0064	0.0064	0.0064	0.0064		0.0063 [4]
	fish consumption only	0.587	0.59	0.59	0.59		0.22 [4]
Nitrosodiethylamine,N	water and fish ingestion	0.0008	0.00080	0.00080	0.00080		0.00080
	fish consumption only	1.24	1.2	1.2	1.2		1.24
Nitrosodimethylamine, N-	water and fish ingestion	0.0014	0.00069	0.00069	0.00068		0.00069
	fish consumption only	16	3.0	0.37	0.14		3.0
Nitrosodi-n-Propylamine, N-	water and fish ingestion		0.0050	0.0046	0.0041		0.0050
	fish consumption only		0.51	0.062	0.023		0.51
Nitrosodiphenylamine, N-	water and fish ingestion	4.9	3.3	0.67	0.26		3.3
	fish consumption only	16.1	6.0	0.74	0.27		6.0
Nitrosopyrrolidine,N	water and fish ingestion	0.016	0.016	0.016	0.016		0.016
	fish consumption only	91.9	92	92	92		34 [4]
Parathion	water and fish ingestion						
	fish consumption only						
Pentachlorobenzene	water and fish ingestion	74	1.4	0.18	0.068		1.4
	fish consumption only	85	1.5	0.19	0.068		1.5
Pentachlorophenol	water and fish ingestion	1010	0.27	0.16	0.093		0.27
	fish consumption only		3.0	0.37	0.14		3.0
Phenanthrene	water and fish ingestion						
	fish consumption only						
Phenol	water and fish ingestion	3500	2.1E+04	1.9E+04	1.7E+04		2.1E+04

Compound	Exposure	Current OR Criteria	TAC			PAC	DEQ
			low	medium	high		
	fish consumption only		1.7E+06	2.1E+05	7.7E+04		1.7E+06
Phosphorus Elemental	water and fish ingestion						
	fish consumption only						
Polychlorinated biphenyls PCBs:	water and fish ingestion	0.000079	0.000064	0.0000079	0.0000029		0.000064
	fish consumption only	0.000079	0.000064	0.0000079	0.0000029		0.000064
Pyrene	water and fish ingestion		830	330	150		830
	fish consumption only		4000	490	180		4000
Selenium	water and fish ingestion	10	170	130	91		170
	fish consumption only		4200	510	190		4200
Silver	water and fish ingestion	50					
	fish consumption only						
Sulfide-Hydrogen Sulfide	water and fish ingestion						
	fish consumption only						
Tetrachlorobenzene,1,2,4,5	water and fish ingestion	38	0.97	0.13	0.048		0.97
	fish consumption only	48	1.1	0.13	0.048		1.1
Tetrachloroethane 1,1,2,2-	water and fish ingestion	0.17	0.17	0.13	0.089		0.17
	fish consumption only	10.7	4.0	0.49	0.18		4.0
Tetrachloroethylene	water and fish ingestion	0.80	0.69	0.28	0.13		0.69
	fish consumption only	8.85	3.3	0.40	0.15		3.3
Thallium	water and fish ingestion	13	1.20	0.26	0.10		0.24 [3]
	fish consumption only	48	2.3	0.29	0.11		0.47 [3]
Toluene	water and fish ingestion	14300	6400	4000	2300		1300 [3]
	fish consumption only	424000	75000	9200	3400		15000 [3]

Compound	Exposure	Current OR Criteria	TAC			PAC	DEQ
			low	medium	high		
Toxaphene	water and fish ingestion	0.00071	0.00028	0.000034	0.000012		0.00028
	fish consumption only	0.00073	0.00028	0.000034	0.000012		0.00028
Tributyltin TBT	water and fish ingestion						
	fish consumption only						
Trichlorobenzene 1,2,4-	water and fish ingestion		180	38	15		35 [3]
	fish consumption only		350	43	16		70 [3]
Trichloroethane 1,1,1-	water and fish ingestion	18400	3000	2300	1500		
	fish consumption only	1030000	64000	7900	2900		
Trichloroethane 1,1,2-	water and fish ingestion	0.60	0.59	0.47	0.33		0.59
	fish consumption only	41.80	16	1.9	0.70		16
Trichloroethylene	water and fish ingestion	2.7	2.5	1.6	0.91		2.5
	fish consumption only	80.7	30	3.7	1.3		30
Trichlorophenol 2,4,5	water and fish ingestion	2600	1800	400	160		1800
	fish consumption only		3600	450	160		3600
Trichlorophenol 2,4,6-	water and fish ingestion	1.2	1.4	0.27	0.11		1.4
	fish consumption only	3.6	2.4	0.30	0.11		2.4
Vinyl Chloride	water and fish ingestion	2.0	2.0	1.9	1.6		0.025 [3]
	fish consumption only	525.0	200	24	8.8		2.4 [3]
Zinc	water and fish ingestion		7400	2400	1000		7400
	fish consumption only		26000	3100	1200		26000

[1]TAC recommended that DEQ adopt a Toxic Equivalency approach for dioxins, furans, and PCBs that act through the Ah receptor.
[2]Staff recommend that DEQ adopt criteria for 2,3,7,8-TCDD.
[3]Based on EPA (2002b).
[4]Based on EPA (2002a).

Summary Table of Recommended Criteria for the Protection of Human Health

Table 4.8 presents a comparison of the current Oregon and the DEQ recommended human health criteria for all compounds, including those that were not reviewed because no changes had occurred.

Table 4.8 Comparison of Human Health Criteria between current Oregon values and DEQ recommended values. All values are expressed as µg/L except where noted. Compounds are listed in alphabetical order with the corresponding EPA (1999) number ("N" following a number indicates that the compound is listed by EPA under Non-Priority Pollutants) and the Chemical Abstract Service (CAS) number.

			Current Oregon Criteria		DEQ Recommended Criteria	
EPA No.	Compound	CAS	water and fish ingestion	fish consumption only	water + organism	organism only
56	Acenaphthene	83329			670	990
57	Acenaphthylene	208968				
17	Acrolein	107028	320	780	190	290
18	Acrylonitrile	107131	0.058	0.65	0.051	0.250
102	Aldrin	309002	0.000074	0.000079	0.000049	0.000050
2 N	Aluminum (pH 6.5 - 9.0)	7429905				
3 N	Ammonia (@18 C & pH=7.5)	7664417				
58	Anthracene	120127			8300	40000
1	Antimony	7440360	146	45000	5.6	640
2	Arsenic	7440382	0.0022	0.0175	0.018	0.14
15	Asbestos	1332214	3.0E+04 fibers/L		7.0E+06 fibers/L	
6 N	Barium	7440393	1000		1000	
19	Benzene	71432	0.66	40	2.2	51
59	Benzidine	92875	0.00012	0.00053	0.000086	0.00020
60	Benzo(a)Anthracene	56553			0.0038	0.018
61	Benzo(a)Pyrene	50328			0.0038	0.018
62	Benzo(b)Fluoranthene	205992			0.0038	0.018
63	Benzo(g,h,i)Perylene	191242				
64	Benzo(k)Fluoranthene	207089			0.0038	0.018
3	Beryllium	7440417	0.0068	0.117		
103	BHC, alpha-	319846	0.0092	0.031	0.0026	0.0049
104	BHC, beta-	319857	0.0163	0.0547	0.0091	0.017
106	BHC, delta-	319868				
105	BHC, gamma- (Lindane)	58899			0.98	1.8
7 N	Boron	7440428				
20	Bromoform	75252			4.3	140
69	Bromophenyl Phenyl Ether 4-	101553				
70	Butylbenzyl Phthalate	85687			1500	1900

EPA No.	Compound	CAS	Current Oregon Criteria		DEQ Recommended Criteria	
			water and fish ingestion	fish consumption only	water + organism	organism only
4	Cadmium	7440439	10	10		
21	Carbon Tetrachloride	56235	0.4	6.94	0.23	1.6
107	Chlordane	57749	0.00046	0.00048	0.00080	0.00081
8 N	Chloride	16887006				
9 N	Chlorine	7782505				
22	Chlorobenzene	108907			130	1600
23	Chlorodibromomethane	124481			0.40	13
24	Chloroethane	75003				
65	ChloroethoxyMethane, Bis2-	111911				
66	ChloroethylEther, Bis2-	111444	0.03	1.36	0.030	0.53
25	Chloroethylvinyl Ether 2-	110758				
26	Chloroform	67663	0.19	15.7	5.7	470
67	ChloroisopropylEther, Bis2-	108601	34.7	4360	1400	65000
15 N	ChloromethylEther, Bis	542881	3.76E-09	0.00184	0.00010	0.00029
71	Chloronaphthalene 2-	91587			1000	1600
45	Chlorophenol 2-	95578			81	150
10 N	Chlorophenoxy Herbicide (2,4,5,-TP)	93721	10			
11 N	Chlorophenoxy Herbicide (2,4-D)	94757	100		100	
72	Chlorophenyl Phenyl Ether 4-	7005723				
12 N	Chloropyrifos	2921882				
5.1	Chromium (III)		170000	3433000		
5.2	Chromium (VI)	18540299	50			
73	Chrysene	218019			0.0038	0.018
6	Copper	7440508			1300	
14	Cyanide	57125	200		140	16000
108	DDT 4,4'-	50293	0.000024	0.000024	0.00022	0.00022
109	DDE 4,4'-	72559			0.00022	0.00022
110	DDD 4,4'-	72548			0.00031	0.00031
14 N	Demeton	8065483				
74	Dibenzo(a,h)Anthracene	53703			0.0038	0.018
75	Dichlorobenzene 1,2-	95501	400		420	1300
76	Dichlorobenzene 1,3-	541731			320	960
77	Dichlorobenzene 1,4-	106467			63	190
78	Dichlorobenzidine 3,3'-	91941	0.01	0.02	0.021	0.028
27	Dichlorobromomethane	75274			0.55	17
28	Dichloroethane 1,1-	75343				
29	Dichloroethane 1,2-	107062	0.94	243	0.38	37
30	Dichloroethylene 1,1-	75354	0.033	1.9	330	7100
46	Dichlorophenol 2,4-	120832	3090		77	290
31	Dichloropropane 1,2-	78875			0.50	15
32	Dichloropropene 1,3-	542756	87	14100	0.34	21

EPA No.	Compound	CAS	Current Oregon Criteria		DEQ Recommended Criteria	
			water and fish ingestion	fish consumption only	water + organism	organism only
111	Dieldrin	60571	0.000071	0.000076	0.000052	0.000054
79	DiethylPhthalate	84662	350000	1800000	17000	44000
47	Dimethylphenol 2,4-	105679			380	850
80	DimethylPhthalate	131113			270000	1100000
81	Di-n-Butyl Phthalate	84742	35000	154000	2000	4500
49	Dinitrophenol 2,4-	51285			69	5300
27 N	Dinitrophenols	25550587			69	5300
82	Dinitrotoluene 2,4-	121142	0.11	9.1	0.11	3.4
83	Dinitrotoluene 2,6-	606202				
84	Di-n-Octyl Phthalate	117840				
16	Dioxin (2,3,7,8-TCDD)	1746016	1.30E-08	1.40E-08	5.0E-09	5.1E-09
85	Diphenylhydrazine 1,2-	122667			0.036	0.20
	Endosulfan	115297	74	159	62	89
114	Endosulfan Sulfate	1031078			62	89
112	Endosulfan, alpha-	959988			62	89
113	Endosulfan, beta-	33213659			62	89
115	Endrin	72208	1		0.059	0.060
116	Endrin Aldehyde	7421934			0.29	0.30
33	Ethylbenzene	100414	1400	3280	530	2100
68	EthylhexylPhthalate, Bis2-	117817	15000	50000	1.2	2.2
86	Fluoranthene	206440	42	54	130	140
87	Fluorene	86737			1100	5300
17 N	Guthion	86500				
117	Heptachlor	76448	0.00028	0.00029	0.000079	0.000079
118	Heptachlor Epoxide	1024573			0.000039	0.000039
88	Hexachlorobenzene	118741	0.00072	0.00074	0.00028	0.00029
89	Hexachlorobutadiene	87683	0.45	50	0.44	18
19 N	Hexachlorocyclo-hexane-Technical	319868	0.0123	0.0414	0.0123	0.0414
90	Hexachlorocyclopentadiene	77474			40	1100
91	Hexachloroethane	67721	1.9	8.74	1.4	3.3
92	Ideno1,2,3-(c,d)Pyrene	193395			0.0038	0.018
20 N	Iron	7439896	300		300	
93	Isophorone	78591	5200	520000	35	960
7	Lead	7439921				
21 N	Malathion	121755				
22 N	Manganese	7439965	50	100	50	100
8	Mercury	7439976	0.14	0.15		(see methylmercury criterion)
23 N	Methoxychlor	72435	100		100	
34	Methyl Bromide	74839			47	1500
35	Methyl Chloride	74873				

EPA No.	Compound	CAS	Current Oregon Criteria		DEQ Recommended Criteria	
			water and fish ingestion	fish consumption only	water + organism	organism only
48	Methyl-4,6-Dinitrophenol 2-	534521	13400000	765	13	280
52	Methyl-4-Chlorophenol 3-	59507				
36	Methylene Chloride	75092			4.6	590
8b	Methylmercury					300 ug/kg [1]
24 N	Mirex	2385855				
94	Naphthalene	91203				
9	Nickel	7440020	13	100	610	4600
25 N	Nitrates	14797558	10000		10000	
95	Nitrobenzene	98953	19800		17	690
50	Nitrophenol 2-	88755				
51	Nitrophenol 4-	100027				
26 N	Nitrosamines	35576911	0.0008	1.24	0.0008	1.24
28 N	Nitrosodibutylamine,N	924163	0.0064	0.587	0.0063	0.22
29 N	Nitrosodiethylamine,N	55185	0.0008	1.24	0.0008	1.24
30 N	Nitrosopyrrolidine,N	930552	0.016	91.9	0.016	34
96	N-Nitrosodimethylamine	62759	0.0014	16	0.00069	3.0
97	N-Nitrosodi-n-Propylamine	621647			0.0050	0.51
98	N-Nitrosodiphenylamine	86306	4.9	16.1	3.3	6.0
33 N	Parathion	56382				
34 N	Pentachlorobenzene	608935	74	85	1.4	1.5
53	Pentachlorophenol	87865	1010		0.27	3.0
99	Phenanthrene	85018				
54	Phenol	108952	3500		21000	1700000
37 N	Phosphate Phosphorus					
36 N	Phosphorus Elemental	7723140				
119	Polychlorinated Biphenyls (PCBs)	1336363	0.000079	0.000079	0.000064	0.000064
100	Pyrene	129000			830	4000
10	Selenium	7782492	10		170	4200
11	Silver	7440224	50			
40 N	Sulfide-Hydrogen Sulfide	7783064				
43 N	Tetrachlorobenzene, 1,2,4,5-	95943	38	48	0.97	1.1
37	Tetrachloroethane, 1,1,2,2-	79345	0.17	10.7	0.17	4.0
38	Tetrachloroethylene	127184	0.8	8.9	0.69	3.3
12	Thallium	7440280	13	48	0.24	0.47
39	Toluene	108883	14300	424000	1300	15000
120	Toxaphene	8001352	0.00071	0.00073	0.00028	0.00028
40	Trans-Dichloroethylene 1,2-	156605		1.85	140	10000
44 N	Tributyltin (TBT)	688733				
101	Trichlorobenzene 1,2,4-	120821			35	70
41	Trichloroethane 1,1,1-	71556	18400	1030000		
42	Trichloroethane 1,1,2-	79005	0.6	41.8	0.59	16

EPA No.	Compound	CAS	Current Oregon Criteria		DEQ Recommended Criteria	
			water and fish ingestion	fish consumption only	water + organism	organism only
43	Trichloroethylene	79016	2.7	80.7	2.5	30
45 N	Trichlorophenol 2,4,5-	95954	2600		1800	3600
55	Trichlorophenol 2,4,6-	88062	1.2	3.6	1.4	2.4
44	Vinyl Chloride	75014	2	525	0.025	2.4
13	Zinc	7440666			7400	26000

[1]Methylmercury value expressed as µg/kg fish.

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Chapter 6 Appendix A

Aquatic Life Criteria Profiles for Toxic Pollutants

The following pages contain brief descriptions of the toxic pollutants considered by the Toxics Technical Advisory Committee for revision of criteria for the protection of aquatic life. A general format is followed for each compound. Each compound description contains the type of waters and set of circumstances for which the criteria apply (e.g. Freshwater Acute Criterion). Next, the criteria for Oregon and EPA are described, followed by the date when each criterion was changed between the value for Oregon and the current EPA value. The Rationale for Change describes the existence of new data or other circumstances that led to the revision, the 4 most sensitive genera used in calculating the criterion (if available), and information on salmonids. Finally, citations of references used to generate the above information are provided.

Brief Description of Criteria Development

EPA's (and OR's) criteria for protection of aquatic life may be provided for freshwater and/or saltwater and as a value that is based on the Criterion Maximum Concentration (CMC; the one-hour maximum concentration should not exceed this value more than once every three years) or a Criterion Continuous Concentration (CCC; the four-day average concentration should not exceed this value more than once every three years).

Acute criteria are developed after reviewing existing aquatic toxicological data on the pollutant and subsequent calculation of the Final Acute Value (FAV) based on the acute toxicity of the compound to various species of aquatic life. The acceptable toxicity data for freshwater criterion development must include results from at least one species in at least 8 different families (the stipulations of which families must be included differ somewhat between freshwater and saltwater). From these data (generally, from the acute toxicity values assigned to the genera for the four most sensitive genera), a FAV is calculated and the Criterion Maximum Concentration (CMC) is derived by dividing the FAV by 2. The sensitivity of a commercially or recreationally important species may cause further adjustment in the CMC.

Chronic criteria are developed after a more complicated process—due to the generally more scarce nature of information on chronic toxicity. If available, acceptable chronic toxicity data must include at least one species in at least 8 different families. If there are insufficient data, then the Final Chronic Value (FCV) can be calculated if there is enough information to quantitatively describe the relation between acute and chronic toxicity for a number of individual genera (called the Genus Mean Acute Chronic Ratio; GMACR). The Final Acute Chronic Ratio is calculated from all the acceptable GMACRs. The FCV then becomes the result of dividing the Final Acute Value by the Final Acute Chronic Ratio. Chronic criteria can also be developed by calculating a Final Residue Value (FRV) from data on bioaccumulation of the pollutant. The CCC is defined as the lowest value between the Final Chronic Value (whichever way it is calculated) and the Final Residue Value. The sensitivity of a commercially or recreationally important species may cause further adjustment in the CCC.

The aim in providing the following descriptions was to help the Toxics Technical Advisory Committee make recommendations regarding whether Oregon should adopt the 1999 EPA criteria.

Aluminum (between pH 6.5 and 9.0)

Freshwater Acute (CMC)
OR Criterion: none
EPA Criterion: 750 µg/L

Date Changed: 1988

Rationale for Change: This criterion was proposed in 1988. The Final Acute Value (FAV) was based on the geometric mean of the Genus Mean Acute Values (GMAVs) from the four most sensitive genera (out of 14):

4. amphipod (Gammarus);
3. rainbow trout (Oncorhynchus);
2. brook trout (Salvelinus); and
1. cladoceran (Ceriodaphnia)

Information on Salmonids. The GMAVs were available for Salvelinus (brook trout) (sensitivity rank=2); Oncorhynchus (rainbow trout) (3); and Oncorhynchus (chinook salmon) (10).

Note: At the time of criterion publication, rainbow trout was classified as Salmo gairdneri—which is why there are separate GMAVs for rainbow trout and chinook salmon.

Reference: "Ambient Water Quality Criteria for Aluminum - 1988" (1988) EPA 440-5-86-008.

Freshwater Chronic (CCC)
OR Criterion: none
EPA Criterion: 87 µg/L

Date Changed: 1988

Rationale for Change: Data on chronic effects were available from studies on fathead minnow (Pimephales) and two cladocerans (Ceriodaphnia and Daphnia). There were insufficient data to calculate the Final Chronic Value (FCV) using the 8 family procedure; therefore, the FCV was initially calculated by dividing the FAV by the Final Acute-Chronic Ratio (FACR). The FACR varied widely between these three species and the first option was invoked to set the FACR equal to the Genus Mean Acute Chronic Ratio (GMACR) from most acutely sensitive species. However, this value was less than 2, which is not allowed in EPA procedures because it results in a CCC greater than the CMC. Therefore, the FACR was set to 2 in calculating the FCV with the end result being that the FCV would equal the CMC. Yet, additional data on the toxicity of aluminum to brook trout and striped bass demonstrated that the FCV should be lowered to 87 µg/L to protect these two important species. Thus, the CCC was set to 87 µg/L because brook trout and striped bass exposed to aluminum at or near this concentration showed no or minimal adverse effects.

Information on Salmonids. No GMACRs available for salmonids.

Reference: "Ambient Water Quality Criteria for Aluminum - 1988" (1988) EPA 440-5-86-008.

Ammonia

Freshwater Acute (CMC)

OR Criterion (in µg/L): salmonids present….CMC = 0.52 / FT / FPH / 2

where FT = 1 when $20 \le T \le 30$

or FT = $10^{0.03(20-T)}$ when $0 \le T \le 20$

and FPH = 1 when $8 \le pH \le 9$

or FPH = $\frac{1+10^{7.4-pH}}{1.25}$ when $6.5 \le pH \le 8$

salmonids absent….CMC = 0.52 / FT / FPH / 2

where FT = 0.71 when $25 \le T \le 30$

or FT = $10^{0.03(20-T)}$ when $0 \le T \le 25$

and FPH = 1 when $8 \le pH \le 9$

or FPH = $\frac{1+10^{7.4-pH}}{1.25}$ when $6.5 \le pH \le 8$

EPA Criterion (in µg/L): salmonids present….CMC = $\frac{0.275}{1+10^{7.204-pH}} + \frac{39.0}{1+10^{pH-7.204}}$

salmonids not present…CMC= $\frac{0.411}{1+10^{7.204-pH}} + \frac{58.4}{1+10^{pH-7.204}}$

Date Changed: 1999

Rationale for Change: The old criterion (OR criterion) was based on the toxicity of un-ionized ammonia (even though a table on total ammonia was provided in EPA's "Quality Criteria for Water—1986"); the new EPA criterion is based on the toxicity of total ammonia (un-ionized ammonia + ammonium ion). The old criterion included a temperature component; the new criterion does not (re-analysis of old data and analysis of 1992 data on fish indicated that for the species used in the acute criterion calculations, no temperature correction for acute toxicity was appropriate). Derivation of the new criterion relies solely on acute tests reported in the 1984/1985 criteria document, supplemented by some newer studies relevant to the revised pH relationship. New data were not used in the derivation of the new CMC, but they were used to compare the performance of the new CMC with that of the old CMC. The Genus Mean Acute Values (GMAVs) differ between 1984/1985 and 1998/1999 EPA documents in that 1) pH and temperature are addressed differently in the two sets of calculations; 2) golden trout, cutthroat trout, and rainbow trout are now in the genus Oncorhynchus (same as Pacific salmon); and 3) new GMAVs are expressed in terms of total ammonia nitrogen instead of un-ionized ammonia (from 1984/1985). The FAV was initially calculated based on the four most sensitive genera (out of 34):

4. trout/salmon (Oncorhynchus);
3. orangethroat darter (Ethiostoma);
2. golden shiner (Notemigonus); and
1. mountain whitefish (Prosopium; a salmonid)

However, since the Species Mean Acute Value (SMAV) for rainbow trout was lower than this geometric mean, the FAV was lowered to the SMAV for rainbow trout.

Information on Salmonids. In 1984/1985, the genus mean acute values had the following species sensitivity ranks (1=most sensitive):

4. walleye (Stizostedion);

3. orangethroat darter (Ethiostoma);
2. golden shiner (Notemigonus); and
1. mountain whitefish (Prosopium; a salmonid)

In that document, rainbow trout fell into the Salmo group which was the 5th most sensitive; the Pacific salmon group was the 9th most sensitive. However, because rainbow trout had a Species Mean Acute Value (SMAV) lower than the Final Acute Value (FAV) calculated from other four species, the FAV was lowered to the SMAV for rainbow trout in order to derive the CMC (which is ½ of this FAV). The same approach was followed for calculating the 1999 CMC, i.e. use the SMAV of rainbow trout to derive the CMC.

Reference: "Ambient Water Quality Criteria for Ammonia—1984" (1985) EPA 440/5-85-001; "1999 Update of Ambient Water Quality Criteria Documents for Ammonia" (1999) EPA-822-R-99-014.

<u>Freshwater Chronic (CCC)</u>

OR Criterion (µg/L): salmonids present….CCC = 0.80 / FT / FPH / RATIO

where FT = 1.4 when $15 \le T \le 30$

or FT = $10^{0.03(20-T)}$ when $0 \le T \le 15$

and FPH = 1 when $8 \le pH \le 9$

or FPH = $\frac{1+10^{7.4-pH}}{1.25}$ when $6.5 \le pH \le 8$

and RATIO = 16 when $7.7 \le pH \le 9$

or RATIO = $24 \times \frac{10^{7.7-pH}}{1+10^{7.4-pH}}$ when $6.5 \le pH \le 7.7$

salmonids absent….CCC = 0.80 / FT / FPH / RATIO

where FT = 1 when $20 \le T \le 30$

or FT = $10^{0.03(20-T)}$ when $0 \le T \le 20$

and FPH = 1 when $8 \le pH \le 9$

or FPH = $\frac{1+10^{7.4-pH}}{1.25}$ when $6.5 \le pH \le 8$

and RATIO = 16 when $7.7 \le pH \le 9$

or RATIO = $24 \times \frac{10^{7.7-pH}}{1+10^{7.4-pH}}$ when $6.5 \le pH \le 7.7$

Note: these formulae would be applied to calculate the 4-day average concentration limit.

EPA Criterion (in µg/L): fish early life stages present

$$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}}\right) * MIN(2.85, 1.45*10^{0.028*(25-T)})$$

fish early life stages not present

$$CCC = \left(\frac{0.0577}{1+10^{7.688-pH}} + \frac{2.487}{1+10^{pH-7.688}}\right) * 1.45*10^{0.028*(25-MAX(T,7))}$$

Note: these formulae would be applied to calculate the 30-day average concentration limit; in addition, the highest 4-day average within the 30-day period should not exceed 2.5 times the CCC.

Date Changed: 1999

Rationale for Change: The old criterion (OR Table 20) CCC was derived by dividing the Final Acute Value (FAV) by an Acute-Chronic Ratio (ACR) due to the lack of sufficient data for directly calculating Final Chronic Values (FCVs). Both the old and new criterion calculation take temperature (T) and pH into account. The old criterion calculation varies depending on the presence of salmonids; the new criterion varies depending on the presence of early life history stages of fish. For the 1984/1985 approach, the analyses were split into two groups: those data for pH>7.7 and those data for pH<7.7. For pH>7.7, 5 of 9 GMACRs (channel catfish, bluegill, rainbow trout, fathead minnow, and white sucker) were used; GMACRs from green sunfish, largemouth bass, and 2 cladocerans were excluded because these species had markedly higher chronic values. For pH<7.7, few data were present. The 1999 EPA criteria document indicates that the approach used in 1984/1985 to develop the old criterion 1) had uncertainties associated with both FAVs and ACRs; and 2) the number of chronic studies with acceptable data was far fewer than the number of acute studies. The new criterion (EPA) CCC is based on re-analysis of the 1984/1985 data and newer chronic data to calculate 9 Genus Mean Chronic Values (GMCVs) for appropriate endpoints. The FCV was based on the four most sensitive genera (out of 34) normalized to a temperature of 25°C:

4. fathead minnow (Pimephales);
3. sunfish (Lepomis);
2. fingernail clam (Musculium); and
1. amphipod (Hyalella)

The CCC was derived based on the presence or absence of early life stages of fish.

Information on Salmonids. In 1984/1985, Genus Mean Acute Chronic Ratios (GMACRs) were available for 10 species, including the following salmonids (pink salmon and rainbow trout). In 1999, the CCC was calculated directly from Genus Mean Chronic Values (GMCVs); therefore, GMACRs and Genus Mean Acute Chronic Ratios were presented in the criteria document as a comparison with the direct calculation from the GMCVs.

Reference: "Ambient Water Quality Criteria for Ammonia—1984" (1985) EPA 440/5-85-001; "1999 Update of Ambient Water Quality Criteria Documents for Ammonia" (1999) EPA-822-R-99-014.

Arsenic

<u>Freshwater Acute (CMC)</u>
OR Criterion: 360 µg/L
EPA Criterion: 340 µg/L

Note: These values are expressed as total recoverable concentrations.

Date Changed: 1995

Rationale for Change: New data (references from 1986) from studies on fathead minnow and three cladocerans (2 Daphnia; 1 Ceriodaphnia) were analyzed and incorporated into the calculation of the Final Acute Value (FAV). The FAV was based on the four most sensitive genera (out of 14):

4. cladoceran (Daphnia);
3. cladoceran (Ceriodaphnia);
2. cladoceran (Simocephalus); and
1. amphipod (Gammarus).

Information on Salmonids. Genus mean acute value (GMAV) available for rainbow trout (sensitivity rank=5) and brook trout (7).

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Freshwater Chronic (CCC)
OR Criterion: 190 µg/L
EPA Criterion: 150 µg/L

Date Changed: 1995

Rationale for Change: New data (reference from 1986) from studies on fathead minnow were analyzed. There were insufficient data to calculate a Final Chronic Value (FCV) using the 8 family procedure; therefore, the FCV was calculated by dividing the FAV by the Final Acute-Chronic Ratio (FACR). The FACR was calculated based on geometric mean of the Genus Mean Acute Chronic Ratio (GMACR) from 3 species: cladoceran (Daphnia), fathead minnow (Pimephales), and flagfish (Jordanella).

Information on Salmonids. No GMACRs were available for salmonids. EPA judged that the FCV did not need to be lowered to protect a commercially or recreationally important species.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Cadmium

Freshwater Acute (CMC)
OR Criterion: 3.9 µg/L
EPA Criterion: 2.1 µg/L

note: These criteria are expressed as a function of hardness:

$$CMC = e^{(m_a[\ln(hardness)]+b_a)}$$

The values given here correspond to a hardness of 100 mg/L and are expressed as total recoverable concentration. The values for variables m_a (1.0166) and b_a (-3.924) are provided in "2001 Update of Ambient Water Quality Criteria for Cadmium" (2001) EPA-822-R-01-001.

Date Changed: 2001

Rationale for Change: New data from studies on coho salmon (1975; Oncorhynchus kisutch), chinook salmon (1975, 1978, 1982; O. tshawytscha), and rainbow trout (1975, 1976, 1978, 1985, 1986, 1999; O. mykiss); striped bass (1985; Morone saxatilis); brook trout (1979; Salvelinus fontinalis) and bull trout (1999; S. confluentus); and brown trout (1984; Salmo trutta) were analyzed and incorporated into the calculation of the Final Acute Value (FAV). The FAV was based on the four most sensitive genera (out of 55):

4. salmon/trout (Oncorhynchus);
3. striped bass (Morone);
2. char (Salvelinus); and
1. trout (Salmo).

Information on Salmonids. Genus mean acute values (GMAVs) were available for Oncorhynchus (coho salmon, chinook salmon, and rainbow trout) (sensitivity rank=4); Salvelinus (brook trout and bull trout) (2); and Salmo (brown trout) (1).

Reference: "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001; "2001 Update of Ambient Water Quality Criteria for Cadmium" (2001) EPA-822-R-01-001.

<u>Freshwater Chronic (CCC)</u>
OR Criterion: 1.13 µg/L
EPA Criterion: 0.27 µg/L

note: These criteria are expressed as a function of hardness:

$$CCC = e^{(m_c[\ln(hardness)]+b_c)}$$

The values given here correspond to a hardness of 100 mg/L and are expressed as total recoverable concentration. The values for variables m_c (0.7409) and b_c (-4.719) are provided "2001 Update of Ambient Water Quality Criteria for Cadmium" (2001) EPA-822-R-01-001.

Date Changed: 2001

Rationale for Change: New data from studies on midge (unpublished; Chironomus tentans); coho salmon (1978), chinook salmon (1975), and rainbow trout (1994); cladocerans (1984, 1988, 1989, manuscript; Daphnia sp.); and amphipod (unpubl.; Hyalla azteca) were analyzed and incorporated into the calculation of the Final Chronic Value (FCV). The FCV was based on the four most sensitive genera (out of 16):

4. midge (Chironomus);
3. salmon/trout (Oncorhynchus);
2. cladoceran (Daphnia); and
1. amphipod (Hyalella)

Information on Salmonids. Genus mean chronic values (GMCVs) were available for Oncorhynchus (coho salmon, chinook salmon, and rainbow trout) (sensitivity rank=3); Salvelinus (brook trout and lake trout) (5); and Salmo (Atlantic salmon and brown trout) (8).

Reference: "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001; "2001 Update of Ambient Water Quality Criteria for Cadmium" (2001) EPA-822-R-01-001.

<u>Saltwater Acute (CMC)</u>
OR Criterion: 43 µg/L
EPA Criterion: 40 µg/L

Date Changed: 2001

Rationale for Change: New data from studies on a mysid (1982, 1985; Mysidopsis bigelowi); American lobster (1979; Homarus americanus); striped bass (1985; Morone saxatilis); and a mysid (1977, 1982, 1985; Americamysis bahia) were analyzed and incorporated into the calculation of Final Acute Value (FAV) for saltwater. The FAV was based on the four most sensitive genera (out of 54):

4. mysid (Mysidopsis);
3. American lobster (Homarus);
2. striped bass (Morone); and

1. mysid (Americamysis).

Information on Salmonids. Genus mean acute value (GMAV) was available for Oncorhynchus (coho salmon) (sensitivity rank=28).

Reference: "2001 Update of Ambient Water Quality Criteria for Cadmium" (2001) EPA-822-R-01-001.

Saltwater Chronic (CCC)
OR Criterion: 9.3 µg/L
EPA Criterion: 8.8 µg/L

Date Changed: 2001

Rationale for Change: New data were insufficient for calculation of Final Chronic Value (FCV) for saltwater using the 8 family procedure; therefore, the saltwater FCV was calculated using the saltwater FAV divided by the Final Acute Chronic Ratio (FACR). The Genus Mean Acute Chronic Ratios (GMACR) from two saltwater species (both mysids) were used to calculate a FACR.

Information on Salmonids. No GMACRs were available for salmonids.

Reference: "2001 Update of Ambient Water Quality Criteria for Cadmium" (2001) EPA-822-R-01-001.

Chromium (III)

Freshwater Acute (CMC)
OR Criterion: 1700 µg/L
EPA Criterion: 1800 (1803) µg/L

note: These criteria are expressed as a function of hardness:

$$CMC = e^{(m_a[\ln(hardness)]+b_a)}$$

The values given here correspond to a hardness of 100 mg/L and are expressed as total recoverable concentration. The values for variables m_a (0.8190) and b_a (3.7256) are provided in "National Recommended Water Quality Criteria—Correction"(1999).

Date Changed: 1995

Rationale for Change: New data (reference from 1986) from studies on amphipod were analyzed and incorporated into the calculation of the Final Acute Value (FAV). The FAV was based on the four most sensitive genera (out of 19):

4. goldfish (Carassius);
3. guppy (Poecilia);
2. amphipod (Gammarus); and
1. mayfly (Ephemerella)

Information on Salmonids. A Genus Mean Acute Value (GMAV) was available for Oncorhynchus (rainbow trout) (sensitivity rank=6).

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Freshwater Chronic (CCC)
OR Criterion: 210 µg/L
EPA Criterion: 86 µg/L

note: These criteria are expressed as a function of hardness:

$$CCC = e^{(m_c[\ln(hardness)]+b_c)}$$

The values given here correspond to a hardness of 100 mg/L and are expressed as total recoverable concentration. The values for variables m_c (0.8190) and b_c (0.6848) are provided in "National Recommended Water Quality Criteria—Correction"(1999).

Date Changed: 1995

Rationale for Change: No new chronic data were available, so there were still insufficient data to calculate the Final Chronic Value (FCV) by the 8 family procedure. Therefore, the FCV was calculated by dividing the FAV by the Final Acute Chronic Ratio (FACR). The FACR was calculated based on the geometric mean of the Genus Mean Acute Chronic Ratios (GMACRs) from 2 of 3 species: fathead minnow (Pimephales), and rainbow trout (Oncorhynchus)—the third GMACR was excluded because it was from the least sensitive species.

Information on Salmonids. A GMACR was available for Oncorhynchus (rainbow trout) (sensitivity rank=6). EPA judged that the FCV did not need to be lowered to protect a commercially or recreationally important species since GMACR for rainbow trout was greater than GMACR for fathead minnow.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Chromium (VI)

Freshwater Acute (CMC)
OR Criterion: 16 µg/L
EPA Criterion: 16 (16.3) µg/L

Date Changed: 1995

Rationale for Change: New data (references from 1987) were available from studies on cladocerans (Daphnia sp.), amphipod (Crangonyx pseudogracilis), bluegill (Lepomis macrochirus), and fathead minnow (Pimephales promelas) and were used to calculate FAV. The FAV was based on the four most sensitive genera (out of 28):

4. amphipod (Gammarus);
3. cladoceran (Ceriodaphnia);
2. cladoceran (Simocephalus); and
1. cladoceran (Daphnia)

Information on Salmonids. Genus mean acute values (GMAVs) were available for Salvelinus (brook trout) (sensitivity rank=19); and Oncorhynchus (rainbow trout) (22).

Notes: EPA rounds to 2 significant digits; therefore, the EPA criterion is expressed as 16 µg/L in the 1999 "National Recommended Water Quality Criteria—Correction".

Therefore, the Oregon and new EPA criteria can be considered to be the same.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

<u>Freshwater Chronic (CCC)</u>
OR Criterion: 11 µg/L
EPA Criterion: 11 (11.4) µg/L

Date Changed: 1995

Rationale for Change: No new chronic data; therefore, FCV calculated by dividing the FAV by the FACR. The FACR was calculated based on the geometric mean of the Genus Mean Acute Chronic Ratios (GMACRs) from 4 of 8 species: all cladocerans—GMACRs were excluded from resistant species such as fathead minnow (Pimephales), brook trout (Salvelinus), and rainbow trout (Oncorhynchus), as well as from one cladoceran with a 'greater than' value.

Information on Salmonids. GMACRs were available for Salvelinus (brook trout) and Oncorhynchus (rainbow trout). EPA judged that the FCV did not need to be lowered to protect a commercially or recreationally important species.

Notes: EPA rounds to 2 significant digits; therefore, EPA criteria is expressed as 11 µg/L in the 1999 "National Recommended Water Quality Criteria—Correction".

Therefore, the Oregon and new EPA criteria can be considered to be the same.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

<u>Saltwater Acute (CMC)</u>
OR Criterion: 1100 µg/L
EPA Criterion: 1100 (1108) µg/L

Date Changed:

Rationale for Change: EPA believes that freshwater and saltwater criteria for metals should be expressed in terms of dissolved metal in the water column, which is how this criterion is expressed in the 1999 EPA criteria document. The EPA criterion of 1108 is back-calculated from the published dissolved value which is derived by multiplying the 'total recoverable' (comparable to Oregon's criterion) by a conversion factor. EPA rounds to 2 significant digits; therefore, both the dissolved and total recoverable would be expressed as '1100 µg/L'. Thus, the EPA and Oregon criteria can be considered the same.

Reference: "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" (1985) PB85-227049.

Saltwater Chronic (CCC)
OR Criterion: 50 µg/L
EPA Criterion: 50 (50.4) µg/L

Date Changed:

Rationale for Change: The EPA criterion of 50.4 is back-calculated from the published dissolved value which is derived by multiplying the 'total recoverable' (comparable to Oregon's criterion) by a conversion factor. EPA rounds to 2 significant digits; therefore, both the dissolved and total recoverable would be expressed as '50 µg/L'. Thus, the EPA and Oregon criteria can be considered the same.

Reference: "Guidelines for Deriving Numerical National Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses" (1985) PB85-227049.

Copper

Freshwater Acute (CMC)
OR Criterion: 18 µg/L
EPA Criterion: 14 µg/L

note: These criteria are expressed as a function of hardness:

$$CMC = e^{(m_a[\ln(hardness)]+b_a)}$$

The values given here correspond to a hardness of 100 mg/L and are expressed as total recoverable concentration. The values for variables m_a (0.9422) and b_a (-1.700) are provided in "National Recommended Water Quality Criteria—Correction"(1999).

Date Changed: 1995

Rationale for Change: New data (references from 1986) from studies on cladocerans (1 Daphnia; 1 Ceriodaphnia) were analyzed and incorporated into the calculation of Final Acute Value (FAV). Data from Gammarus pulex (used in 1985) were excluded for lack of geographical relevance. The FAV was based on the four most sensitive genera (out of 43):

4. amphipod (Gammarus);
3. Northern pikeminnow (Northern squawfish; Ptycholcheilus);
2. cladoceran (Daphnia); and
1. cladoceran (Ceriodaphnia)

Information on Salmonids. Genus mean acute values (GMAVs) were available for Oncorhynchus (rainbow trout, chinook salmon, cutthroat trout, sockeye salmon, coho salmon) (sensitivity rank=12); Salmo (Atlantic salmon) (19); and Salvelinus (brook trout) (20).

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Freshwater Chronic (CCC)
OR Criterion: 12 µg/L

EPA Criterion: 9.3 µg/L

note: These criteria are expressed as a function of hardness:

$$CCC = e^{(m_c[\ln(hardness)]+b_c)}$$

The values given here correspond to a hardness of 100 mg/L and are expressed as total recoverable concentration. The values for variables m_c (0.8545) and b_c (-1.702) are provided in "National Recommended Water Quality Criteria—Correction"(1999).

Date Changed: 1995

Rationale for Change: New data (reference from 1986) were analyzed from studies on fathead minnow. There were insufficient data to calculate the Final Chronic Value (FCV) using the 8 family procedure; therefore, the FCV was calculated by dividing the FAV by the Final Acute-Chronic Ratio (FACR). The FACR was calculated based on the geometric mean of the Genus Mean Acute Chronic Ratios (GMACRs) from 2 of 8 species: a cladoceran and an amphipod—GMACRs were excluded from resistant species such as snail (Physa), salmon/trout (Oncorhynchus), brook trout (Salvelinus), minnow (Pimephales), blue gill (Lepomis) and snail (Campeloma).

Information on Salmonids. GMACRs were available for Oncorhynchus (chinook salmon) and Salvelinus (brook trout). EPA judged that the FCV did not need to be lowered to protect a commercially or recreationally important species.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

<u>Saltwater Acute (CMC)</u>
OR Criterion: 2.9 µg/L
EPA Criterion: 5.8 µg/L

Date Changed: 1995

Rationale for Change: New data from six new species (clam [Mulinia], copepod [Tigriopus], sea urchin [Arbacia], sheepshead minnow [Cyprinodon], mummichog [Fundulus], and topsmelt [Atherinops], were added to the database for deriving the saltwater copper criteria. The FAV was initially calculated based on the four most sensitive genera (out of 26):

4. oyster (Crassostrea);
3. coot clam (Mulinia);
2. summer flounder (Paralichthys); and
1. blue mussel (Mytilus)

However, in order to protect the commercially important blue mussel, the FAV was lowered to the Genus Mean Acute Value for this species.

Information on Salmonids. No Genus Mean Acute Values (GMAVs) were available for salmonids.

Reference: "Ambient Water Quality Criteria – Saltwater Copper Addendum (Draft)" (1995) no EPA No.; "Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance—Revision of Metals Criteria" (1995) 60 FR 22229-222237.

Saltwater Chronic (CCC)
OR Criterion: 2.9 µg/L
EPA Criterion: 3.7 µg/L

Date Changed: 1995

Rationale for Change: No new chronic data were available; therefore, the Final Chronic Value (FCV) was calculated by dividing the FAV by the Final Acute Chronic Ratio (FACR). The FACR was calculated by taking the geometric mean of Genus Mean Acute Chronic Ratios (GMACRs) from 4 species (3 freshwater; 1 saltwater): Daphnia, Gammarus, Physa, and Mysidopsis.

Information on Salmonids. No GMACRs were available for salmonids.

Reference: "Ambient Water Quality Criteria – Saltwater Copper Addendum (Draft)" (1995) no EPA No.; "Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance—Revision of Metals Criteria" (1995) 60 FR 22229-222237.

Dieldrin

Freshwater Acute (CMC)
OR Criterion: 2.5 µg/L
EPA Criterion: 0.24 µg/L

Date Changed: 1995

Rationale for Change: New data from studies on stonefly (1986; Pteromarcys sp. and Claassenia sabulosa) and rainbow trout (1985; Oncorhynchus mykiss) were analyzed and incorporated into the calculation of Final Acute Value (FAV). The FAV was based on the four most sensitive genera (out of 18):

4. salmon/trout (Oncorhynchus);
3. stonefly (Claassenia);
2. stonefly (Pteronarcys); and
1. stonefly (Pternarcella)

Information on Salmonids. A Genus Mean Acute Value (GMAV) was available for Oncorhynchus (rainbow trout, chinook salmon, cutthroat trout, coho salmon) (sensitivity rank=4).

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Freshwater Chronic (CCC)
OR Criterion: 0.0019 µg/L
EPA Criterion: 0.056 µg/L

Date Changed: 1995

Rationale for Change: No new data were analyzed. There were insufficient data to calculate the Final Chronic Value (FCV) using the 8 family procedure; therefore, the FCV was calculated by dividing the FAV by the Final Acute-Chronic Ratio (FACR). The FACR was based on the geometric mean of the Genus Mean Acute Chronic Ratios (GMACRs) from 3 of 3 species: rainbow trout (Oncorhynchus), guppy (Poecilia), and a saltwater mysid. The OR criterion was based on 1980 methods that calculated a Freshwater Final Residue Value (based on FDA action level for fish tissue concentration, lipid content, and bioconcentration factor) that became the FCV.

Information on Salmonids. GMACR was available for Oncorhynchus (rainbow trout). EPA judged that the FCV did not need to be lowered to protect a commercially or recreationally important species.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

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alpha-Endosulfan

Freshwater Acute (CMC)
OR Criterion: none
EPA Criterion: 0.22 µg/L

Date Changed: 1992

Rationale for Change: This criterion, first published in 1992 and again in 1999, is the same as that published in 1986 for endosulfan in the "Gold Book" which indicates that technical endosulfan typically contains a ratio of alpha- to beta-endosulfan of 70:30. The 1992 "Establishment of Numeric Criteria for Priority Toxic Pollutants" provides distinct criteria for alpha- and beta-endosulfan with the following footnote:

> "Aquatic life criteria for these compounds were issued in 1980 utilizing the 1980 Guidelines for criteria development. The acute values shown are final acute values (FAV) which by the 1980 Guidelines are instantaneous values as contrasted with a CMC which is a one-hour average."

The 1999 "National Recommended Water Quality Criteria—Correction" continues to provide distinct criteria for alpha- and beta-endosulfan and has the following footnotes:

> "This criterion is based on 304(a) aquatic life criterion in 1980, and was issued in one of the following documents:…Endosulfan (EPA 440/5-80-046)…. The minimum data requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines. For example, a 'CMC' derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines."

and

> "This value was derived from data for endosulfan and is most appropriately applied to the sum of alpha-endosulfan and beta-endosulfan."

The four most sensitive genera (out of 10) were:

4. white sucker (Catastomus);
3. stonefly (Pteronarcys);
2. fathead minnow (Pimephales); and

1. rainbow trout (Oncorhynchus)

Information on Salmonids. Genus mean acute value (GMAV) available for Oncorhynchus (rainbow trout) (sensitivity rank=1).

Reference: "Ambient Water Quality Criteria for Endosulfan" (1980) EPA 440-5-80-046; "Quality Criteria for Water 1986" (1986) EPA 440-5-86-001; "Establishment of Numeric Criteria for Priority Toxic Pollutants" (1992) EPA 823-Z-92-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

<u>Freshwater Chronic (CCC)</u>
OR Criterion: none
EPA Criterion: 0.056 µg/L

Date Changed: 1992

Rationale for Change: see rationale for Freshwater Acute Criterion. Genus Mean Acute Chronic Ratios (GMACRs) were available for 2 freshwater (Daphnia and Pimephales) and 2 saltwater species (Mysidopsis and Cyprinodon). The Final Chronic Value was calculated by dividing the FAV by the Final Acute Chronic Ratio.

Information on Salmonids. No GMACR was available for salmonids.

Reference: see references for Freshwater Acute.

<u>Saltwater Acute (CMC)</u>
OR Criterion: none
EPA Criterion: 0.034 µg/L

Date Changed: 1992

Rationale for Change: see rationale for Freshwater Acute Criterion. The four most sensitive genera (out of 12) were:

4. copepod (Acartia);
3. striped bass (Morone);
2. spot (Leiostomus); and
1. pink shrimp (Penaeus)

Information on Salmonids. No data for salmonids were available.

Reference: see references for Freshwater Acute.

<u>Saltwater Chronic (CCC)</u>
OR Criterion: none
EPA Criterion: 0.0087 µg/L

Date Changed: 1992

Rationale for Change: see rationale for Freshwater Acute Criterion. Species Mean Acute-Chronic Ratios were available for 2 freshwater (Daphnia and Pimephales) and 2 saltwater species (Mysidopsis and

Cyprinodon). The Final Chronic Value was calculated by dividing the FAV by the Final Acute Chronic Ratio.

Information on Salmonids. No GMACR was available for salmonids.

Reference: see references for Freshwater Acute.

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beta-Endosulfan

Freshwater Acute (CMC)
OR Criterion: none
EPA Criterion: 0.22 µg/L

Date Changed: 1992

Rationale for Change: see rationale for Freshwater Acute Criterion for alpha-Endosulfan.

Reference: see references for Freshwater Acute for alpha-Endosulfan.

Freshwater Chronic (CCC)
OR Criterion: none
EPA Criterion: 0.056 µg/L

Date Changed: 1992

Rationale for Change: see rationale for Freshwater Acute Criterion and for Freshwater Chronic Criterion for alpha-Endosulfan.

Reference: see references for Freshwater Acute for alpha-Endosulfan.

Saltwater Acute (CMC)
OR Criterion: none
EPA Criterion: 0.034 µg/L

Date Changed: 1992

Rationale for Change: see rationale for Freshwater Acute Criterion for alpha-Endosulfan.

Reference: see references for Freshwater Acute for alpha-Endosulfan.

Saltwater Chronic (CCC)
OR Criterion: none
EPA Criterion: 0.0087 µg/L

Date Changed: 1992

Rationale for Change: see rationale for Freshwater Acute Criterion and for Saltwater Chronic Criterion for alpha-Endosulfan.

Reference: see references for Freshwater Acute for alpha-Endosulfan.

Endrin

Freshwater Acute (CMC)
OR Criterion: 0.18 µg/L
EPA Criterion: 0.086 µg/L

Date Changed: 1995

Rationale for Change: New data from studies on yellow perch (1986; Perca flavascens), bluegill (1985; Lepomis macrochirus), and largemouth bass (1986; Micropterus salmoides) were analyzed and incorporated into the calculation of Final Acute Value (FAV). The FAV was based on the four most sensitive genera (out of 27):

4. largemouth bass (Micropterus);
3. stonefly (Pteronarcys);
2. bluegill (Lepomis); and
1. yellow perch (Perca)

Information on Salmonids. A Genus Mean Acute Value (GMAV) was available for Oncorhynchus (rainbow trout, chinook salmon, coho salmon) (sensitivity rank=8).

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001; "Ambient Water Quality Criteria for Aldrin/Dieldrin" (1980) EPA 440/5-80-019.

Freshwater Chronic (CCC)
OR Criterion: 0.0023 µg/L
EPA Criterion: 0.036 µg/L

Date Changed: 1995

Rationale for Change: No new data were analyzed. There were insufficient data to calculate the Final Chronic Value (FCV) using the 8 family procedure; therefore, the FCV was calculated by dividing the FAV by the Final Acute-Chronic Ratio (FACR).

Note: the fathead minnow acute-chronic ratio was excluded.

The FACR was calculated based on the geometric mean of the Genus Mean Acute Chronic Ratios (GMACRs) from 3 of 4 species: two saltwater species and one for a freshwater species, the flagfish (Jordanella). The OR criterion was based on 1980 methods that calculated a Freshwater Final Residue Value (based on FDA action level for fish tissue concentration, lipid content, and bioconcentration factor) that became the FCV.

Information on Salmonids. No GMACRs were available for salmonids. EPA judged that the FCV did not need to be lowered to protect a commercially or recreationally important species.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001; "Ambient Water Quality Criteria for Endrin" (1980) EPA 440/5-80-047.

Heptachlor Epoxide

Freshwater Acute (CMC)
OR Criterion: none
EPA Criterion: 0.52 µg/L

Date Changed: 1992

Rationale for Change: This criterion, first published in 1992 and again in 1999, is the same as that published in 1986 for heptachlor in the "Gold Book". Heptachlor undergoes oxidation to form heptachlor epoxide. The 1992 "Establishment of Numeric Criteria for Priority Toxic Pollutants" provides criteria for heptachlor epoxide with the following footnote:

> "Aquatic life criteria for these compounds were issued in 1980 utilizing the 1980 Guidelines for criteria development. The acute values shown are final acute values (FAV) which by the 1980 Guidelines are instantaneous values as contrasted with a CMC which is a one-hour average."

The 1999 "National Recommended Water Quality Criteria—Correction" continues to provide criteria for heptachlor epoxide and has the following footnotes:

> "This criterion is based on 304(a) aquatic life criterion in 1980, and was issued in one of the following documents:…Heptachlor (EPA 440/5-80-052)…. The minimum data requirements and derivation procedures were different in the 1980 Guidelines than in the 1985 Guidelines. For example, a 'CMC' derived using the 1980 Guidelines was derived to be used as an instantaneous maximum. If assessment is to be done using an averaging period, the values given should be divided by 2 to obtain a value that is more comparable to a CMC derived using the 1985 Guidelines."

and

> "This value was derived from data for heptachlor and the criteria document provides insufficient data to estimate the relative toxicities of heptachlor and heptachlor epoxide"
>
> The four most sensitive genera (out of 18) were:
>
> 4. stonefly (Claassenia);
> 3. glass shrimp (Palaemonotes);
> 2. stonefly (Pteronarcys); and
> 1. stonefly (Pteronarcella)

Information on Salmonids. Species Mean Acute Values (SMAVs) were available for rainbow trout (sensitivity rank=6), chinook salmon (sensitivity rank=8), and coho salmon) (sensitivity rank=15).

References: "Ambient Water Quality Criteria for Heptachlor" (1980) EPA 440-5-80-052; "Quality Criteria for Water 1986" (1986) EPA 440-5-86-001; "Establishment of Numeric Criteria for Priority Toxic Pollutants" (1992) EPA 823-Z-92-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

Freshwater Chronic (CCC)
OR Criterion: none
EPA Criterion: 0.0038 μg/L

Date Changed: 1992

Rationale for Change: see rationale for Freshwater Acute Criterion, and the following footnote was included for CCCs.

> "This CCC is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria."

In addition, the 1986 "Water Quality Advisory—Heptachlor Epoxide" indicates that at that time there were insufficient data to calculate a criterion; however,

> "Since preliminary indications are that heptachlor epoxide is less toxic than heptachlor to aquatic organisms, the EPA chronic criteria for heptachlor of 0.0038 μg/L and 0.0036 μg/L would be a conservative advisory concentration for heptachlor epoxide as well."

Information on Salmonids. No GMACRs were available for salmonids.

Reference: "Ambient Water Quality Criteria for Heptachlor" (1980) EPA 440-5-80-052; "Quality Criteria for Water 1986" (1986) EPA 440-5-86-001; "Establishment of Numeric Criteria for Priority Toxic Pollutants" (1992) EPA 823-Z-92-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

Saltwater Acute (CMC)
OR Criterion: none
EPA Criterion: 0.053 μg/L

Date Changed: 1992

Rationale for Change: see rationale for Freshwater Acute Criterion.

References: "Ambient Water Quality Criteria for Heptachlor" (1980) EPA 440-5-80-052; "Quality Criteria for Water 1986" (1986) EPA 440-5-86-001; "Establishment of Numeric Criteria for Priority Toxic Pollutants" (1992) EPA 823-Z-92-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

Saltwater Chronic (CCC)
OR Criterion: none
EPA Criterion: 0.0036 μg/L

Date Changed: 1992

Rationale for Change: see rationale for Freshwater Acute Criterion, and the following footnote was included for CCCs.

> "This CCC is based on the Final Residue Value procedure in the 1985 Guidelines. Since the publication of the Great Lakes Aquatic Life Criteria Guidelines in 1995 (60FR15393-15399, March 23, 1995), the Agency no longer uses the Final Residue Value procedure for deriving CCCs for new or revised 304(a) aquatic life criteria."

References: "Ambient Water Quality Criteria for Heptachlor" (1980) EPA 440-5-80-052; "Quality Criteria for Water 1986" (1986) EPA 440-5-86-001; "Establishment of Numeric Criteria for Priority Toxic Pollutants" (1992) EPA 823-Z-92-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

Lead

Saltwater Acute (CMC)
OR Criterion: 140 µg/L
EPA Criterion: 220 µg/L

note: These criteria are expressed as total recoverable concentration.

Date Changed: 1992

Rationale for Change: The new criterion resulted from a correction of data. EPA recognized in the "Establishment of Numeric Criteria for Priority Toxic Pollutants" (1992; page 60882, comment 45) an error in the Genus Mean Acute Value (GMAV) for Fundulus and subsequent recalculation of the CMC to the value above (no details on the error in question are given; however, this value can be attained by removing the value for Fundulus from the four most sensitive species and adding the value for a copepod to calculate the Final Acute Value). The four species used in calculating the CMC were: Mytilus (mussel), Ampelisca (amphipod), Cancer (crab), and Acartia (copepod). The FAV was based on the four most sensitive genera (out of 27):

4. copepod (Acartia);
3. Dungeness crab (Cancer);
2. amphipod (Ampelisca); and
1. blue mussel (Mytilus)

Information on Salmonids. No GMACRs were available for salmonids.

Reference: "Ambient Water Quality for Lead—1984" (1985) EPA 440/5-84-027; "Establishment of Numeric Criteria for Priority Toxic Pollutants" (1992) EPA 823-Z-92-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

Saltwater Chronic (CCC)
OR Criterion: 5.6 µg/L
EPA Criterion: 8.5 µg/L

note: These criteria are expressed as total recoverable concentration.

Date Changed: 1992

Rationale for Change: No new data were used. The CCC was recalculated based on the new FAV (see Rationale for Change for Saltwater Acute Criterion).

Reference: "Ambient Water Quality for Lead—1984" (1985) EPA 440/5-84-027; "Establishment of Numeric Criteria for Priority Toxic Pollutants" (1992) EPA 823-Z-92-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

Lindane (γ-BHC)

Freshwater Acute (CMC)
OR Criterion: 2 μg/L
EPA Criterion: 0.95 μg/L

Date Changed: 1995

Rationale for Change: New data from studies on stonefly (1986; Pteronarcys californicus), backswimmer (1976; Notonecta undulata), and snail (1979; Lymnaea stagnalis) were analyzed and incorporated into the calculation of Final Acute Value (FAV). The FAV was based on the four most sensitive genera (out of 23):

4. isopod (Asellus);
3. snail (Lymnae);
2. backswimmer (Notonecta); and
1. stonefly (Pteronarcys)

Information on Salmonids. Genus mean acute values (GMAVs) were available for Salmo (brown trout) (sensitivity rank=5); Oncorhynchus (rainbow trout, chinook salmon, coho salmon) (10); Salvelinus (brook trout, lake trout) (11).

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Freshwater Chronic (CCC)
OR Criterion: 0.08 μg/L
EPA Criterion: no criteria

Date Changed: 1995

Rationale for Change: No new data were found. The Genus Mean Acute Chronic Ratio (GMACR) for fathead minnow was deemed unacceptable; therefore, GMACRs were available from 2 of 3 species (a midge and a cladoceran) which EPA deemed unacceptable for calculating the Final Chronic Value (FCV) by dividing the FAV by the Final Acute Chronic Ratio (FACR). Thus, the CCC could not be determined.

Information on Salmonids. No GMACRs were available for salmonids.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Mercury

Freshwater Acute (CMC)
OR Criterion: 2.4 µg/L
EPA Criterion: 1.6 µg/L

Date Changed: 1995

Rationale for Change: New data from studies on cladoceran (1986; Ceriodaphnia reticulata) were analyzed and incorporated into the calculation of Final Acute Value (FAV). The FAV was based on the four most sensitive genera (out of 29):

4. crayfish (Faxonella);
3. amphipod (Gammarus);
2. cladoceran(Daphnia); and
1. cladoceran (Ceriodaphnia)

Information on Salmonids. Genus mean acute value (GMAV) was available for Oncorhynchus (rainbow trout, coho salmon) (sensitivity rank=19).

Note: T&E concerns were raised by NMFS & USFWS with EPA over the criterion in California Toxics Rule (2000).

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001; "Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California" (2000) 65 FR 31682-31719.

Freshwater Chronic (CCC)
OR Criterion: 0.012 µg/L
EPA Criterion: 0.91 µg/L

Date Changed: 1995

Rationale for Change: No new data were obtained. There were insufficient data to calculate the Final Chronic Value (FCV) using the 8 family procedure; therefore, the FCV was calculated by dividing the FAV by the Final Acute-Chronic Ratio (FACR)—data on ACR from the highly resistant fathead minnow was excluded.

Information on Salmonids. No GMACRs were available for salmonids. EPA provided estimates of the chronic values for rainbow trout (0.42 µg/L), coho salmon (0.37 µg/L), and bluegill (0.25 µg/L), all of which were more than a factor of two below that of the FCV of 0.91 µg/L; therefore, EPA concluded that the criterion of 0.91 µg/L might not be protective of those three important species.

Note: T&E concerns were raised by NMFS & USFWS with EPA over the criterion in California Toxics Rule (2000).

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001; "Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants for the State of California" (2000) 65 FR 31682-31719.

Nickel

Freshwater Acute (CMC)
OR Criterion: 1400 µg/L
EPA Criterion: 470 (469) µg/L

note: These criteria are expressed as a function of hardness:

$$CMC = e^{(m_a[\ln(hardness)]+b_a)}$$

The values given here correspond to a hardness of 100 mg/L and are expressed as total recoverable concentration. The values for variables m_a (0.8460) and b_a (2.255) are provided in "National Recommended Water Quality Criteria—Correction"(1999).

Date Changed: 1995

Rationale for Change: New data from studies on snail (1986; Physa gyrina) were analyzed and incorporated into the calculation of Final Acute Value (FAV). The FAV was based on the four most sensitive genera (out of 21):

4. mayfly (Ephemerella);
3. rock bass (Amboplites);
2. cladoceran(Daphnia); and
1. snail (Physa)

Information on Salmonids. A Genus Mean Acute Value (GMAV) was available for Oncorhynchus (rainbow trout) (sensitivity rank=13).

Note: EPA rounds criterion to 470 (2 significant digits).

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Freshwater Chronic (CCC)
OR Criterion: 160 µg/L
EPA Criterion: 52 (52.2) µg/L

note: These criteria are expressed as a function of hardness:

$$CCC = e^{(m_c[\ln(hardness)]+b_c)}$$

The values given here correspond to a hardness of 100 mg/L and are expressed as total recoverable concentration. The values for variables m_c (0.8460) and b_c (0.0584) are provided in "National Recommended Water Quality Criteria—Correction"(1999).

Date Changed: 1995

Rationale for Change: No new data were available. There were insufficient data to calculate the Final Chronic Value (FCV) using the 8 family procedure; therefore, the FCV was calculated by dividing the FAV by the Final Acute-Chronic Ratio (FACR). The FACR was calculated based on the geometric mean of Genus Mean Acute Chronic Ratios (GMACRs) from 3 of 3 species: two freshwater species (cladoceran and fathead minnow) and one saltwater species.

Information on Salmonids. No GMACRs were available for salmonids. EPA judged that the FCV did not need to be lowered to protect a commercially or recreationally important species.

Note: EPA rounds criterion to 470 (2 significant digits).

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Pentachlorophenol

Freshwater Acute (CMC)
OR Criterion: 20 µg/L
EPA Criterion: 19 µg/L

note: These criteria are expressed as a function of pH:

OR Criterion: $CMC = e^{(1.005[pH]-4.830)}$

EPA Criterion: $CMC = e^{(1.005[pH]-4.869)}$

The values given above correspond to a pH of 7.8.

Date Changed: 1995

Rationale for Change: No new data were available. However, the new taxonomy of salmonids and correction of data for Rana catesbeiana provided data that required re-analysis, which was incorporated into the calculation of the equation that provides the Final Acute Value (FAV). The FAV was based on the four most sensitive genera (out of 32):

4. bullfrog (Rana);
3. salmon/trout (Oncorhynchus);
2. channel catfish (Ictalurus); and
1. common carp (Cyprinus)

Information on Salmonids. Genus mean acute values (GMAVs) were available for Oncorhynchus (rainbow trout, coho salmon, sockeye salmon, chinook salmon) (sensitivity rank=3); and Salvelinus (brook trout) (5). Brook trout had previously (for the OR criterion) occupied the 4th most sensitive genera and rainbow trout (then classified as Salmo gairdneri) occupied the 5th most sensitive genera.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Freshwater Chronic (CCC)
OR Criterion: 13 µg/L
EPA Criterion: 15 µg/L

note: These criteria are expressed as a function of pH:

OR Criterion: $CCC = e^{(1.005[pH]-5.290)}$

EPA Criterion: $CCC = e^{(1.005[pH]-5.134)}$

The values given above correspond to a pH of 7.8.

Date Changed: 1995

Rationale for Change: No new data were available. There were insufficient data to calculate FCV using the 8 family procedure; therefore, the FCV was calculated by dividing the FAV by the FACR (as was the case for the 1986 criteria document on which OR's criterion is based). The FACR was calculated based on the geometric mean of the Genus Mean Acute Chronic Ratio (GMACR) from 4 of 6 species: rainbow trout, cladoceran (Simocephalus), fathead minnow, and cladoceran (Daphnia); GMACRs were excluded from a cladoceran (Ceriodaphnia) and a snail with 'greater than' values.

"Ambient Water Quality Criteria for Pentachlorophenol—1986" (1986), on which OR criteria were based, incorporated a GMACR from a 5th species (the saltwater-dwelling sheepshead minnow) into its calculation of the FACR, resulting in a larger number than that provided in the "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1995 update provides no explanation for why the sheepshead minnow GMACR was not included). This results in the difference between the OR and EPA criteria.

Information on Salmonids. GMACR was available for Oncorhynchus (rainbow trout). EPA judged that the FCV did not need to be lowered to protect a commercially or recreationally important species.

Reference: "Ambient Water Quality Criteria for Pentachlorophenol—1986" (1986) EPA 440/5-86-009; "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

<u>Saltwater Chronic (CCC)</u>
OR Criterion: 7.9 µg/L (published as a guidance value)
EPA Criterion: 7.9 µg/L

Date Changed: 1986

Rationale for Change: The Summary Table from "Quality Criteria for Water 1986" (the Gold Book) places an "*" by the 7.9 µg/L to indicate that it is a guidance value, not a criterion, based on the lowest observed effect level (LOEL) because there were insufficient data., The "Ambient Water Quality Criteria for Pentachlorophenol – 1986" indicates that the 7.9 µg/L is a criterion. Only two saltwater species had usable data on toxicity, so the Final Chronic Value (FCV) was calculated by dividing the Final Acute Value (FAV) by the Final Acute Chronic Ratio (FACR), which was calculated as the geometric mean of 5 of the 7 available Genus Mean Acute Chronic Ratios (GMACRs): cladoceran (Daphnia), fathead minnow, cladoceran (Simocephalus), rainbow trout, and sheepshead minnow (the only saltwater species).

Information on Salmonids. No GMACRs were available from salmonids during saltwater lifestage.

Reference: "Quality Criteria for Water 1986" (1986) EPA 440/5-86-001; "Ambient Water Quality Criteria for Pentachlorophenol – 1986" (1986) EPA 440/5-86-009.

Polychlorinated Biphenyls (PCBs)

Freshwater Acute (CMC)
OR Criterion: 2.0 µg/L
EPA Criterion: none

Date Changed: 1992

Rationale for Change: According to Cindy Roberts at EPA (Health and Ecological Criteria Division), this number was never meant to be an acute criterion. The actual description of criteria from the 1986 EPA Gold Book does specify 0.014 µg/L as a criterion (for chronic); however, the value of 2.0 µg/L is mentioned as follows "The available data indicate that acute toxicity to freshwater aquatic life probably will only occur at concentrations above 2.0 µg/L and that the 24-hour average [0.014 µg/L], should provide adequate protection against acute toxicity." Further reading of the entire criteria document shows that 2.0 µg/L was the lower limit of the range of values attained for what is termed "acute toxicity" which were derived as LC50s for 96-hour flow-through exposures. The most sensitive fish species of the four tested was rainbow trout (newly hatched).

Reference: "Ambient Water Quality Criteria for Polychlorinated Biphenyls" (1980) EPA 440-5-80-068; phone messages and emails with Cindy Roberts, EPA Health and Ecological Criteria Division.

Saltwater Acute (CMC)
OR Criterion: 10 µg/L
EPA Criterion: none

Date Changed: 1992

Rationale for Change: According to Cindy Roberts at EPA (Health and Ecological Criteria Division), this number was never meant to be an acute criterion. The actual description of criteria from the 1986 EPA Gold Book does specify 0.030 µg/L as a criterion (for chronic); however, the value of 10 µg/L is mentioned as follows "The available data indicate that acute toxicity to saltwater aquatic life probably will only occur at concentrations above 10 µg/L and that the 24-hour average [0.03 µg/L], should provide adequate protection against acute toxicity." Further reading of the entire criteria document shows that 10 µg/L was the lower limit of the range of values attained for what is termed "acute toxicity" which were derived as LC50s for flow-through exposures. The most sensitive invertebrate species of the 3 tested was Eastern oyster (newly hatched); reports from exposures of saltwater fish did not produce data that could be used to calculate an LC50.

Reference: "Ambient Water Quality Criteria for Polychlorinated Biphenyls" (1980) EPA 440-5-80-068; phone messages and emails with Cindy Roberts, EPA Health and Ecological Criteria Division.

Selenium

Freshwater Acute (CMC)
OR Criterion: 260 µg/L
EPA Criterion: 190* (185.9) µg/L (see equation)
*note: based on highest CMC from EPA formula (below) for proportion of total selenium composed of selenite (selenium IV) and selenate (selenium VI):

$$CMC = \left(\frac{1}{[(f1/CMC1)+(f2/CMC2)]} \right)$$

where f1 & f2 are the fractions of total selenium treated as selenite and selenate, respectively, and CMC1=185.9 and CMC2=12.83. EPA rounds to the nearest two digits.

Date Changed: 1996

Rationale for Change: EPA proposed the new criterion to address 1) a court challenge that the 1995 CMC did not take into account the relative toxicities of the two oxidation states of selenium, and 2) new data that indicated an additive toxicity effect of the different forms of selenium. New data from studies on cladoceran (1987; Daphnia magna) were analyzed and incorporated into the calculation of Final Acute Value (FAV). The FAV for selenite (selenium IV) was based on the four most sensitive genera (out of 22):

4. hydra (Hydra);
3. fathead minnow (Pimephales);
2. cladoceran (Ceriodaphnia); and
1. amphipod (Hyalella)

Information on Salmonids. Genus Mean Acute Values (GMAVs) were available for Salvelinus (brook trout) (sensitivity rank=9); and Oncorhynchus (rainbow trout) (10).

The FAV for selenate (selenium VI) was based on the four most sensitive genera (out of 11):

4. fathead minnow (Pimephales);
3. amphipod (Hyalella);
2. cladoceran (Daphnia); and
1. amphipod (Gammarus)

Information on Salmonids. Genus mean acute value (GMAV) available for Oncorhynchus (rainbow trout) (7).

Note: T&E concerns were raised by NMFS & USFWS with EPA over the criterion in California Toxics Rule (2000).

Reference: "Proposed Selenium Criterion Maximum Concentration for the Water Quality Guidance for the Great Lakes System (1996) Federal Register 61FR58444-58449, November 14, 1996; "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

<u>Freshwater Chronic (CCC)</u>
OR Criterion: 35 µg/L
EPA Criterion: 5 µg/L

Date Changed: 1995

Rationale for Change: No new data were available. There were insufficient data to calculate the Final Chronic Values (FCVs) for selenite or selenate using the 8 family procedure; therefore, the FCVs were calculated by dividing the FAVs by the Final Acute Chronic Ratios (FACRs) for each compound. The FACR for selenite (selenium IV) was calculated based on the geometric mean of the Genus Mean Acute Chronic Ratios (GMACRs) from 3 of 4 species: fathead minnow and two cladocerans (Daphnia); the GMACR from rainbow trout was excluded because it was an acutely resistant species.

Although GMACRs were available for 3 species, the FACR for selenate (selenium VI) was calculated based on GMACR from the most sensitive species, a cladoceran (Daphnia).

Information on Salmonids. A GMACR for selenite was available for Oncorhynchus (rainbow trout). The FCV was lowered to protect rainbow trout as a commercially and recreationally important species. A GMACR for selenate was available for Oncorhynchus (rainbow trout). EPA judged that the FCV for selenate did not need to be lowered to protect a commercially or recreationally important species. However, EPA reviewed field studies that indicated that selenium might be more toxic to some freshwater fish species than had been observed in laboratory studies. Therefore, the CCC for total selenium was set to 5 µg/L—the level in the field at which no chronic effects on fish were observed.

Reference: "Proposed Selenium Criterion Maximum Concentration for the Water Quality Guidance for the Great Lakes System (1996) Federal Register 61FR58444-58449, November 14, 1996; "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

<u>Saltwater Acute (CMC)</u>
OR Criterion: 410 µg/L
EPA Criterion: 290 (291) µg/L

Date Changed: 1987

Rationale for Change: The Oregon criterion was derived by EPA in 1980 and published in 1986 in the "Gold Book" using data from selenite toxicity tests of 13 genera (5 invertebrates, 7 fish). In 1986, the four most sensitive genera were:

4. Dungeness crab (Cancer);
3. copepod (Acartia);
2. mysid shrimp (Mysidopsis); and
1. haddock (Melanogrammus)

New data (in 1987) on a mysid shrimp and on a copepod affected the rankings for these genera. The 1987 criteria document used data from 15 genera (7 invertebrates, 8 fish) for selenite and 2 genera (both fish) for selenate. The FAV for the new criterion was based on the four most sensitive genera (out of 17):

4. copepod (Acartia);
3. brown shrimp (Penaeus);
2. Dungeness crab (Cancer); and
1. haddock (Melanogrammus)

Note: EPA rounds to 2 significant digits.

Information on Salmonids. No GMACs were available for salmonids.

Reference: "Ambient Water Quality Criteria for Selenium" (1980) EPA 440/5-80-070; "Quality Criteria for Water 1986" (1986) EPA 440-5-86-001; "Ambient Water Quality Criteria for Selenium" (1987) EPA 440/5-87-006.

<u>Saltwater Chronic (CCC)</u>
OR Criterion: 54 µg/L
EPA Criterion: 71 µg/L

Date Changed: 1987

Rationale for Change: For both the 1980 and 1987 criteria documents, the chronic saltwater toxicity was determined using data from two species: sheepshead minnow and mysid shrimp. The 1980 criterion document describes the Final Chronic Value (FCV) being derived by dividing the FAV by the Final Acute Chronic Ratio (FACR). In the 1987 document, the FCV is also calculated from dividing the FAV by the FACR. In the 1987 criterion, the value used for sheepshead minnow was the same as that in the 1980 document; in the 1987 document, the value used for mysid shrimp differed from that noted in the 1980 document due to the incorporation of new data into the 1987 calculation. In both documents, only chronic data for selenite were available for deriving the criterion.

Information on Salmonids. No chronic toxicity information was available for salmonids in saltwater.

Reference: "Ambient Water Quality Criteria for Selenium" (1980) EPA 440/5-80-070; "Ambient Water Quality Criteria for Selenium" (1987) EPA 440/5-87-006.

Silver

<u>Freshwater Chronic (CCC)</u>
OR Criterion: 0.12 µg/L
EPA Criterion: none

Date Changed: 1992

Rationale for Change: The CCC expressed in the Summary Table from "Quality Criteria for Water 1986" is based on the following statement: "The available data indicate that chronic toxicity to freshwater life may occur at concentrations as low as 0.12." Such a statement might be questioned as to whether it qualifies as a criterion. However, this value is more formally put forward as a criterion in "Ambient Aquatic Life Water Quality Criteria for Silver – Draft 1987" which derived a Final Acute Chronic Ratio (FACR) from Genus Mean Acute Chronic Ratios for two freshwater species: rainbow trout, fathead minnow; and one saltwater species: mysid (Mysidopsis). The old criterion (OR's current) was derived by dividing the FAV by the FACR. EPA proposed this value as the final criterion in the Federal Register in May of 1990. The reason that EPA decided to remove the chronic criterion in 1992 remains obscure—in "Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants" (1992), aka "National Toxics Rule", the response to Comment 48 indicates that due to comments made on the May 14, 1990 proposed silver criteria, EPA decided to promulgate "its 1980 criteria for silver…" That decision may indicate that EPA did not consider the initial quote above to be a criterion and thus, the number was removed.

Reference: "Ambient Water Quality Criteria for Silver" (1980) EPA 440/5-80-071; "Ambient Aquatic Life Water Quality Criteria for Silver—Draft" (1987) EPA 440/5-87-011; "Ambient Water Quality Criteria" (1990) Federal Register 55FR19986-19992; "Establishment of Numeric Criteria for Priority Toxic Pollutants" (1992) EPA 823-Z-92-001

<u>Saltwater Acute (CMC)</u>
OR Criterion: 2.3 µg/L
EPA Criterion: 2.2 µg/L (should be 2.3)

Date Changed: 1995

Rationale for Change: The difference in criteria is due to rounding. The latest 1999 EPA criterion for silver presents a value of 1.9 µg/L for dissolved silver; to calculate total recoverable silver, the correction factor provided by EPA is 0.85 (i.e. divide 1.9 by 0.85). The original EPA criterion (OR's current) was 2.3 µg/L for total recoverable silver; when EPA published its guidance ("Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance—Revision of Metals Criteria" [1995]) for calculating dissolved metals from total recoverable, it provided a correction factor of 0.85 for silver (i.e. multiply 2.3 by 0.85). EPA indicated in the 1995 document that this should yield a dissolved metals criterion of 1.9 µg/L—which is rounded down from 1.955. Therefore, the EPA criterion of 2.2 µg/L is an artifact of this rounding error; the total recoverable silver criterion should be expressed as 2.3 µg/L.

Reference: "Ambient Water Quality Criteria for Silver" (1980) EPA 440/5-80-071; "Water Quality Standards; Establishment of Numeric Criteria for Priority Toxic Pollutants; States' Compliance—Revision of Metals Criteria" (1995) 60 FR 22229-22237; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

Tributyltin (TBT)

<u>Freshwater Acute (CMC)</u>
OR Criterion: none
EPA Criterion: 0.46 µg/L

Date Changed: 1997

Rationale for Change: This concentration was published by EPA in 1997 as a proposed criterion. Although EPA has yet to complete its response to comments, it continues to publish this concentration for States and Tribes to consider for adoption as a criterion. The FAV was based on the four most sensitive genera (out of 14):

4. amphipod (Gammarus);
3. fathead minnow (Pimephales);
2. hydra (Chlorohydra); and
1. hydra (Hydra)

Information on Salmonids. Genus Mean Acute Values (GMAVs) were available for Oncorhynchus (rainbow trout) (sensitivity rank=6); and Salvelinus (lake trout) (11).

Reference: "Water Quality Criteria; Ambient Water Quality Criteria; Notice of Ambient Water Quality Criteria Document for Tributyltin (TBT) and Request for Comments" (1997) 62 FR 42554; "Ambient Aquatic Life Water Quality Criteria—Tributyltin (Draft)" (1997) EPA-822-D-97-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

<u>Freshwater Chronic (CCC)</u>
OR Criterion: none
EPA Criterion: 0.063 µg/L

Date Changed: 1997

Rationale for Change: This concentration was published by EPA in 1997 as a proposed criterion. Although EPA has yet to complete its response to comments, it continues to publish this concentration for States and Tribes to consider for adoption as a criterion. There were insufficient data to calculate FCV using the 8 family procedure; therefore, the FCV was calculated by dividing FAV by FACR. The FACR was calculated based on the geometric mean of the Genus Mean Acute Chronic Ratio (GMACR) from 4 of 4 species: cladoceran (Daphnia) and fathead minnow; both freshwater species; and mysid (Acanthomysis) and copepod (Eurytemora); both saltwater species.

Information on Salmonids. No GMACRs were available for salmonids.

Reference: "Water Quality Criteria; Ambient Water Quality Criteria; Notice of Ambient Water Quality Criteria Document for Tributyltin (TBT) and Request for Comments" (1997) 62 FR 42554; "Ambient Aquatic Life Water Quality Criteria—Tributyltin (Draft)" (1997) EPA-822-D-97-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

<u>Saltwater Acute (CMC)</u>
OR Criterion: none
EPA Criterion: 0.37 µg/L

Date Changed: 1997

Rationale for Change: This concentration was published by EPA in 1997 as a proposed criterion. Although EPA has yet to complete its response to comments, it continues to publish this concentration for States and Tribes to consider for adoption as a criterion. The FAV was based on the four most sensitive genera (out of 27):

4. Pacific oyster (Crassostrea);
3. copepod (Acartia);
2. mysid (Metamysidopsis); and
1. mysid (Acanthomysis)

Information on Salmonids. A Genus Mean Acute Value (GMAV) was available for Oncorhynchus (chinook salmon) (sensitivity rank=7).

Reference: "Water Quality Criteria; Ambient Water Quality Criteria; Notice of Ambient Water Quality Criteria Document for Tributyltin (TBT) and Request for Comments" (1997) 62 FR 42554; "Ambient Aquatic Life Water Quality Criteria—Tributyltin (Draft)" (1997) EPA-822-D-97-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

<u>Saltwater Chronic (CCC)</u>
OR Criterion: none
EPA Criterion: 0.01 µg/L

Date Changed: 1997

Rationale for Change: This concentration was published by EPA in 1997 as a proposed criterion. Although EPA has yet to complete its response to comments, it continues to publish this concentration for States and Tribes to consider for adoption as a criterion. There were insufficient data to calculate FCV using the 8 family procedure; therefore, the FCV was initially calculated by dividing FAV by FACR. However, because the resulting value was less than the concentrations at which some commercially or

ecologically important saltwater species show reductions in growth, the FCV was lowered to the above criterion in order to protect Acartia, Mercenaria, Crassostrea, and Ostrea from unacceptable impacts.

Information on Salmonids. No GMACRs were available for salmonids.

Reference: "Water Quality Criteria; Ambient Water Quality Criteria; Notice of Ambient Water Quality Criteria Document for Tributyltin (TBT) and Request for Comments" (1997) 62 FR 42554; "Ambient Aquatic Life Water Quality Criteria—Tributyltin (Draft)" (1997) EPA-822-D-97-001; "National Recommended Water Quality Criteria—Correction" (1999) EPA 822-Z-99-001.

Zinc

Freshwater Acute (CMC)
OR Criterion: 120 µg/L
EPA Criterion: 120 µg/L

note: These criteria are expressed as a function of hardness:

$$CMC = e^{(m_a[\ln(hardness)]+b_a)}$$

The values given here correspond to a hardness of 100 mg/L and are expressed as total recoverable concentration. The values for variables m_a (0.8473) and b_a (0.844) are provided in "National Recommended Water Quality Criteria—Correction"(1999).

Date Changed: 1995

Rationale for Change: New data from studies on cladoceran (1984; Daphnia magna) were analyzed and incorporated into the calculation of Final Acute Value (FAV). The FAV was based on the four most sensitive genera (out of 36):

4. cladoceran (Daphnia);
3. longfin dace (Agosia);
2. striped bass (Morone); and
1. cladoceran (Ceriodaphnia)

Information on Salmonids. Genus Mean Acute Values (GMAVs) were available for Oncorhynchus (rainbow trout, coho salmon, sockeye salmon, chinook salmon) (sensitivity rank=6); Salvelinus (brook trout) (14); and Salmo (Atlantic salmon) (15).

Note: No change in criterion.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.

Freshwater Chronic (CCC)
OR Criterion: 110 µg/L
EPA Criterion: 120 µg/L

note: These criteria are expressed as a function of hardness:

$$CCC = e^{(m_c[\ln(hardness)]+b_c)}$$

The values given here correspond to a hardness of 100 mg/L and are expressed as total recoverable concentration. The values for variables m_c (0.8473) and b_c (0.844) are provided in "National Recommended Water Quality Criteria—Correction" (1999).

Date Changed: 1995

Rationale for Change: No new data were available. There were insufficient data to calculate the Final Chronic Value (FCV) using the 8 family procedure; therefore, the FCV was calculated by dividing the FAV by the Final Acute Chronic Ratio (FACR)—the Genus Mean Acute Chronic Ratios (GMACRs) were excluded from resistant species. The FACR was calculated based on the geometric mean of the GMACRs from 3 of 7 species: rainbow trout, cladoceran (Daphnia), and chinook salmon; GMACRs were excluded from resistant species--flagfish, brook trout, and fathead minnow—as well as sockeye salmon which had a 'less than' value. This geometric mean was less than 2, which is not allowed in EPA procedures; therefore, the FACR was set to 2 in calculating the FCV.

Information on Salmonids. GMACRs were available for Oncorhynchus (rainbow trout, chinook salmon, sockeye salmon ('less than' value)); and Salvelinus (brook trout). EPA judged that the FCV did not need to be lowered to protect a commercially or recreationally important species.

Reference: "1995 Updates: Water Quality Criteria Documents for the Protection of Aquatic Life in Ambient Water" (1996) EPA-820-B-96-001.